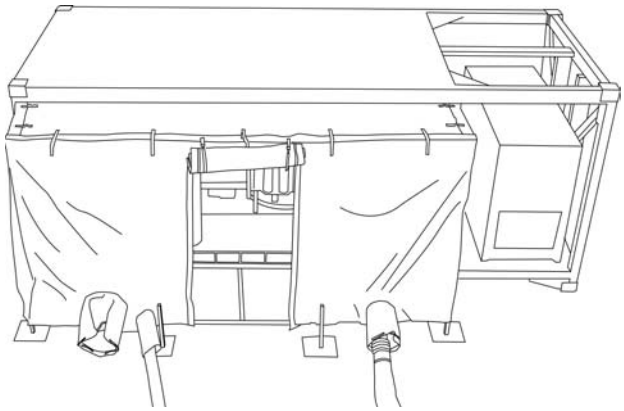
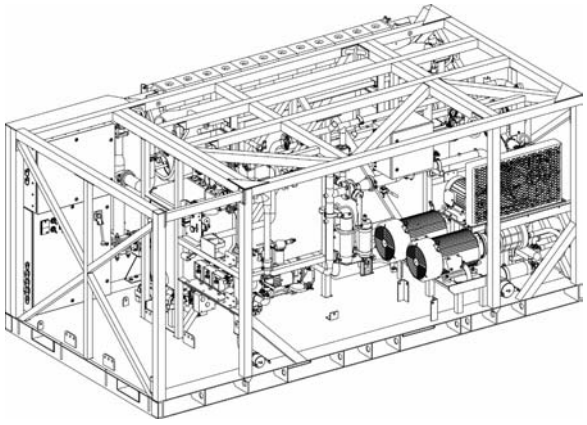
TECHNICAL MANUAL

OPERATOR, UNIT, AND DIRECT SUPPORT OPERATION AND MAINTENANCE MANUAL FOR TACTICAL WATER PURIFICATION SYSTEM (TWPS) ARMY NSN 4610-01-488-9656 MARINE CORPS NSN 4610-01-488-6961





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WARNING SUMMARY

This warning summary contains general safety warnings and hazardous materials warnings that must be understood and applied during operation and maintenance of this equipment. Failure to observe these warnings could result in serious injury or death to personnel.

WARNING

HOT SURFACES

The muffler/exhaust system may be hot. Do not touch the muffler/exhaust system if it is hot. Failure to observe this warning can result in burns.

WARNING

TWO PERSON LIFT

Two-person lift. Two persons must move the diesel engine assembly. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

WARNING

FIRE HAZARD

If the engine has been running, it may be hot enough to ignite fuel as it is drained from the fuel tank. Make sure that the engine and its parts are cool to the touch before draining fuel from the fuel tank. Failure to observe this warning can result in a fire.

WARNING

PROJECTILE HAZARD

If it is necessary to perform the next step, be sure to reinstall the retaining plate and nuts. If they are not reinstalled, the compression from the engine could cause the fuel injection valve to fly out forcefully and could result in injury.

WARNING

ELECTRICAL / MECHANICAL HAZARD

The pump motor must be turned off and disconnected from its source of electrical power in a specific order before performing maintenance on the pump. Failure to observe this warning may result in serious injury or death from electrocution or injury from moving parts.

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LIST OF EFFECTIVE PAGES/WORK PACKAGES

Date of issue for the original manual is:

Original . . . 0 . . . 1 May 2005

TOTAL NUMBER OF PAGES FOR FRONT AND REAR MATTER IS 26 AND TOTAL NUMBER OF WORK PACKAGES IS 84 CONSISTING OF THE FOLLOWING:

Page/WP No.	***Revision No.**
a	0
b blank	0
A	0
B blank	0
i – iv	0
WP 0001 00 - 0084 00	0
Glossary-1	0
Index-1	0

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WASHINGTON, DC
1 MAY 2005

TECHNICAL MANUAL

OPERATOR, UNIT, AND DIRECT SUPPORT OPERATION AND MAINTENANCE MANUAL FOR TACTICAL WATER PURIFICATION SYSTEM ARMY NSN 4610-01-488-9656 MARINE CORPS NSN 4610-01-488-6961

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (Recommended Changes to Equipment Technical Publications), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is http://aeps.ria.army.mil. If you need a password, scroll down and click on "ACCESS REQUEST FORM". The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS. Fill out the form and click on SUBMIT. Using this form on the AEPS will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax or E-mail your letter, DA Form 2028 direct to: Technical Publication Information Office, TACOM-RI, 1 Rock Island Arsenal, Rock Island, IL 61299-7630. The email address is TACOM-TECH-PUBS@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726.

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HOW TO USE THIS MANUAL

This manual contains general information, operating instructions, Preventive Maintenance Checks and Services (PMCS), and maintenance/repair instructions for the Tactical Water Purification System (TWPS).

Front matter consists of a warning summary, table of contents, and instructions on how to use this manual. A separate work package, 0001 00 contains general information on the TWPS equipment including maintenance forms, records, and reports; instructions for recommending equipment improvements; corrosion prevention and control; ozone depleting substances and procedures for material destruction to prevent enemy use. Chapter 1 provides a TWPS equipment description and theory of operation. Chapter 2 provides instructions for off-loading components from the TWPS platform and setting up the various components in preparation for TWPS operations. Chapter 3 contains Operator instructions for operating, cleaning, and preparing to move or store the TWPS equipment. Chapter 4 contains troubleshooting procedures. Chapter 5 contains Operator/Crew Maintenance procedures. Chapter 6 contains Unit Maintenance instructions. Chapter 7 contains Direct Support maintenance procedures. Chapter 8 contains the Maintenance Allocation Chart (MAC), lists of Expendable and Durable Items, tools and other supporting information. Rear matter consists of the alphabetical index, DA Form 2028 and authentication page, and back cover.

Manual Organization and Page Numbering

This manual is divided into eight major chapters that detail the topics mentioned above. Within each chapter are work packages covering a wide range of topics. Each work package is numbered sequentially starting at page 1, and has its own page numbering scheme that is independent of the page numbering used by other work packages. Each page of a work package has a page number of the form “XXXX YY-ZZ”, where “XXXX YY” is the work package number (e.g. 0010 00 is work package 10) and “ZZ” represents the number of the page within that work package. A page number such as “0010 00-1/2 Blank” means that page 1 of that work package contains information but page 2 has been intentionally left blank.

Finding Information

The Table of Contents permits the reader to quickly find information in the manual. The reader should start here first when looking for a specific topic. The Table of Contents lists the topics contained within each chapter and the work package sequence number where it can be found. The index, located at the back of the manual, lists topics in alphabetical order and identifies the work packages where the information is located.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) GENERAL INFORMATION

0001 00

SCOPE

Equipment Covered

This technical manual contains instructions for the operation, preventive maintenance, Operator, Unit and Direct Support corrective maintenance for the 1500 Tactical Water Purification System (TWPS) and its associated equipment for both the Army version (A-TWPS) and the Marine Corps version (MC-TWPS).

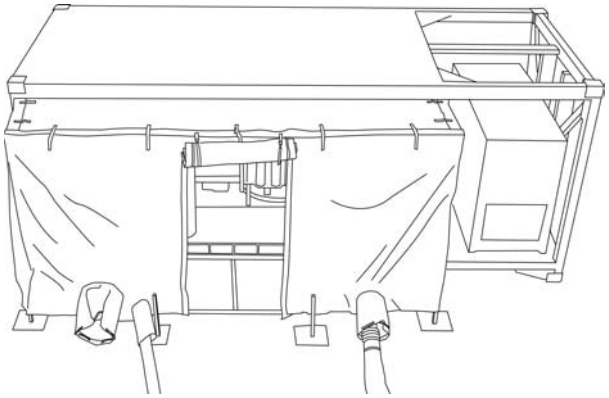

Figure 1. Army Tactical Water Purification System (A-TWPS).

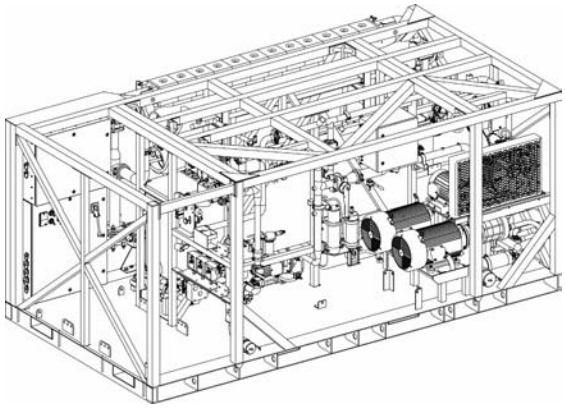

Figure 2. Marine Corps Tactical Water Purification System (MC-TWPS).

Type of Manual

Two-volume Operator's, Unit and Direct Support Operation and Maintenance Manual. The Repair Parts and Special Tools List is included in a separate manual, TM 10-4610-309-24P (Army) and TM 10802A-24P/2 (Marine Corps).

Equipment Name and Model Number

Tactical Water Purification System. This manual covers two models:

- A-TWPS, NSN 4610-01-488-9656
- MC-TWPS, NSN 4610-01-488-6961

TACTICAL WATER PURIFICATION SYSTEM (TWPS) GENERAL INFORMATION

0001 00

The information in this manual applies to both models. When information applies to only one model or the other, a statement similar to “A-TWPS ONLY” or “MC-TWPS ONLY” is placed with the applicable statement.

Purpose of Equipment

The 1500 Gallons Per Hour (GPH) Tactical Water Purification System (1500 TWPS) is a fully contained mobile water purification system capable of purifying, storing, and dispensing water meeting Tri-Service Field Water Quality Standards for long term consumption. The TWPS is intended to supply potable water to ground, amphibious and air-mobile units of the U.S. Army and Marine Corps. It can also be used to provide potable water support to civilian agencies or host nations for emergencies, disaster relief, humanitarian efforts, and peacekeeping missions.

The TWPS can produce drinking water from a broad range of water sources including:

- Fresh water containing dirt (suspended solids) and micro-organisms
- Brackish water containing dirt, micro-organisms and salt
- Seawater containing dirt, micro-organisms and a high concentration of salt
- Freshwater containing nuclear, biological, or chemical warfare (NBC) agents.

MAINTENANCE FORMS, RECORDS, REPORTS

Department of the Army forms and procedures used for the equipment maintenance will be those prescribed by DA PAM 738-750, The Army Maintenance Management System.

REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your TWPS needs improvement let us know. Send us an EIR. You, the user, are the only one who can tell us what you don’t like about your equipment. Let us know why you don’t like the design or performance. Put it on a SF 268 (Product Quality Deficiency Report). Mail it to the address specified in DA PAM 738-750, Functional Users Manual for the Army Maintenance Management System (TAMMS), or as specified by the acquiring activity. We will send you a reply.

CORROSION PREVENTION AND CONTROL (CPC)

Corrosion Prevention and Control (CPC) of Army material is a continuing concern. It is important that any corrosion problems with this item be reported so that the problem can be corrected and improvements can be made to prevent the problem in future items.

While corrosion is typically associated with rusting of metals, it can also include deterioration of other material, such as rubber and plastic. Unusual cracking, softening, swelling, or breaking of these materials may be a corrosion problem.

If a corrosion problem is identified, it can be reported using SF 368, Product Quality Deficiency Report. Use of key words such as “corrosion”, “rust”, “deterioration”, or “cracking” will ensure that the information is identified as a CPC problem. The form should be submitted to the address specified in DA PAM 738-750, Functional Users Manual for the Army Maintenance Management System (TAMMS).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) GENERAL INFORMATION

0001 00

OZONE DEPLETING SUBSTANCES (ODS)

The continued use of ODS has been prohibited by Executive Order 12856 of 3 August 1993. The use of ODS in Army IETMs is prohibited. A listing of these substances will be provided by the acquiring activity.

DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE

For general destruction procedures for this equipment, refer to TM 750 224-3, Procedures for Destruction of Equipment to Prevent Enemy Use.

PREPARATION FOR STORAGE OR SHIPMENT

Refer to work packages 0028 through 0032 of this manual for preparation for movement and preparation for storage instructions.

WARRANTY INFORMATION

Refer to the Warranty Terms and Procedure included at the back of this manual.

LIST OF ABBREVIATIONS/ACRONYMS

The following abbreviations/acronyms are used in this manual:

TERM	DEFINITION	TERM	DEFINITION
AC	Alternating Current	NSN	National Stock Number
amp	ampere	OISS	Ocean Intake Structure System
BII	Basic Issue Item	OCP	Operator Control Panel
CAGEC	Commercial and Government Entity Code	ODS	Ozone Depleting Substances
		OM	Operator Maintenance
COEI	Components of End Item	PDP	Power Distribution Panel
CPC	Corrosion Prevention and Control	PLC	Programmable Logic Controller
DC	Direct Current	PMCS	Preventive Maintenance Checks and Services
DS	Direct Support		
EIR	Equipment Improvement Recommendation	P/N	Part Number
		psig	pounds per square inch gauge
ft.	foot, feet	Qty	Quantity
gal.	gallon (U.S.)	RO	Reverse Osmosis
gpm	gallons per minute	RPSTL	Repair Parts & Special Tools List
HP	High Pressure	TDS	Total Dissolve Solids
in.	inch, inches	TQG	Tactical Quiet Generator
lb.	pound	TWPS	Tactical Water Purification System
MAC	Maintenance Allocation Chart	UM	Unit Maintenance
MF	Micro-Filtration or Micro-Filter	v	Volts
NBC	Nuclear, Biological, and Chemical		

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0002 00**
DESCRIPTION AND THEORY OF OPERATION
EQUIPMENT DESCRIPTION AND DATA

EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

The 1500 Gallons Per Hour (GPH) Tactical Water Purification System (1500 TWPS) is a fully contained mobile water purification system capable of purifying, storing, and dispensing water meeting Tri-Service Field Water Quality Standards for long term consumption. The TWPS is intended to supply potable water to ground, amphibious and air-mobile units of the U.S. Army and Marine Corps. It can also be used to provide potable water support to civilian agencies or host nations for emergencies, disaster relief, humanitarian efforts, and peacekeeping missions.

The TWPS can produce drinking water from a broad range of water sources including:

- Fresh water containing dirt (suspended solids) and micro-organisms
- Brackish water containing dirt, micro-organisms and salt
- Seawater containing dirt, micro-organisms and a high concentration of salt
- Freshwater containing nuclear, biological, or chemical warfare (NBC) agents.

The TWPS is designed to produce as much as 1500 gallons per hour (25 GPM) of potable water from a fresh or brackish water source and 1200 gallons per hour (20 GPM) from a seawater source. The TWPS design point of reference is 1500 GPH of potable water from a fresh or brackish water source at 50 degrees F that contains up to 5,000 mg/l TDS (total dissolved solids), and 1200 GPH from a seawater source at 50 degrees F that contains 45,000 mg/l TDS. Because water production is a function of water temperature and the type of water being processed, water production will vary with the characteristics of the water source. A summary of production performance with various raw water sources is shown in Table 1.

Table 1. TWPS Water Production Performance Characteristics.

RAW WATER CHARACTERISTICS			POTABLE WATER PRODUCTION (normal)
Source	**Composition**	**Temperature**	
Surface water	Up to 20,000 mg/l TDS and up to 150 NTU	32 to 95° F	1500 GPH
Ground water	Up to 2500 mg/l TDS	32 to 95° F	1500 GPH
Ground water	Over 2500 mg/l TDS and up to 150 NTU	50 to 95° F	1200 GPH
Seawater	35,000 mg/l TDS	32 to 95° F	1200 GPH
Seawater	45,000 mg/l TDS	50 to 95° F	1200 GPH
Seawater	45,000 mg/l TDS	32 to 50° F	1000 GPH
Seawater	60,000 mg/l TDS	77° F	950 GPH

The TWPS is fielded in two versions: a Marine Corps version designated MC-TWPS and an Army version designated A-TWPS.

MC-TWPS

The MC-TWPS (shown packed out for deployment in Figure 1) is a basic skid-mounted unit with all BII and a 6,000-gallon water storage and distribution capability. The MC-TWPS may be powered by a 60 kW Tactical Quiet Generator (TQG), NSN 6115-01-274-7390, or a power distribution grid. It is capable of transport by the MTVR truck, (MK23 or MK 25, NSN: 2320-01-465-2174, NSN: 2320-01-465-2176). Forklift pockets and weight allow handling with the standard 5-ton forklift. The MC-TWPS is typically transported with its General Purpose Cover installed (see Figure 2). Roof support sheets are installed on top of the TWPS under the cover to prevent the cover from sagging from accumulations of rain or snow.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0002 00**
DESCRIPTION AND THEORY OF OPERATION
EQUIPMENT DESCRIPTION AND DATA

WARNING

Do not walk on the roof support sheets. They are not designed to support the weight of a person. Failure to observe this warning may result in injury or damage to equipment.

For helicopter transportation, the General Purpose Cover and roof support sheets are removed and cargo nets are installed (see Figure 3).

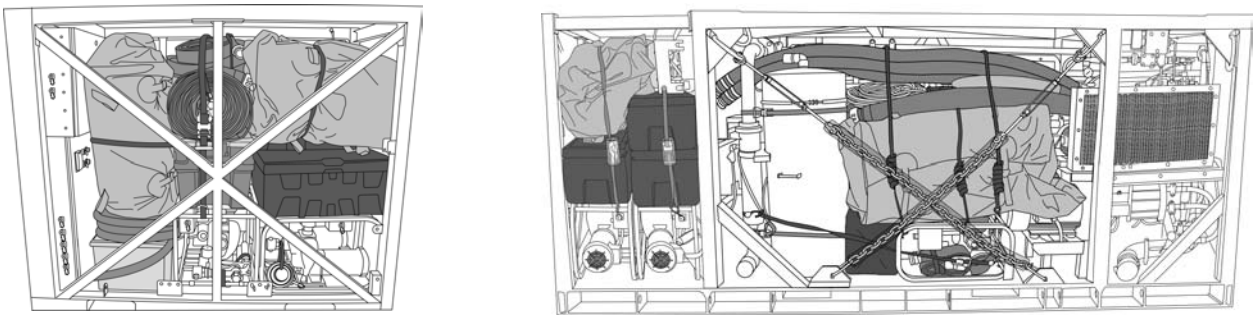

Figure 1. Left End and Front Views of the MC-TWPS Packed Out.

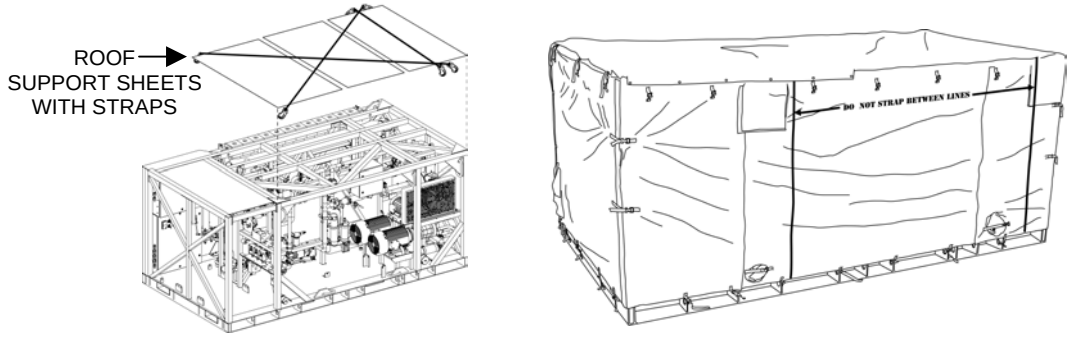

Figure 2. MC-TWPS with Roof Support Sheets and General Purpose Cover Installed.

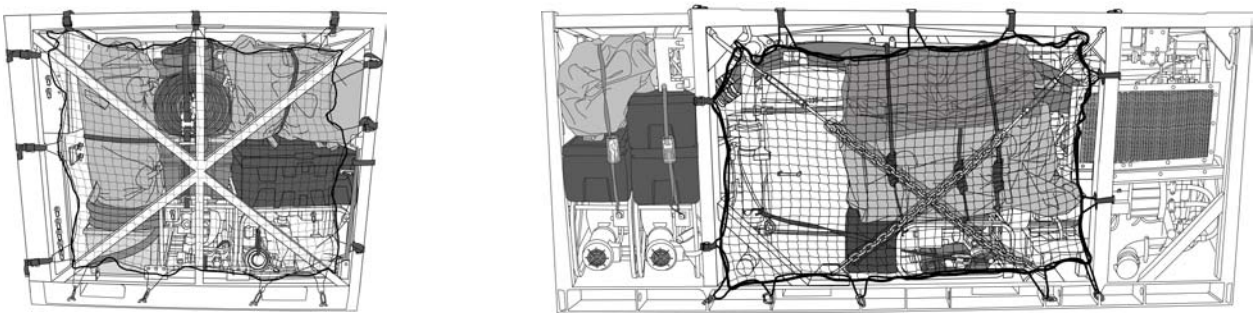

Figure 3. Left End and Front Views of MC-TWPS with Cargo Nets Installed.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0002 00**
DESCRIPTION AND THEORY OF OPERATION
EQUIPMENT DESCRIPTION AND DATA

The MC-TWPS General Purpose Cover is a single piece, water-proof, fabric covering that can be used during deployment to shield the equipment from precipitation and blowing dust and sand (see Figure 4). Straps inside and outside the cover are used to secure the cover to the TWPS frame. Zippered and hook and loop seams at the four corners and in two locations at the front (1) make it possible to separate and roll up and secure individual wall panels for access or ventilation. By releasing snaps and straps around the top of the cover over the operator station, the top can be expanded at that end so that a roof over the operator station can be raised without removing the cover. Sleeves with a hook and loop seam and cinch cord are incorporated to provide access for connecting power cables (2) and inlet (3) and discharge (4) hoses to the TWPS. Hook and loop panels are incorporated to provide access to four rail transport tie-down rings (5). A fifth panel (6) provides access to lift and tie-down instruction plates.

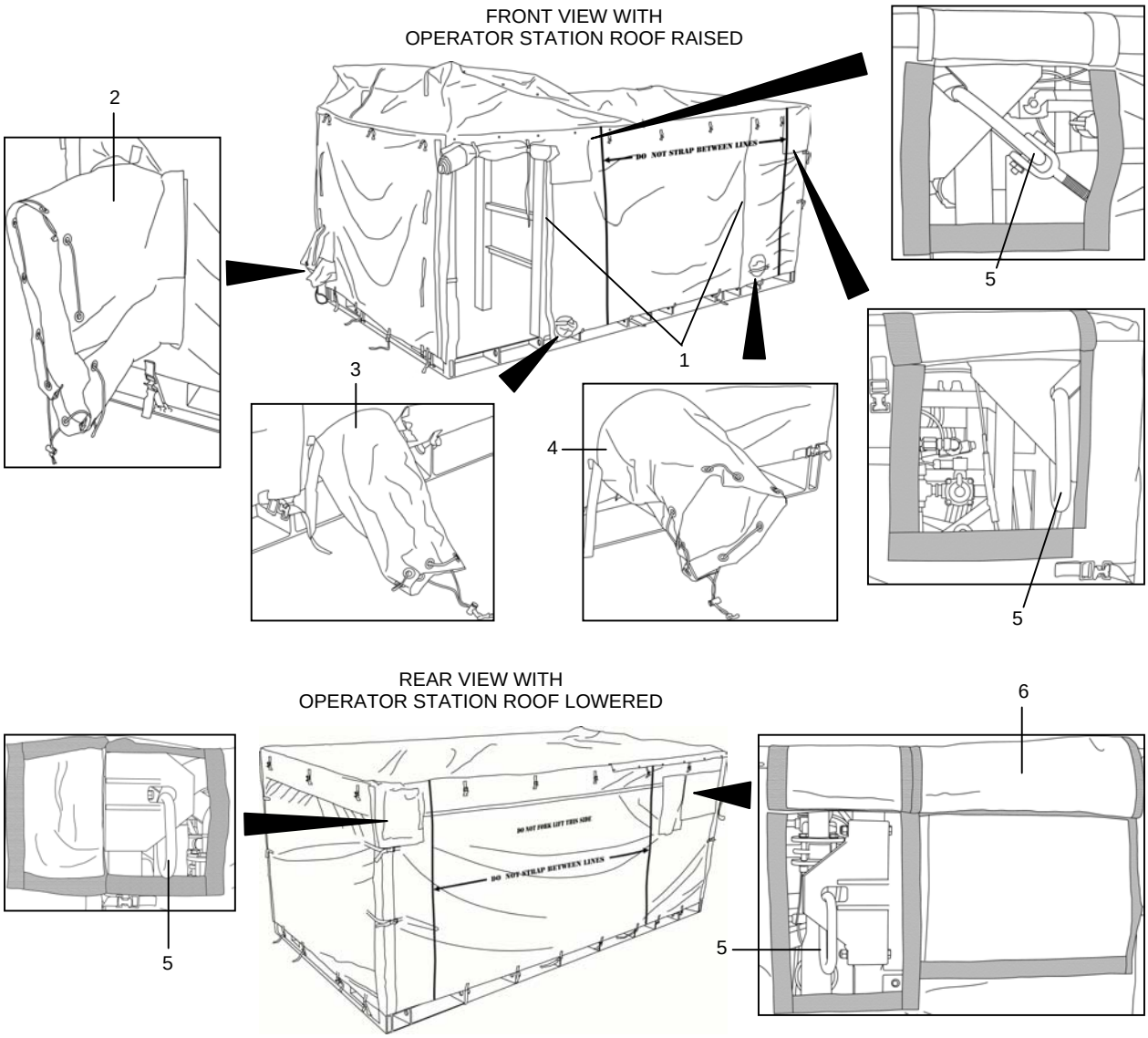

Figure 4. MC-TWPS General Purpose Cover.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0002 00**
DESCRIPTION AND THEORY OF OPERATION
EQUIPMENT DESCRIPTION AND DATA

Five extended capability modules are available for issue and deployment separately as required by the mission profile. The five extended capability Marine Corps modules are:

- **Cold Weather Module:** deployed for operating environments below 32 ^{0}F.
- **Supplemental Cleaning Waste Storage Module**: used to temporarily store the wastes that result from cleaning the micro-filters (MF) and the reverse osmosis (RO) elements.
- **Ocean Intake Structure System (OISS) Module**: deployed at beach locations that are exposed to wave action and at ocean locations with significant tidal variations.
- **NBC Water Treatment Module:** contains the filter media required for final treatment of a raw water source that is contaminated with nuclear, biological or chemical warfare agents.
- **NBC Survivability Module:** contains a contamination avoidance cover (CAC) to protect the TWPS from NBC agent contamination.

The components of each of the five extended capability modules are identified near the end of this work package.

A-TWPS

The A-TWPS (shown packed out for deployment closed and open in Figure 5) is mounted within an 8 x 8 x 20 ISO load handling shelter that is referred to as the “flat rack”. The A-TWPS includes the basic TWPS skid, all BII, all of the features provided by the five extended capability modules described for the Marine Corps version, a 60 kW Tactical Quiet Generator (TQG) NSN 6115-01-274-7390 and an extended distribution kit. The extended distribution kit makes it possible to increase potable water storage capacity from the standard 6,000 gallons to a total capacity of 15,000 gallons and increase total distribution flow from 125 gpm through two nozzles to 250 gpm through four nozzles. The A-TWPS is compatible with the PLS truck (M1074, M1075), HEMTT LHS truck (M1120), and PLS trailer (M1076) for transport.

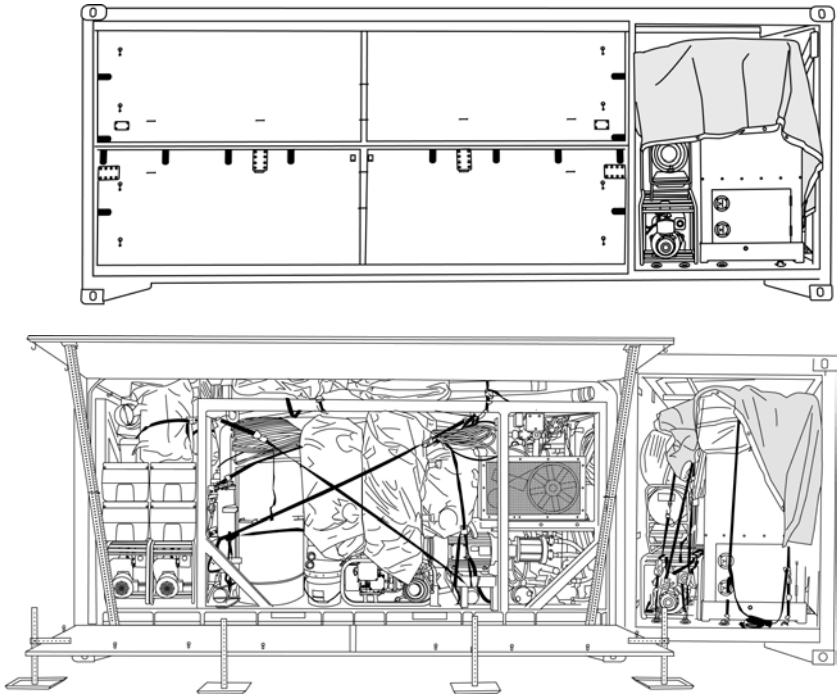

Figure 5. A-TWPS Packed Out for Deployment.

A-TWPS Flat Rack and Fabric Wall

The A-TWPS flat rack (see Figure 6) has two panels in front that are opened during deployment. When opened, the top panel serves as a roof / overhang (1) and the bottom panel serves as a floor (2). Two panels at both ends of the flat rack (3 through 6) and three panels at the back (7 through 9) are removable for access or ventilation. Hinged doors in three of the panels allow easy access for connecting power cables (10) or for operating valves (11, 12). A shipping cover with hook and loop material (13) is secured over the opening below the product water access door (11) to keep the elements out during storage. A return air cover plate (14) in one of the left end panels can be removed when needed during cold weather so that a cold air return duct in the heating system can be hooked up to the panel. Folding steps (15) are incorporated in the back panel closest to the TQG area for access to the top of the flat rack. Two rollers (16) are stored at the TQG end of the flat rack near a bail bar (17). The rollers are installed at the opposite end of the flat rack when loading the flat rack onto an MTVR trailer. The bail bar is used to lift and pull the flat rack onto an MTVR.

The A-TWPS is equipped with a single piece, waterproof, fabric wall (18) that can be installed around the front of the open TWPS to shield the operator and the equipment from the weather. Straps and hook and loop material are used to secure the fabric wall to the opened top and floor panels of the flat rack. A zippered and hook and loop door (19) is provided at the front of the fabric wall for easy access. Sleeves with a Hook and looped seam and a cinch cord are incorporated to provide access for connecting a hot air duct (20) and inlet (21) and discharge (22) hoses to the TWPS.

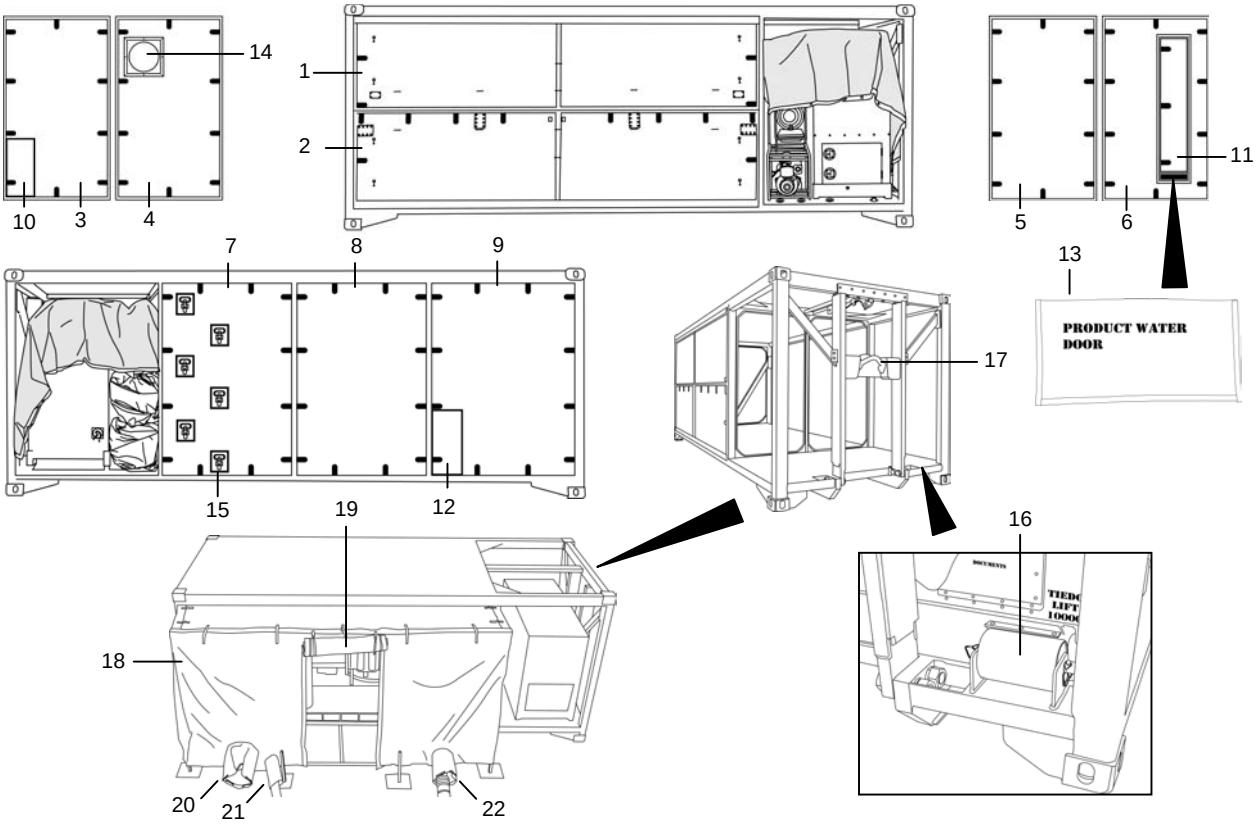

Figure 6. A-TWPS Flat Rack and Fabric Wall.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0002 00**
DESCRIPTION AND THEORY OF OPERATION
EQUIPMENT DESCRIPTION AND DATA

LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

Both the MC-TWPS and the A-TWPS versions are a fully contained mobile water purification system consisting of the following systems and extended capability kits:

Raw Water Supply System (see Figure 7)

The raw water system draws water from a lake, river, ocean or other raw water source and discharges it into a storage tank called the MF feed tank. The raw water system includes the following major components (listed in the general flow sequence through the system):

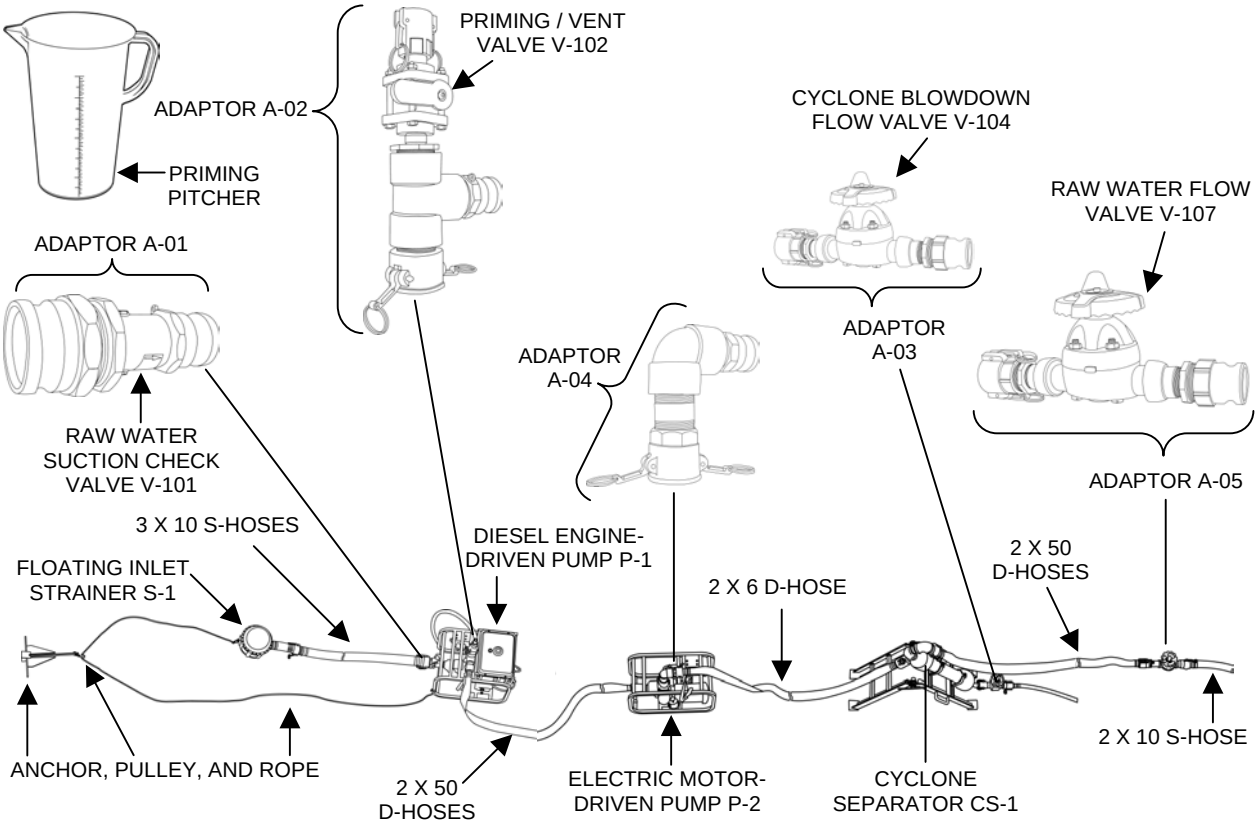

Figure 7. Major Components of the Raw Water Supply System.

- **Floating Inlet Strainer FS-1.** Holds the raw water intake hose off the bottom of the water source and screens out leaves, sticks, fish, and other large objects. It is connected by sections of rigid suction hose to the raw water pump.
- **Anchor, pulley and rope system**. Used to deploy the floating inlet strainer and hold it in place.
- **Thirteen sections of 3-in., 10-ft. long green-banded suction hose**. These are the raw water intake hoses. These hoses deliver raw water from the inlet strainer to the raw water pump. The number of hose sections used depends on site conditions.

- **Diesel Engine Driven Raw Water Pump P-1.** In normal deployment, Raw Water Pump P-1 draws water through the intake strainer and discharges it to the suction side of an Electric Motor-Driven Raw Water Pump P-2. The Diesel Engine-Driven Pump P-1 is not normally used if the Electric Motor-Driven Pump P-2 has the capacity required to draw water from the source. When the P-1 pump is needed, it is deployed first, between the floating inlet strainer and the P-2 pump. With proper adapters, the Diesel Engine-Driven Pump P-1 may be used in the product water distribution system in place of the distribution pump.
- **Electric Motor-Driven Raw Water Pump P-2.** The length of the P-2 pump power cable limits the deployment of the P-2 pump to within 100 ft. of the TWPS. The Electric Motor-Driven Pump P-2 can be used alone as long as it is within 100 ft. of the skid and not more than 25 ft. in elevation below the TWPS skid. Otherwise, the Electric Motor-Driven P-2 Pump is used together with the Diesel Engine-Driven P-1 Pump. When both the P-1 and P2 pumps are deployed, the P-1 pump is installed closest to the raw water source and between the raw water source and the P-2 pump. With proper adapters, the Electric Motor-Driven Pump P-2 can be used in the product water distribution system in place of the distribution pump.
- **Adaptor A-01.** Connects the 3-in. suction hose to the 2-in. inlet of the first raw water pump. Raw Water Suction Check Valve V-101 is a part of Adaptor A-01. The check valve helps hold the prime of the first raw water pump when the pump is stopped.
- **Adaptor A-02.** Connects the 2-in. outlet of the first pump to a 2-in. discharge hose through the tee section of the adaptor. Priming/Vent Valve V-102 and a priming discharge hose are located at the top of the adaptor.
- **Priming Pitcher.** Used to prime the first raw water pump. The water is poured through Priming/Vent Valve V-102.
- **Adaptor A-04**. Connects the 2-in. discharge of the second raw water pump (if used) to a 2-in. discharge hose. The adaptor provides a 90-degree discharge.
- **Cyclone Separator CS-1.** Used at beach locations when the ocean intake structure system is not deployed (refer to **Ocean Intake Structure System Kit**). Sand and heavy dirt may be picked up through the floating inlet strainer with the raw water at beach locations due to wave action. The cyclone separator uses centrifugal water flow action to remove the sand and heavy dirt from the raw water and discharges the sand with some water through a waste flow drain. Both raw water pumps P-1 and P-2 are deployed when using the cyclone separator. The cyclone separator is installed at the outlet of the second raw water pump P-2.
- **Adaptor A-03**. Connected to the cyclone separator drain. Cyclone Blowdown Flow Valve V-104 on Adaptor A-03 is used to control the flow of the wastewater that carries the sand out of the cyclone.
- **One 2-in., 6-ft. long green-banded discharge hose**. Delivers raw water from the second raw water pump P-2 outlet to the inlet of the cyclone separator.
- **Four 2-in., 50-ft. long green-banded discharge hose sections**. As many of the four hoses are used as needed to deliver raw water from raw water pump P-1 to raw water pump P-2 and from the discharge of the last raw water pump (or the cyclone separator if used) to Adaptor A-05.
- **Adaptor A-05**. Connects the end of the last 2-in., 50-ft. long green-banded discharge hose to a 2-in. x 10-ft suction hose. It includes Raw Water Flow Valve V-107.
- **One 2-in., 10-ft. green-banded section of rigid suction hose.** Discharges raw water from Adaptor A-05 into the top of the MF feed tank (see Figure 8 for MF feed tank).

Micro-Filtration System

The micro-filtration system filters the raw water to remove suspended solids and micro-organisms. At regular intervals the filter portion of the micro-filtration system is automatically backwashed to remove the solids and micro-organisms from the filter and discharge it through a waste out hose back to the raw water source. The micro-filtration system includes the following major components (listed in the general flow sequence through the system):

MF System: MF Feed Tank to TWPS Skid (see Figure 8)

- **MF Feed Tank T-1**. A 1000-gallon collapsible tank to hold a sufficient reserve of raw water to support regular, automatic filter backwash operations.
- **MF Feed Tank Bag Filter S-1**. A cloth mesh filter bag that fits inside the MF feed tank and prevents seaweed, algae and other larger material from being drawn out of the tank with the raw water. Two spare filters are provided in the BII. Water drawn from the MF feed tank is referred to as “MF feed water”.
- **Tripod Assembly**. Supports the 2x10 hose that delivers water to the MF feed tank so that the hose does not push down on and collapse the tank.
- **MF Feed Pump P-3**. An electric motor-driven pump that is used to draw water from the MF feed tank and deliver it to the TWPS skid. The pump is deployed off of the TWPS skid near the MF feed tank.
- **One 3-in., 3-ft. long suction hose**. Connects the MF feed tank to the MF Feed Pump P-3.
- **Two 3-in., 10-ft. long discharge hose**. Connect the MF Feed Pump P-3 discharge to the TWPS skid connection at Basket Strainer S-2 (see Figure 9 for Basket Strainer S-2).

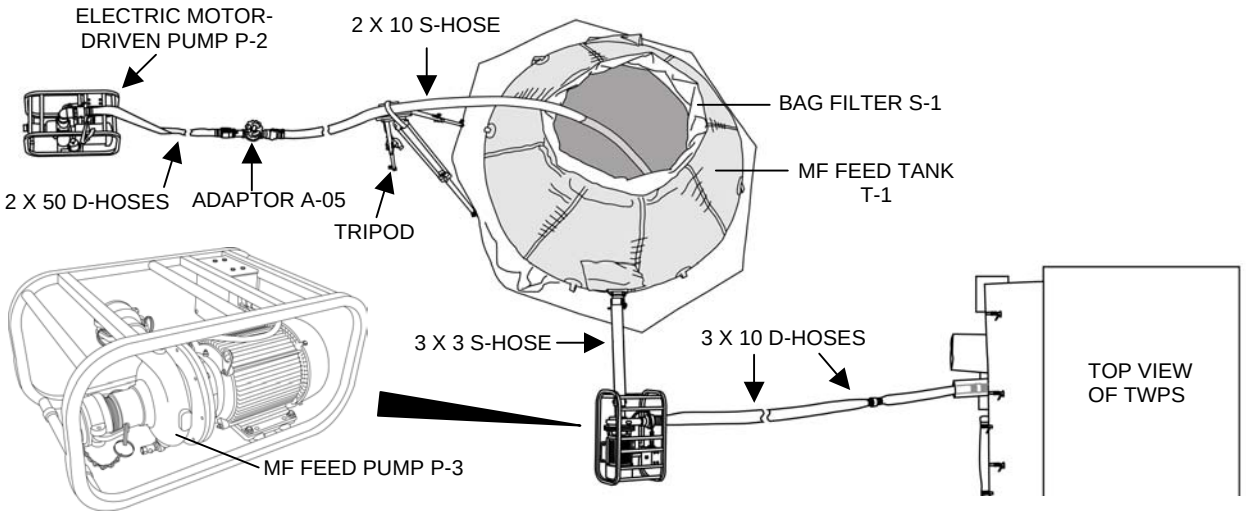

Figure 8. MF System: MF Feed Tank to TWPS Skid.

MF System: Strainer S-2 to MF Modules (see Figure 9)

- **Basket Strainer S-2**. Removes material larger than 600 microns from the MF feed water. The internal basket is removed for cleaning.
- **Drain Valve V-109**. Basket Strainer S-2 drain valve.

- **Vent/Sample Valve V-110**. Used to vent the pipe run above the basket strainer when draining the strainer. Also used as a sample valve for measuring the raw water conductivity.
- **MF Main Feed Valve V-111**. Operates automatically to prevent feed water from flowing back into the MF feed tank when the MF filters are backwashed (during the backwash cycle).
- **Pressure Gauge PI-101**. Measures pressure of the MF feed supplied to the micro-filter (MF) assembly. The pressure indication is for operator reference.
- **Flow Element FE-101 and Flow Transmitter FT-101**. (FT-101 is not shown in Figure 9. It is located in the instrument/solenoid panel box shown in Figure 23). FE-101 and FT-101 measure the MF flow (feed flow to the MF assembly when filtering, backwash flow to the MF assembly during backwash). This flow is displayed at the operator control panel (OCP).
- **Upper Feed Valve V-112 and Lower Feed Valve V-113.** The two valves open and close automatically as required to direct the flow of MF feed water to the MF filter assembly during normal filtering operation and during backwash operations.
- **Pressure Transmitter PT-101.** Measures feed pressure to the Microfiltration Assembly.
- **Micro-Filtration (MF) Assembly.** Consists of 12 parallel filter modules, MF-1 through MF-12, that remove suspended solids and microorganisms from the MF feed water. Each filter module contains a filter element that is composed of a bundle of hollow, porous fibers. MF feed water enters the MF assembly, passes through the porous wall of each fiber, and exits the hollow core of each fiber as filtrate (filtered MF feed water). The suspended solids and microorganisms that accumulate on the fibers are removed from the fibers during regular automatic backwashes.
- **Check Valve V-911.** Allows 15 psig air into the MF Assembly to drain the MF fibers just before backwash and for drain-down. Prevents water from backflowing into the air system.
- **MF Vent Valve V-114.** Vents the MF Assembly during cleaning stages and TWPS shut-down.

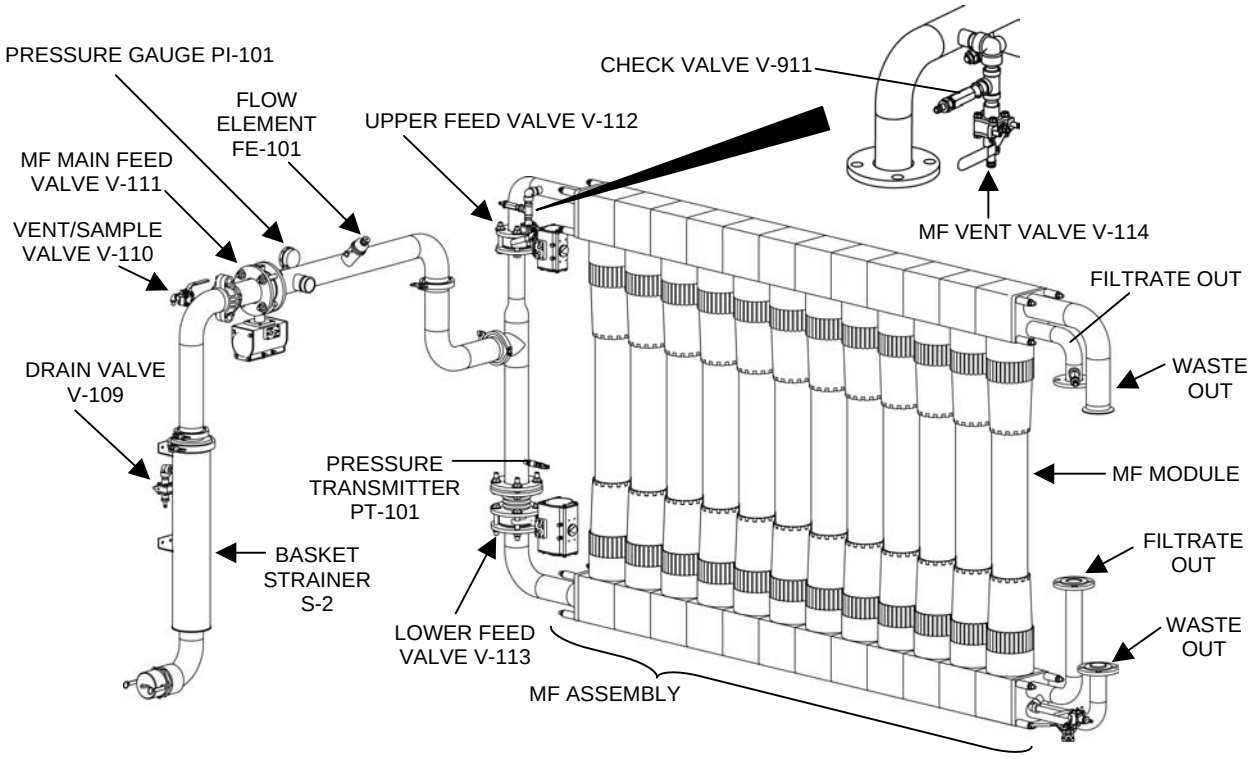

Figure 9. MF System: Strainer S-2 to MF Modules.

MF System: MF Modules to Discharge to RO Feed Tank (see Figure 10)

- **Upper Filtrate Outlet Valve V-201.** V-201 is open during normal filtering operation and is actuated closed or open as required during backwash operations.
- **Filtrate Flow Control Valve V-202.** Controls the filtrate flow to the RO feed tank during normal filtering operation and closes or opens as required during backwash operations.
- **Pressure Transmitter PT-102.** Measures filtrate pressure. The difference between the feed pressure measured by PT-101 (Figure 9) and the filtrate pressure is the trans-membrane pressure (TMP; pressure drop across the membranes, or filter element fibers, of the MF assembly). TMP (pressure drop) is displayed at the operator control panel (OCP) and is an indication of how porous (or how clogged) the fibers are. A high TMP indicates that the MF fibers are becoming clogged with material and need to be cleaned.
- **MF Filtrate Pressure Gauge PI-201.** Measures the filtrate pressure in the line between the micro-filter (MF) assembly and the RO feed tank. The pressure indication is for operator reference. The operator can compare the PI-101 feed pressure gauge reading with the PI-201 filtrate pressure gauge reading as a manual check against the TMP that is measured automatically by Pressure Transmitters PT-101 and PT-102.
- **Check Valve V-912.** Allows 15 psig air into the MF Assembly to drain the MF fibers just before backwash and for drain-down. Allows 100 psig air into the MF Assembly to backwash the MF fibers. Prevents water from backflowing into the air system.
- **MF Filtrate Sample/Drain Valve V-204.** Used to sample filtrate and as a drain.
- **MF Filtrate Drain Valve V-203.** Used to drain the filtrate channels of the MF Assembly.

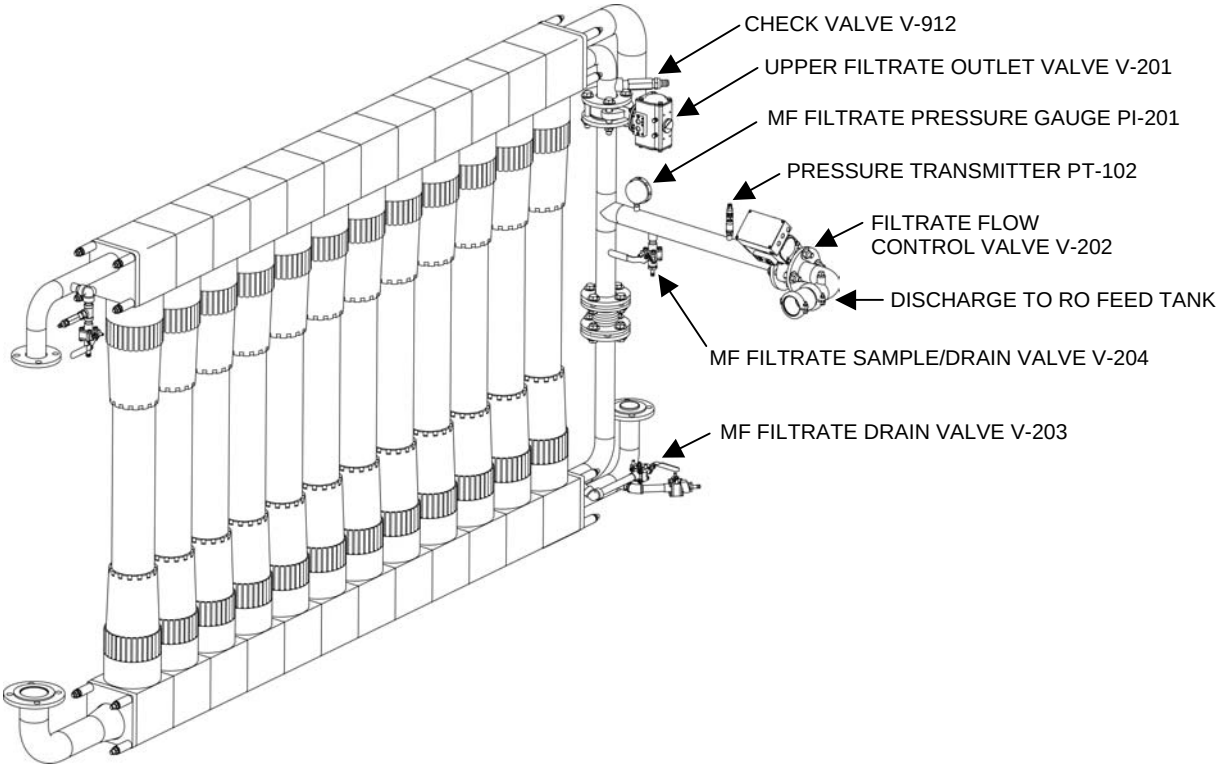

Figure 10. MF System: MF Modules to Discharge to RO Feed Tank.

MF System: MF Modules to Waste Outlet (see Figure 11 and Figure 12)

- **Shell Backwash Upper Outlet Valve V-401.** Opens to discharge the backwash flow from the upper shell of the MF Assembly.
- **Shell Backwash Lower Outlet Valve V-402.** Opens for the air pressure pulse during backwash and when draining the MF.
- **Rupture Disk RD-401.** Rated for 75 psig. The backwash operation creates a sudden and very high velocity surge in the waste out piping and hose. In the event that the waste out hoses are blocked in any manner, the rupture disk will rupture when pressure exceeds 75 psig to release the pressure and protect the TWPS equipment.
- **MF Shell Drain Valve V-403.** Used to drain the shell/waste outlet channels of the MF Assembly.

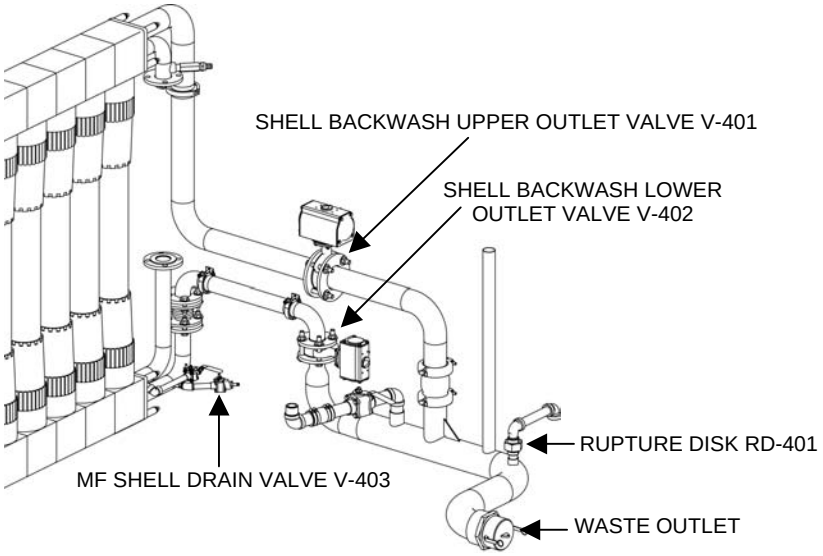

Figure 11. MF System: MF Modules to Waste Outlet.

- **One 4-in., 5-ft. long rigid suction hose**. Connects to the waste outlet on the TWPS skid and discharges the backwash flow and RO reject off the TWPS unit.
- **Adaptor A-09**. Connects the 4-in. diameter waste out suction hose to a 6-in. diameter flexible waste out discharge hose.
- **One 6-in., 50-ft. long discharge hose**. Discharges the backwash flow and RO reject away from the TWPS.

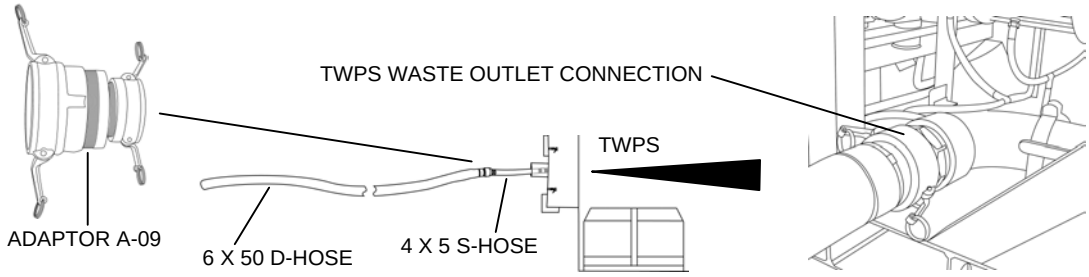

Figure 12. TWPS Waste Discharge.

Reverse Osmosis (RO) System

The MF filtrate becomes the RO feed water. The RO feed water is pressurized in the RO system to flow through the RO elements. A portion of the feed water passes through the RO membranes and is collected as product water that contains only a small amount of dissolved salts (total dissolved solids, TDS). Most of the salts do not pass through the membranes. The remaining water and the salts that do not pass through the RO membranes are called “reject”. The reject water is discharged through the waste out hoses back to the raw water source. The reverse osmosis system includes the following major components (listed in the general flow sequence through the system):

RO System: RO Feed Tank to High Pressure Pumps (see Figure 13)

- **RO Feed Tank T-2**. Stores a sufficient supply of filtrate (for RO feed water) to allow the production of product water to continue uninterrupted during the intervals when the MF modules are being backwashed. Also used for cleaning solutions when cleaning the RO and MF assemblies.
- **Tank Heaters H-1 and H-2**. Submersible heating elements used for heating cleaning solutions and, if needed, to provide added generator load to avoid wet stacking during normal operation. (Wet stacking is the collection of condensation in the generator exhaust system that can occur when operated at low loads. Wet stacking over a period of time can corrode the generator exhaust system.)
- **Temperature Indicator TI-202**. A dial thermometer that indicates the temperature of the fluid inside the RO feed tank. Used primarily for certain cleaning procedures.
- **RO Feed Tank Main Drain Valve V-412 and Auxiliary Drain Valve V-210.** Used to drain the tank.
- **Level Transmitter LT-201**. Provides a level measurement that is used by a PLC to control the level in the RO feed tank.
- **RO Feed Tank Pump Inlet Strainer S-3**. A removable, coarse strainer that is positioned inside the RO feed tank over the tank outlet to the RO feed pump P-4 suction. This strainer prevents coarse objects, which may fall into the tank, from entering the pump.
- **RO Feed Pump P-4.** Draws RO feed water from the RO feed tank and provides the pressure needed by the HP (high pressure) pumps. This pump also circulates the cleaning solutions used when cleaning either of the MF or RO systems.
- **Antiscalant Injection Check Valve V-623.** Injection point for an antiscalant chemical solution that inhibits salt scale formation on the RO membranes.
- **RO Feed Temperature Transmitter TT-201**. Provides a temperature measurement that is used by the PLC to indicate when the feed water temperature exceeds 110° F and to indicate if the RO feed tank heaters are turned off during cleaning.
- **High Pressure Pump Feed Valve V-212.** Used for various cleaning and maintenance procedures.
- **Inline Strainer S-4 and Drain Valve V-213.** Protects the HP pumps. Catches sand and dirt that may have entered the RO feed tank before it reached the HP pumps.
- **RO Feed Pressure Gauge PI-202**. Indicates the pressure from the RO feed pump. Usual pressure is 40 to 45 psig.
- **RO Feed Pressure Transmitter PT-201.** Provides a pressure measurement that is used by the PLC to shut down the HP pumps when the pressure from the RO feed pump drops below 35 psig.
- **High Pressure Pump (HPP) Inlet Drain Valve V-214.** Used to drain water from the HPP inlet pipes and hoses.

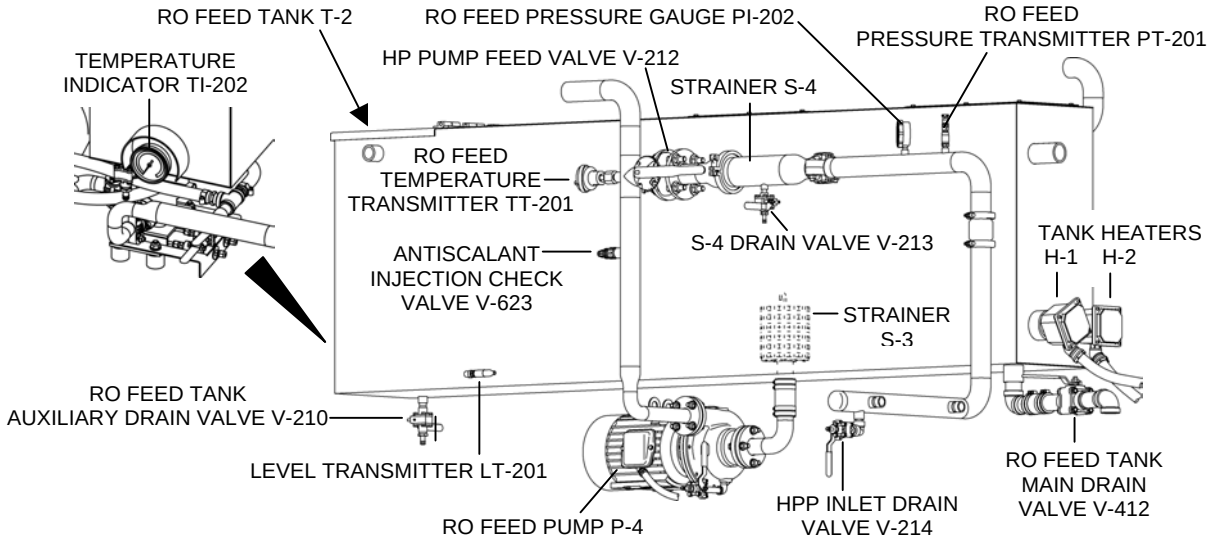

Figure 13. RO System: RO Feed Pump to High Pressure Pumps.

RO System: High Pressure Pumps (see Figure 14)

- **High Pressure (HP) Pumps P-5 and P-6**. The reverse osmosis process is pressure driven. Water only moves through the RO membrane pores if it is under pressure. Higher feed water salt content requires higher pressure to force water through the RO membrane pores and produce water than feed water with lower salt content. The high pressure pumps provide the operating pressure required by the RO elements to produce the desired product water flow.
- **HPP Lubricant Return Lines.** A portion of the feed water that is delivered to the pumps is used to lubricate the pumps and is discharged at low pressure back to the RO feed tank.
- **HPP Case Drain Valve V-215.** Used to drain the high pressure pumps.

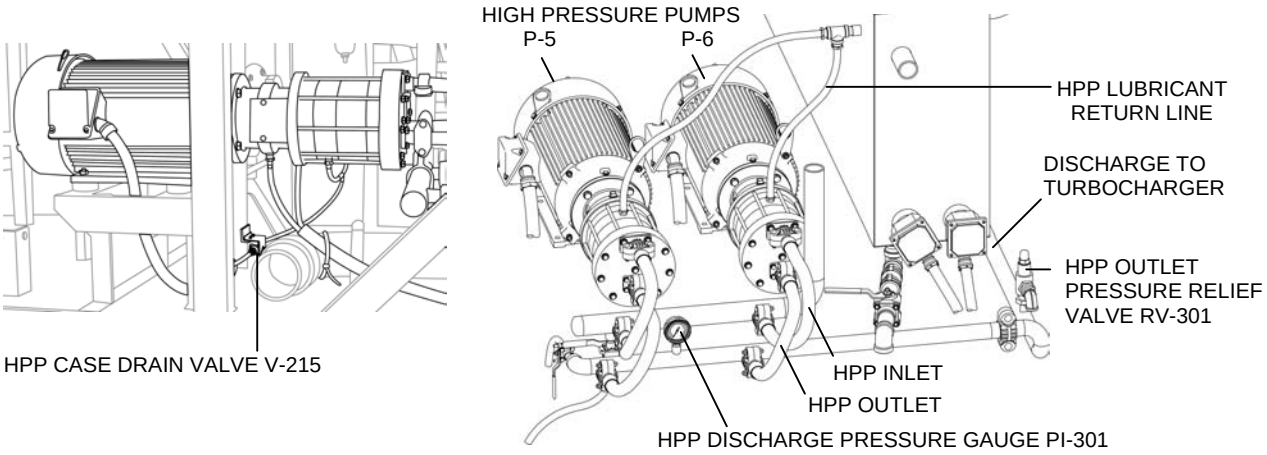

Figure 14. RO System: High Pressure Pumps.

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RO System: High Pressure Pumps to RO Vessels (see Figure 15)

- **HPP Outlet Drain Valve V-301.** Used to drain the HPP outlet hoses and pipe.
- **HPP Discharge Pressure Gauge PI-301.** Indicates the HP pump discharge pressure.
- **HPP Outlet Pressure Relief Valve RV-301**. Rated to withstand up to 1050 psig. Protects the HP pumps from over pressure in excess of 1050 psig.
- **HPP Outlet Drain Valve V-302.** Used to drain high pressure pump outlet hoses and piping.
- **Pressure Recovery Turbocharger PRT-1**. Uses pressure energy from the reject water coming out of the RO vessels to boost the pressure of the RO feed water going into the RO vessels.
- **Turbocharger Feed Drain Valve V-303.** Used to drain the feed water from the turbocharger.
- **Turbocharger Reject Drain Valve V-410.** Used to drain the reject water from the turbocharger.
- **Feed Piping Drain Valve V-304.** Used to drain the feed piping going to RO Vessel #1 and other pipes that are part of the chemical cleaning system.
- **RO Feed Pressure Transmitter PT-302.** Provides a measurement of the pressure to the RO vessels that is displayed at the operator control panel (OCP). If the pressure exceeds 1225 psig, a high-pressure alarm sounds.
- **RO Feed Pressure Gauge PI-304.** Provides a direct reading of the RO feed pressure.
- **RO Feed Pressure Relief Valve RV-302**. Rated to withstand up to 1250 psig. Protects the RO vessels from over pressure in excess of 1250 psig.
- **Air Purge Valve V-913.** After an air hose is connected from the air system to Air Purge Valve V-913, the purge valve is opened so that air can be used to purge water or cleaning solution from the RO system.
- **RO Vessels ROV-1 through ROV-5.** Each vessel contains two RO filter membrane elements. Feed water flows through each of the vessels in series. A portion of the feed water passes through the RO membrane within each element. The RO membranes reject most of the salt producing potable product water. Product water exits the RO element at both ends of the each vessel and flows to a header. The feed water that does not pass through the membranes is concentrated with salt and is discharged from the last vessel as reject water.

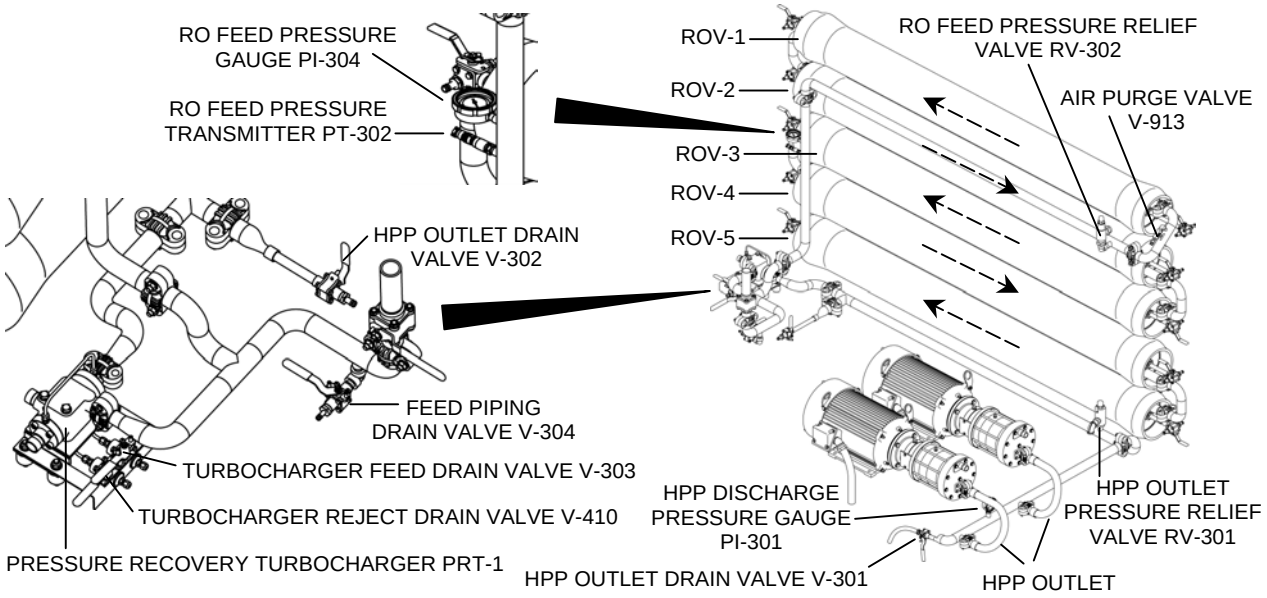

Figure 15. RO System: High Pressure Pumps to RO Vessels.

RO System: RO Vessels to Waste Out (see Figure 16)

- **RO Vessel Drain Valve V-408.** Used to drain water out of the RO vessels.
- **RO Reject Pressure Gage PI-401.** This pressure gage is located in the reject line between pressure control valve HCV-401 and the turbocharger. The gage indicates the reject pressure in the line from the RO vessel ROV-5 reject outlet to the turbocharger.
- **Main Pressure Control Valve HCV-401 and Auxiliary Pressure Control Valve HCV-401A.** Enables the operator to control the pressure boost that the turbocharger delivers to the RO feed by adjusting how much of the reject flow from the RO vessels is bypassed around the turbocharger directly to waste.
- **Reject Check Valve V-411.** Prevents waste water from backing up into the RO system especially during backwash surges.
- **RO Reject Flow Element FE-401 and Flow Transmitter FT-401.** (FT-401 is not shown in Figure 16. It is located in the instrument/solenoid panel box shown in Figure 23). FE-401 and FT-401 measure the reject flow. Reject flow is displayed at the operator control panel (OCP).

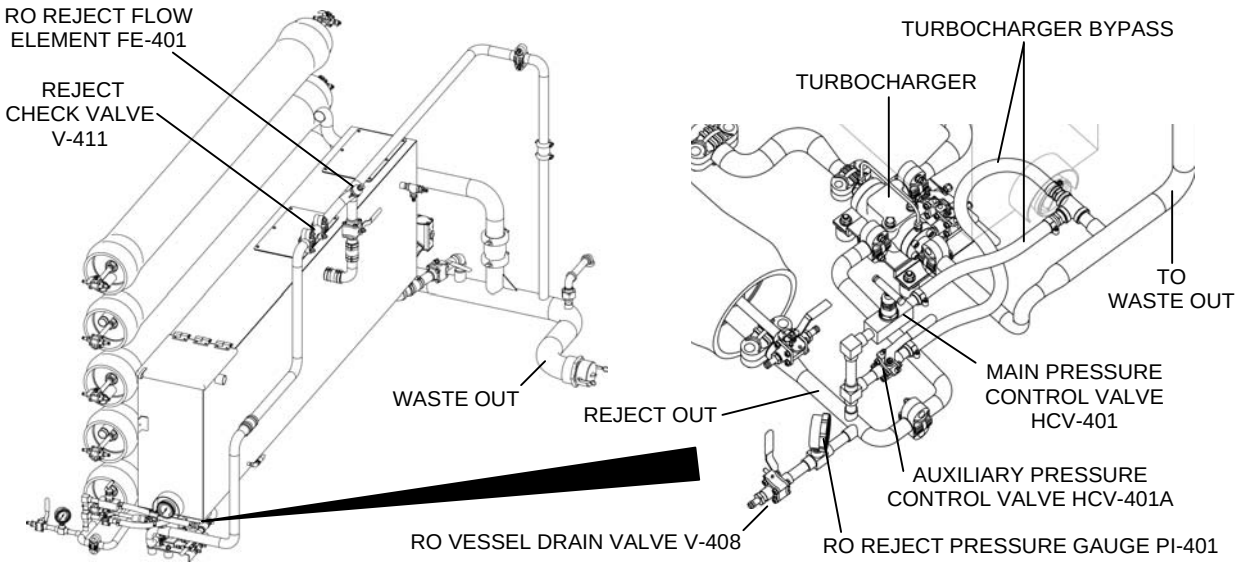

Figure 16. RO System: RO Vessels to Waste Out.

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RO System: RO Vessels to Product Out (see Figure 17)

- **RO Product Flow Three-Way Valves V-501 through V-510.** One three-way valve at the product water out port of each of the ten RO elements. The valve can be positioned to direct product water flow from the element to the product manifold, to a sample/drain port that is used for flow rate and conductivity measurements, or to drain.
- **Low Range Conductivity Element CE-501A and High Range Conductivity Element CE-501B**. Measure product water conductivity and are connected to Conductivity Indicating Transmitter (Analyzer) CIT-501.
- **Conductivity Indicating Transmitter (Analyzer) CIT-501**. (CIT-501 is not shown in Figure 16. It is located in the instrument/solenoid panel box shown in Figure 23). Using inputs from CE-501A and CE-501B, provides an output to the PLC, which displays the measurement on the OCP as mg/l total dissolve solids (TDS). TDS is an indication of how much salt is in the product water. A high alarm indicates when the TDS is greater than 1000 mg/L or when the PLC calculates that the RO membrane salt rejection has become too low.
- **Product Pressure Gauge PI-501**. Indicates the product water discharge pressure.
- **Product Relief Valve RV-501.** Rated for 20 psig. In the event that the product water lines or hoses are blocked in any manner, the relief valve will release pressure from the line when it exceeds 20 psig to protect the RO vessels and elements.
- **Product Vacuum Breaker VB-501.** Prevents chlorinated water from being siphoned from the product water distribution system back into the RO vessels when the TWPS is not in operation. Chlorinated water will damage the RO membranes.
- **Product Utility Valve V-511 and Hose.** Used to deliver product water to the RO feed tank for certain chemical cleaning procedures. Also a product water source for general use.
- **Product Flow Element FE-501 and Product Flow Transmitter FT-501.** (FT-501 is not shown in Figure 16. It is located in the instrument/solenoid panel box shown in Figure 23). FE-501 and FT-501 measure product flow. The flow is displayed at the OCP.
- **Product Water Check Valve V-512**. Prevents chlorinated product water from flowing back into the RO vessels when the TWPS is not in operation. Chlorinated water will damage the RO membranes.
- **Hypochlorite Injection Check Valve V-633.** Injection point for a hypochlorite chemical solution into the product water to prevent microbial growth and contamination.

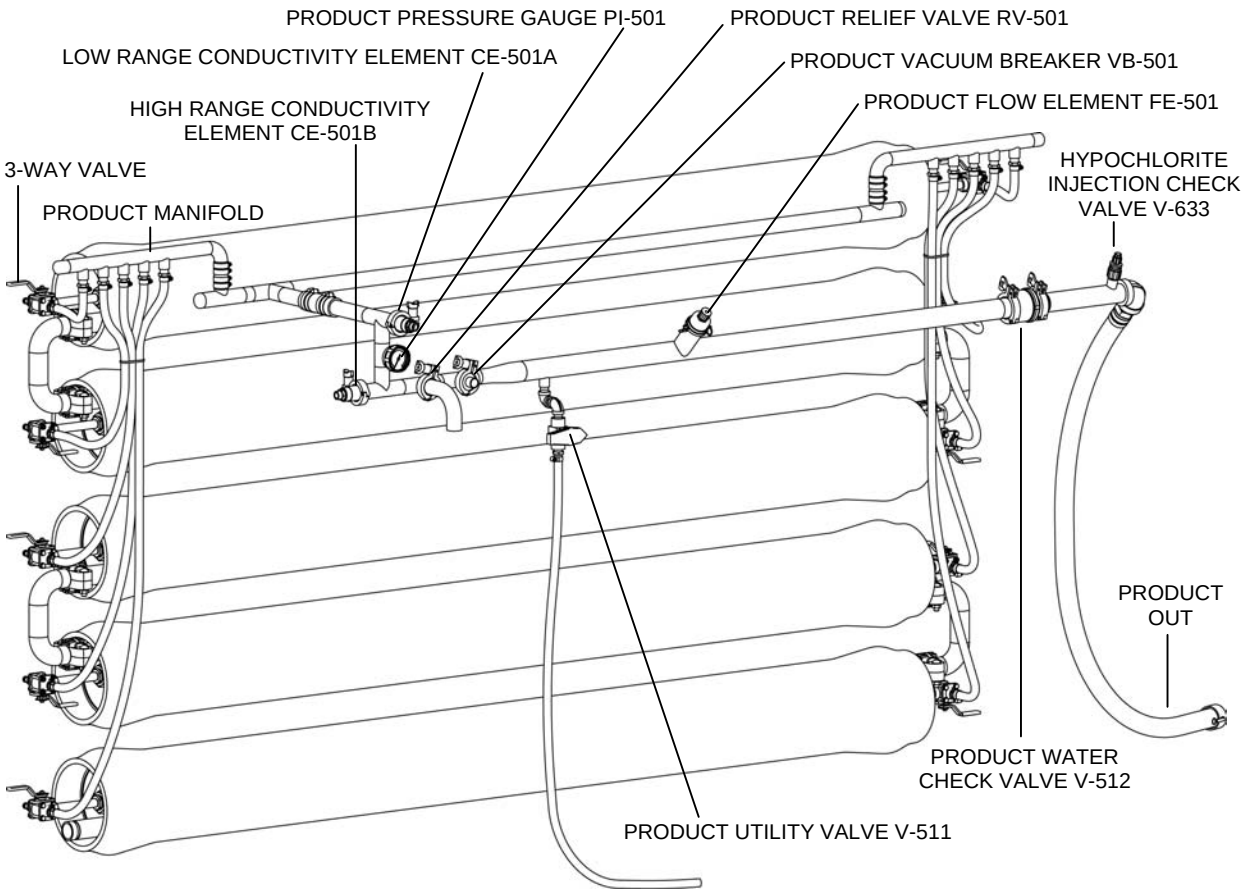

Figure 17. RO System: RO Vessels to Product Out.

Air System

The air system provides pressurized air to operate automatic valves and to blow filtered material loose from the micro-filter elements during backwash. The air system includes the following major components (listed in the general flow sequence through the system):

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Air System: Air Compressor Assembly and Two-Stage Air Filtration System (see Figure 18)

- **Air Compressor AC-1**. A 3-stage air compressor that discharges air at approximately 5 cubic ft. per minute and 1800 psig. The compressor is operated by a five horse-power electric motor.
- **Temperature Switch TSH-901**. Shuts down the compressor if the compressor third-stage temperature is too high.
- **Automatic Drain Valve XV-910.** Opens automatically at 15-minute intervals to blow water from the intermediate filter.
- **Coalescer CO-1.** Located at the discharge of the compressor, CO-1 removes most of the water and oil that may be contained within the air.
- **Drain Shutoff Valve V-902.**
- **Automatic Drain Valve XV-911**. Opens automatically at 15-minute intervals to blow water and oil from the coalescer.
- **High-Pressure Air Relief Valve RV-901.** Releases air when the air pressure exceeds 2200 psig to protect the compressor and other high-pressure air system components.
- **Check Valve V-903**. Prevents filtered air from flowing back toward the compressor when the compressor has cycled off.
- **Air Purification Filter AF-2.** Removes any water and oil remaining in the air.
- **High-Pressure Air Vent Valve V-904**. Used to vent high-pressure air before servicing the air compressor or the two-stage air filtration system (CO-1 and AF-2).

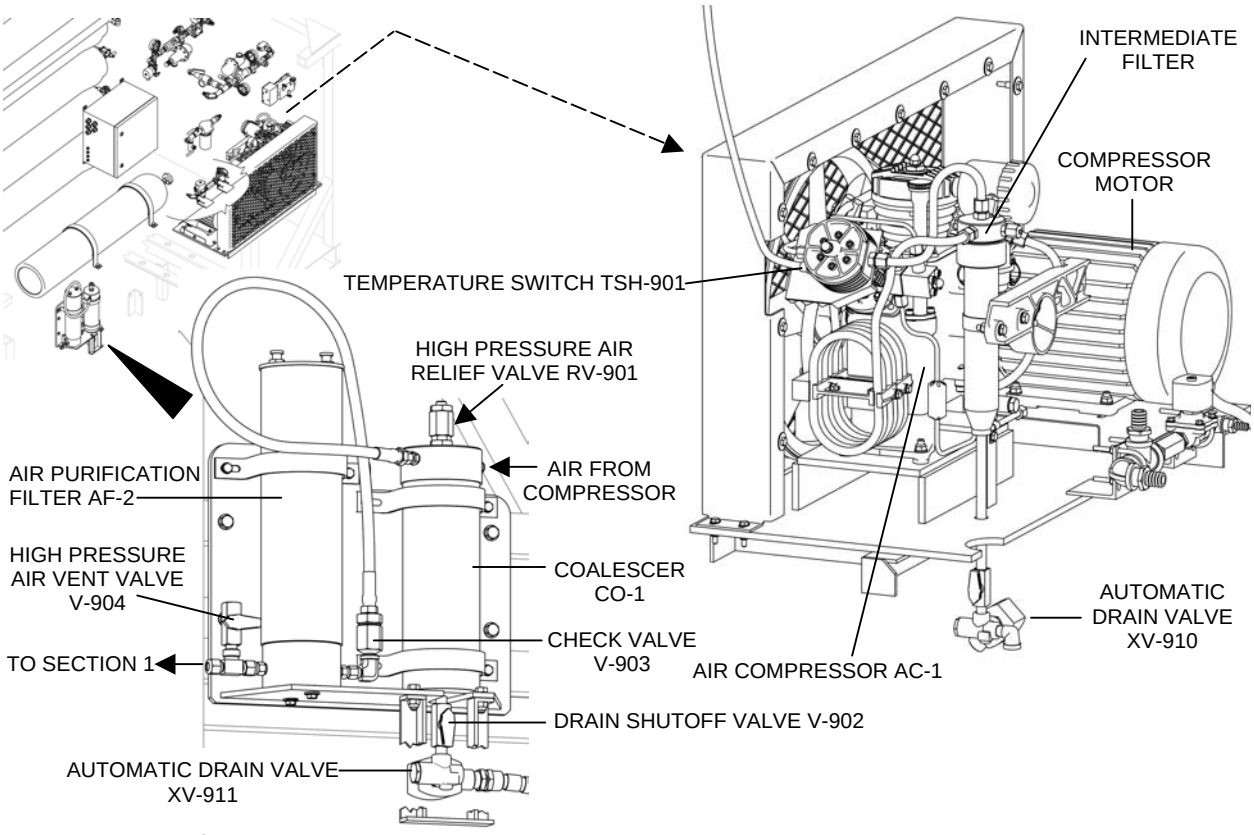

Figure 18. Air System: Air Compressor Assembly and Two-Stage Filtration System.

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Air System: Section 1, Air Receiver Tank R-1, and Pressure Switch PSL/PSH-901 (see Figure 19)

- **Pressure Maintaining Valve V-905.** Maintains approximately 1800 psig in the system between the compressor and itself to ensure proper loading of the compressor cylinder valves.
- **Check Valve V-906.** Maintains pressure to the input side of Pressure Regulating Valve PRV-901.
- **Air Receiver Tank R-1.** Provides a supply of clean, dry, compressed air as needed to operate automatic valves and to blow filtered material loose from the micro-filter elements during backwash.
- **Pressure Switch Assembly PSL/PSH-901.** Turns the compressor on when the air tank pressure drops below 800 psig and off when the air tank pressure exceeds 950 psig.
- **Pressure Gauge PI-901.** Indicates the air receiver tank pressure.
- **Pressure Regulating Valve PRV-901.** Reduces the high pressure air from the air receiver tank / compressor to 100 psig.
- **Pressure Gauge PI-902.** Indicates the pressure as regulated by PRV-901.
- **Relief Valve RV-902.** Rated at 125 psig. In the event that regulator PRV-901 fails to function properly, the relief valve will release air when the air pressure exceeds 125 psig to protect the air system components downstream.

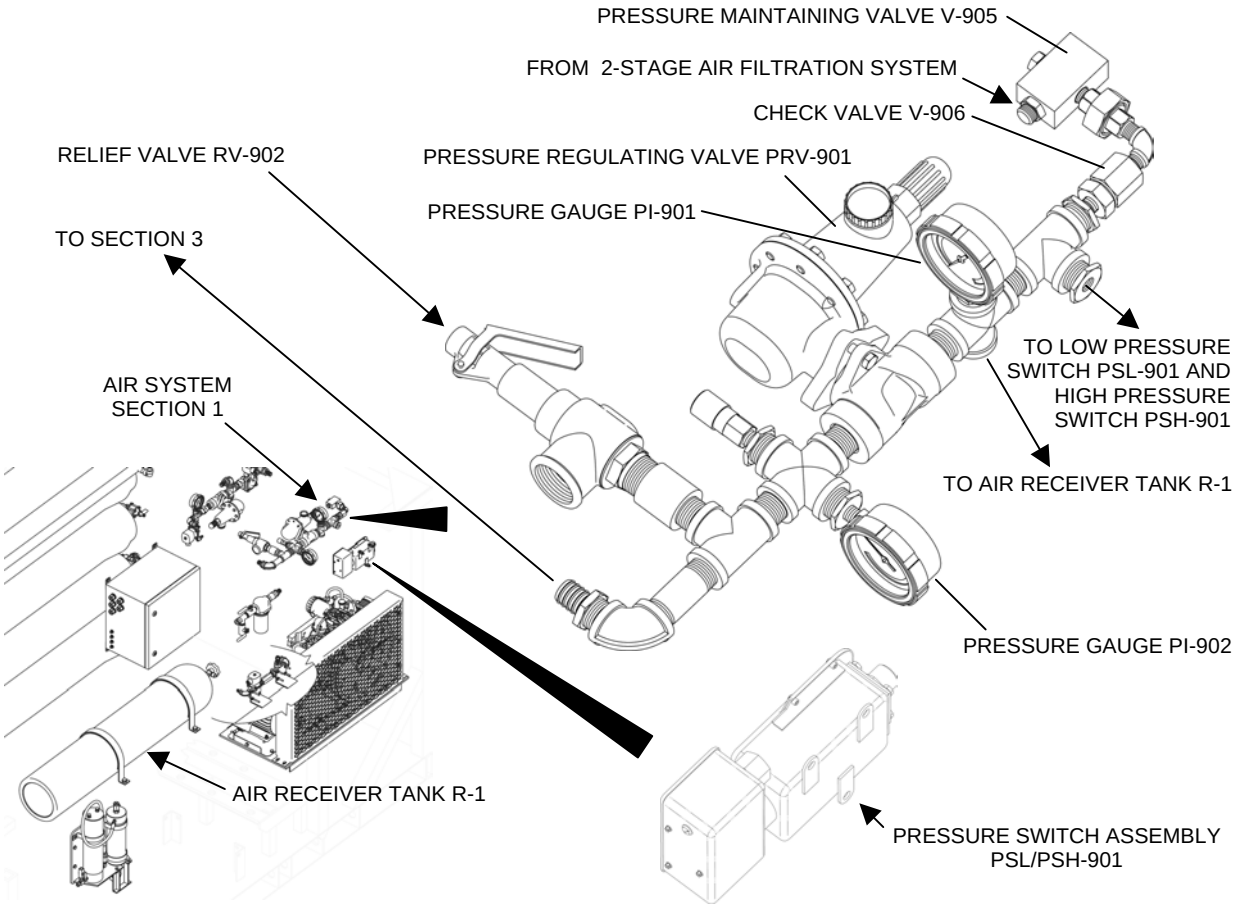

Figure 19. Air System: Section 1, Air Receiver Tank R-1, and Pressure Switch PSL/PSH-901.

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Air System: Section 3 (see Figure 20)

- **Solenoid Valve XV-901.** Opens to provide 100 psig air to the upper filtrate outlet of the MF Assembly for MF backwash.
- **Pressure Regulating Valve PRV-902.** Reduces 100 psig air to 15 psig.
- **Low Pressure Air Vent Valve V-915.** Opened to vent air when it is necessary to adjust pressure PRV-902 to provide a 15 psig reading at PI-903.
- **Pressure Gauge PI-903.** Indicates the pressure as regulated by PRV-902.
- **Solenoid Valve XV-903.** Opens to provide 15 psig air to the feed inlet of the MF Assembly to drain the MF assembly shell during drain-down procedures.

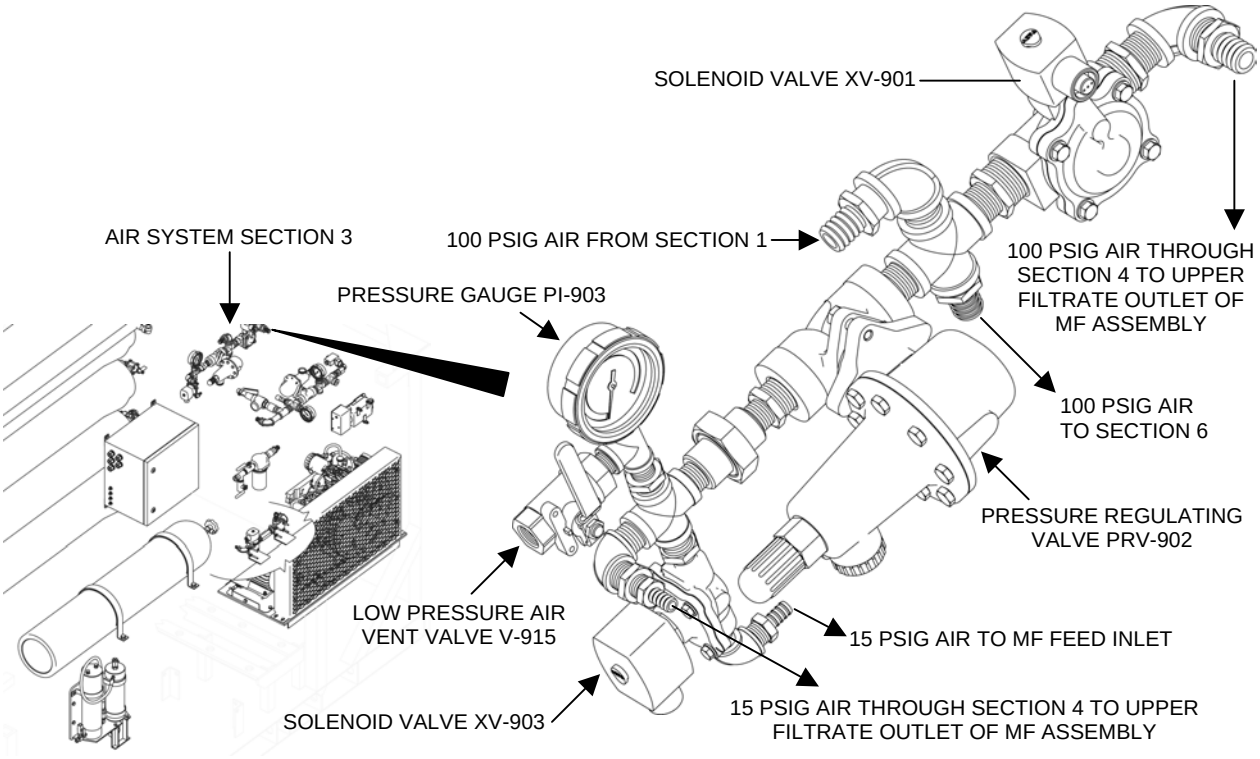

Figure 20. Air System: Section 3.

Air System: Section 4 (see Figure 21)

- **Solenoid Valve XV-902.** Opens to provide 15 psig air from Air System Section 3 to the upper filtrate outlet of the MF Assembly to drain the MF fibers before backwash.
- **Check Valve V-908.** Prevents 100 psig air from entering the MF through the 15 psig air system and Air System Section 3.

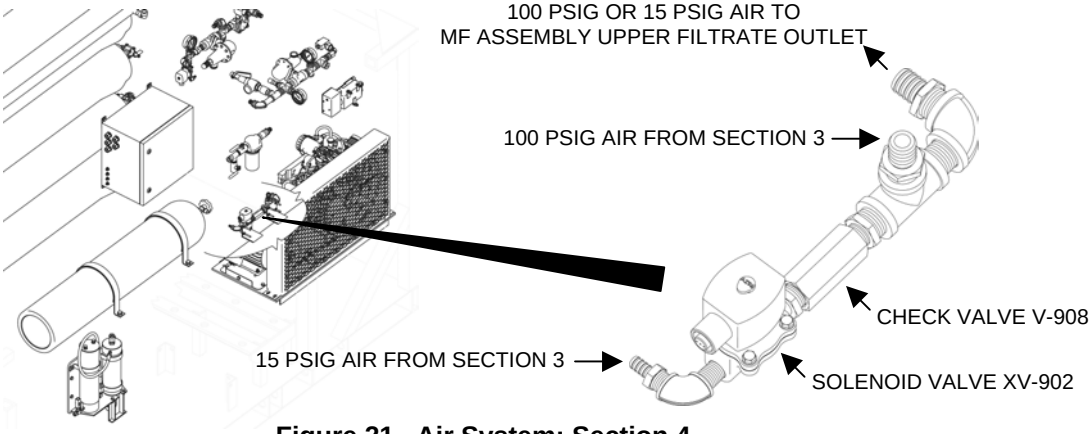

Figure 21. Air System: Section 4.

Air System: Section 6 (see Figure 22)

- **Coalescer CO-2.** Removes any remaining moisture from the 100 psig air that is coming directly through Air System Section 3 from Air System Section 1. Air leaving CO-2 goes to the Feed Flow Control Panel, Filtrate Flow Control Valve V-202, and the Air Manifold Assembly in the Instrument/Solenoid Panel Box.
- **Low Pressure Air Shutoff Valve V-909.** Used to shut off 100 psig air so maintenance can be performed on the Feed Flow Control Panel, Filtrate Flow Control Valve V-202, or the Air Manifold Assembly.
- **Low Pressure Air Vent Valve V-910.** Opened as needed to bleed the air from the entire air system.

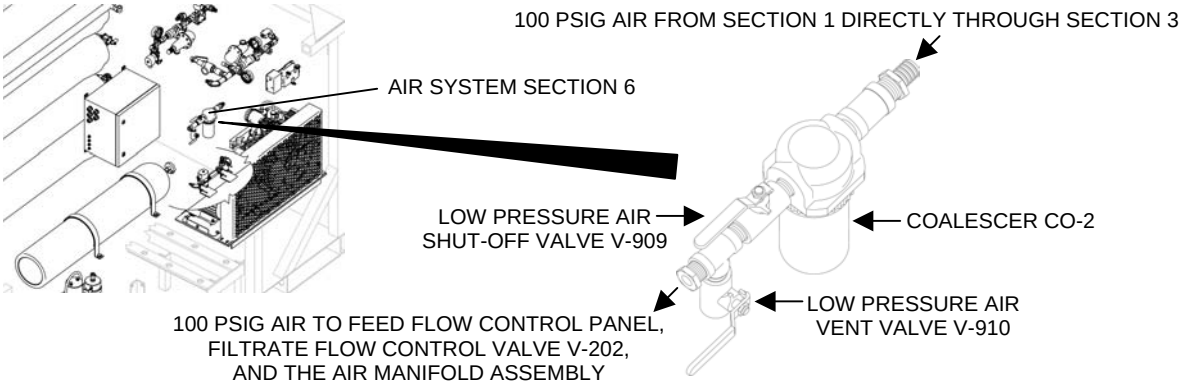

Figure 22. Air System: Section 6.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0002 00**
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Air System: Instrument/Solenoid Panel Box (see Figure 23)

The Instrument/Solenoid Panel Box houses three flow transmitters, one conductivity transmitter, and the air manifold assembly. The transmitters are not part of the air system, but perform functions in the MF and RO system as follows:

- **MF Feed Flow Transmitter FT-101**. Works with Flow Element FE-101 in the MF System to measure the MF flow (feed flow to the MF assembly when filtering, backwash flow to the MF assembly during backwash). This flow is displayed at the operator control panel (OCP).
- **RO Reject Flow Transmitter FT-401.** Works with Flow Element FE-401 in the RO System to measure the reject flow from the RO vessels. Reject flow is displayed at the operator control panel (OCP).
- **Conductivity Indicating Transmitter (Analyzer) CIT-501**. Uses inputs from Conductivity Elements CE-501A and CE-501B in the RO System and provides an output to the PLC to determine total dissolved solids (TDS) in the product water. Product TDS is displayed at the OCP.
- **Conductivity Transmitter ON/OFF switch**. Used to turn the conductivity transmitter on and off.
- **Product Flow Transmitter FT-501.** Works with Flow Element FE-501 in the RO System to measure product flow. The flow is displayed at the OCP.

The Air Manifold Assembly is housed behind the transmitters. It is comprised of six solenoid valves that are activated by the PLC to operate automatic valves in the TWPS. The solenoid valves and the automatic valves that they control are as follows:

- **Solenoid Valve XV-904.** Controls 100 psig air to MF Main Feed Valve V-111.
- **Solenoid Valve XV-905.** Controls 100 psig air to MF Upper Feed Inlet Valve V-112.
- **Solenoid Valve VX-906.** Controls 100 psig air to MF Lower Feed Inlet Valve V-113.
- **Solenoid Valve XV-907.** Controls 100 psig air to MF Upper Shell Outlet Valve V-401.
- **Solenoid Valve XV-908.** Controls 100 psig air to MF Lower Shell Outlet Valve V-402.
- **Solenoid Valve XV-909.** Controls 100 psig air to MF Upper Filtrate Outlet Valve V-201.

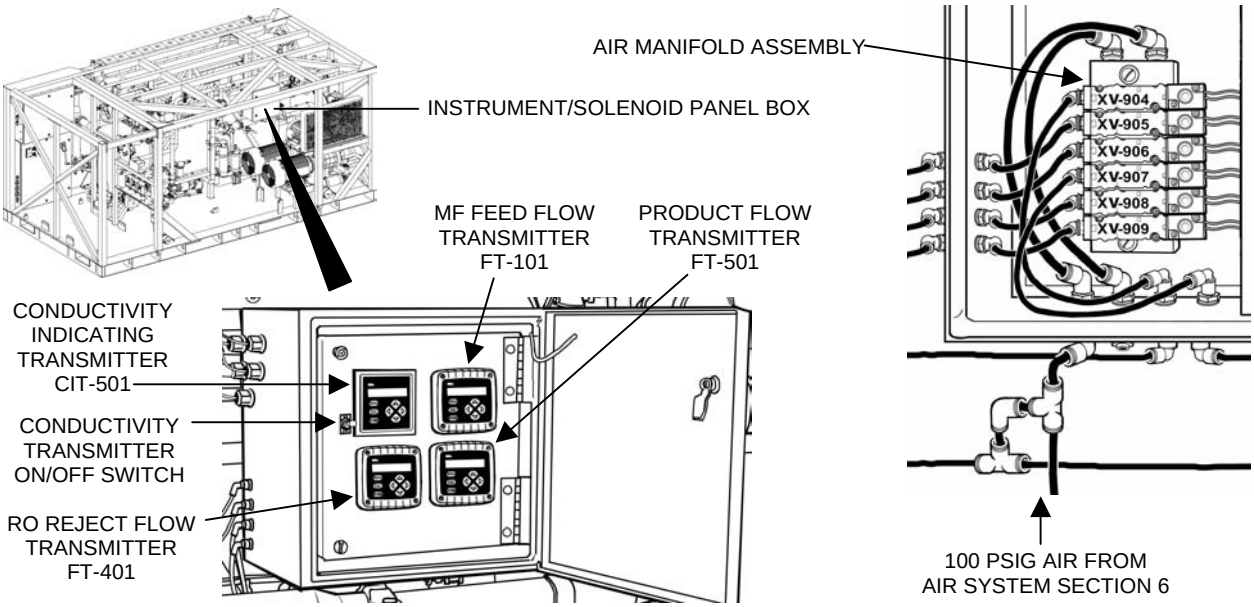

Figure 23. Air System: Instrument/Solenoid Panel Box.

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Chemical Injection System

The chemical injection system is composed of three independent chemical systems: the sodium bisulfite, antiscalant, and calcium hypochlorite chemical injection systems.

The **sodium bisulfite chemical injection system** is used only if the raw water source is chlorinated water. Chlorinated water will rapidly destroy the fibers in the micro-filter elements and the membranes in the reverse osmosis elements. Sodium bisulfite is injected into chlorinated raw water before the water is discharged into the MF Feed Tank to neutralize the chlorine.

The **antiscalant chemical injection system** inhibits salt scale formation on the RO membranes.

The **calcium hypochlorite chemical injection system** prevents microbial growth in the product water.

Each of the three chemical systems consists of the following components (see Figure 24):

- Chemical Injection Pump CP-1, CP-2, or CP-3
- Four Function Valve V-612, V-622, or V-632
- Refillable five gallon bucket to hold the chemical solution
- Foot Valve (V-611, V-621, or V-631), strainer, and ceramic weight
- 3/8 in. suction tubing
- 3/8 in. discharge tubing
- 1/4 in. return/priming tubing.
- Injection Check Valve V-613, V-623, or V-633 (see Figure 25)

An eye wash station is located in the operator station just above the chemical pumps (see Figure 24).

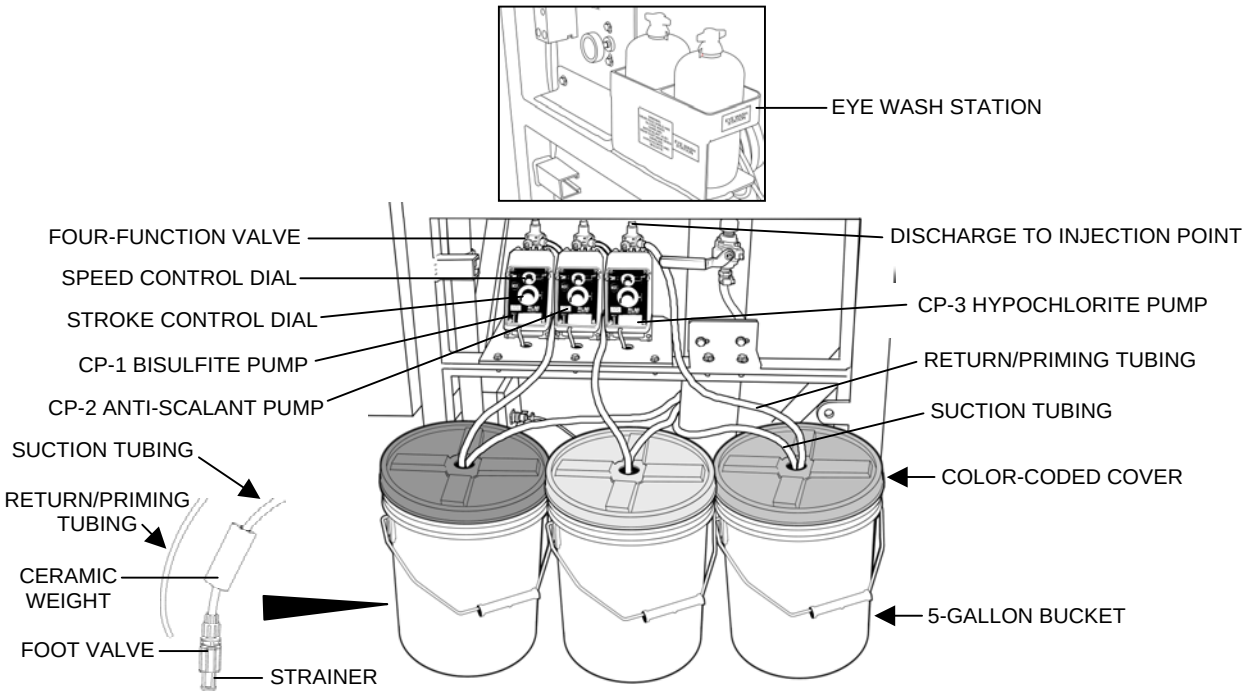

Figure 24. Chemical Injection System Components.

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The chemical bucket covers are color-coded to match labels on the buckets as follows:

- Sodium bisulfite chemical bucket cover **BLUE**
- Antiscalant chemical bucket cover **YELLOW**
- Calcium hypochlorite chemical bucket cover **RED**

The injection points for the chemicals are as follows:

- Sodium bisulfite is injected through Adaptor A-11 in the raw water line to the MF feed tank (see Figure 25).

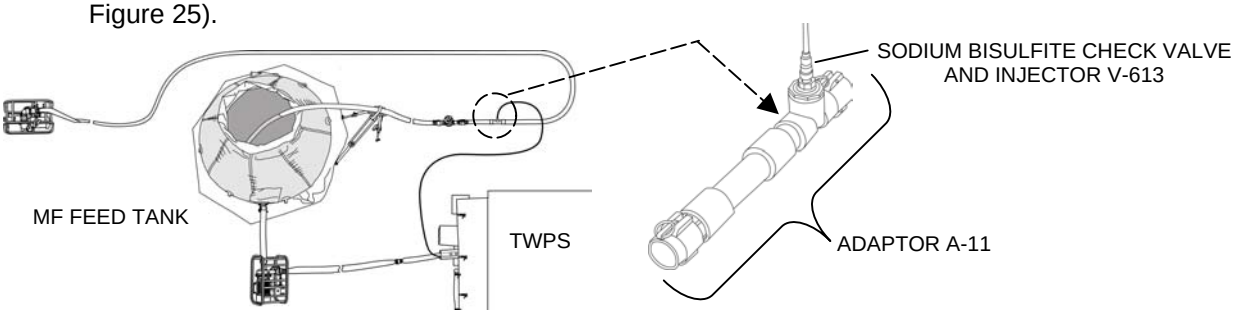

Figure 25. Sodium Bisulfite Chemical Injection Point.

- Antiscalant is injected in the RO feed pump discharge line to mix with the feed water as it is pumped to the high-pressure pumps and on to the RO vessels (see Figure 26).

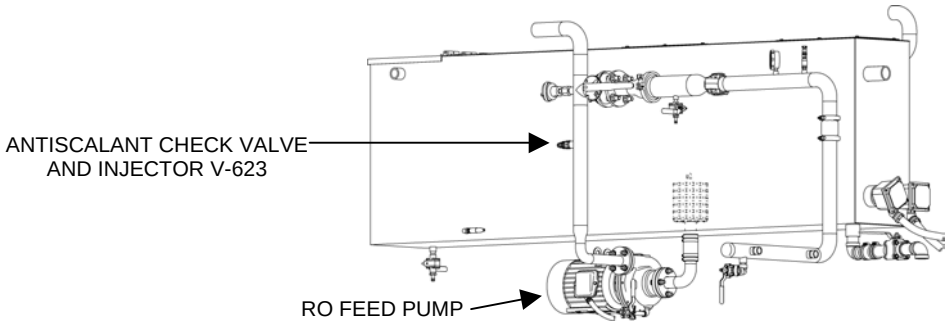

Figure 26. Antiscalant Chemical Injection Point.

- Calcium hypochlorite is injected in the product water discharge line (see Figure 27).

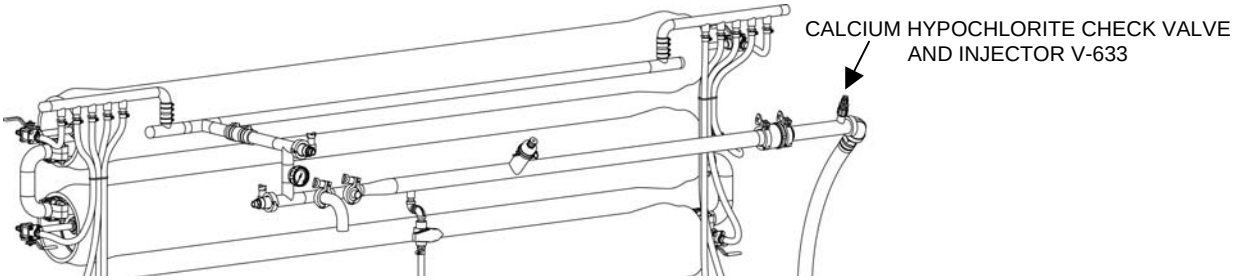

Figure 27. Calcium Hypochlorite Chemical Injection Point.

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Standard Product Water Distribution System (MC-TWPS and A-TWPS) (see Figure 28)

The standard product water distribution system stores the potable product water produced by the TWPS in two 3000-gallon storage tanks and provides up to 125 gpm total distribution capacity through two distribution nozzles. The standard product water distribution system includes the following major components (listed in the general flow sequence through the system):

- **Four 1½ in. x 10-ft. blue-banded suction hoses.** Discharge the product water from the TWPS to the one of the distribution tanks (or to the NBC system if used.)
- **Adaptor A-15.** Connects the product water suction hose to the inlet of one of the product water distribution storage tanks. Adaptor A-15 includes a shut-off valve.
- **Two 3000-gallon collapsible storage tanks T-3 and T-4.**
- **Two 2-in. x 5-ft. blue-banded suction hoses and Adaptor A-07.** Connect the storage tanks to each other and to the distribution pump. Adaptor A-07 includes a shut-off valve.
- **Motor-Driven Distribution Pump P-7.** Distribution Pump P-7 is interchangeable with the Motor-Driven Raw Water Pump P-2.
- **Adaptor A-08.** Connects the P-7 pump outlet to the distribution hoses.
- **Two 2-in. x 65-ft. blue-banded discharge distribution hoses**.
- **Two Dispensing Nozzles V-523A and V-523B.** Connect to the end of the distribution hoses and are used to dispense product water as needed.
- **One 5/8-in. x 50-ft. auxiliary hose.** Can be connected Pump Outlet Adaptor A-08 in place of the one of the distribution hoses to provide water back to the TWPS for MF and RO cleaning and for general purpose potable water use.
- **Auxiliary Hose Valve V-522.** Connected at the end of the auxiliary hose. Used to turn on or shut off the flow of water as needed.

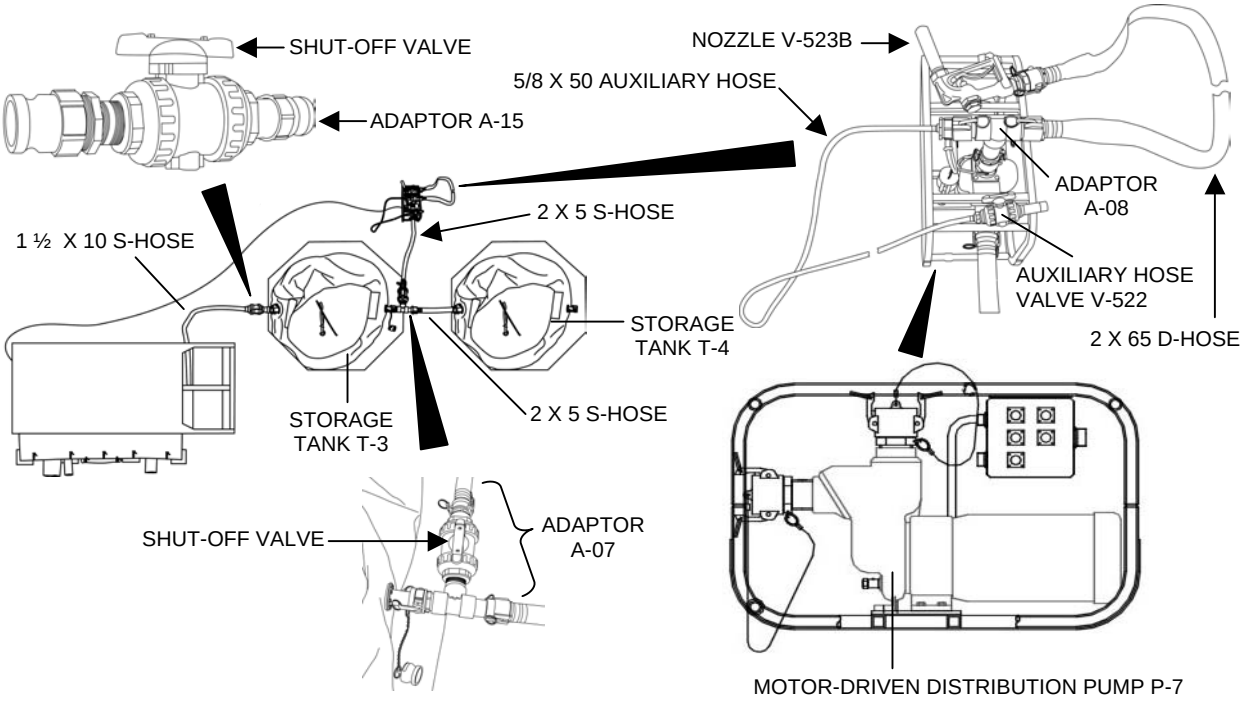

Figure 28. Major Components of the Standard Product Water Distribution System.

Extended Product Water Distribution System (A-TWPS) (see Figure 29)

The extended product water distribution system provides an additional 9000 gallons of product water storage and increase distribution capacity from 125 gpm to 250 gpm when deployed with the basic product water distribution system. The extended system is supplied with the A-TWPS. The extended product water distribution system includes the following major components (these components are in addition to the components in the basic product water distribution system; the components are listed in the general flow sequence through the system):

- **Three 3000-gallon collapsible storage tanks T-5, T-6, and T-7.**
- **Adaptor A-15.** Connects the product water suction hose to the inlet of one of the product water distribution storage tanks. Adaptor A-15 includes a shut-off valve.
- **Three 2-in. x 5-ft. suction hoses and Adaptor A-07.** Connect the storage tanks to each other and to the distribution pump.
- **Diesel Engine-Driven Distribution Pump P-8.** Distribution Pump P-8 is interchangeable with the Diesel Engine-Driven Raw Water Pump P-1.
- **Adaptor A-08.** Connects the P-8 pump outlet to the distribution hoses.
- **Two 2-in. x 65-ft. blue-banded discharge distribution hoses.**
- **Two Dispensing Nozzles V-523C and V-523D.** Connect to the end of the distribution hoses. Used to dispense product water as needed.

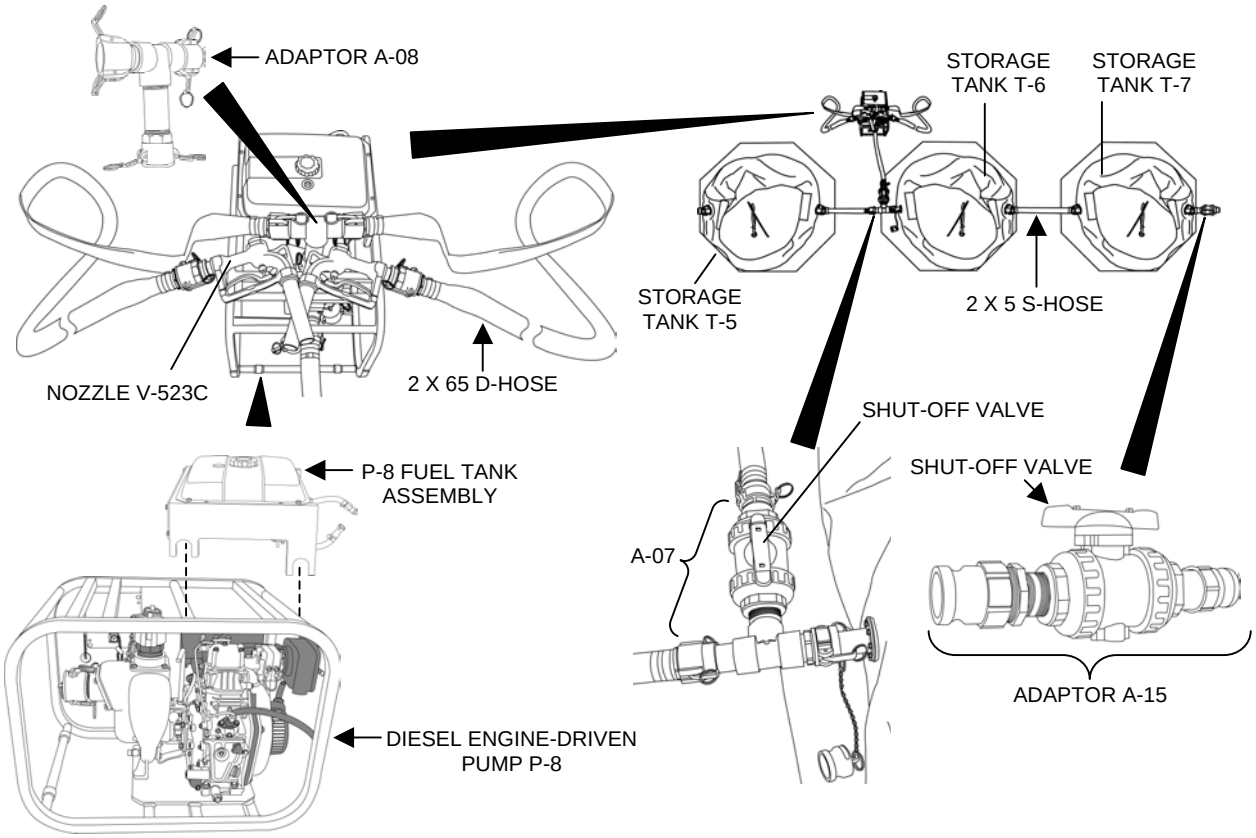

Figure 29. Major Components of the Extended Product Water Distribution System.

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Operating Controls

The Operating Controls include the Operator Control Panel (OCP), the Feed Flow Control Panel, the Programmable Logic Controller (PLC), and several indicators and controls off of the OCP that require occasional adjustment and monitoring for manual operation.

The OCP provides all of the push buttons, switches, alarm lights and displays needed for operator control and monitoring of the system (see Figure 30).

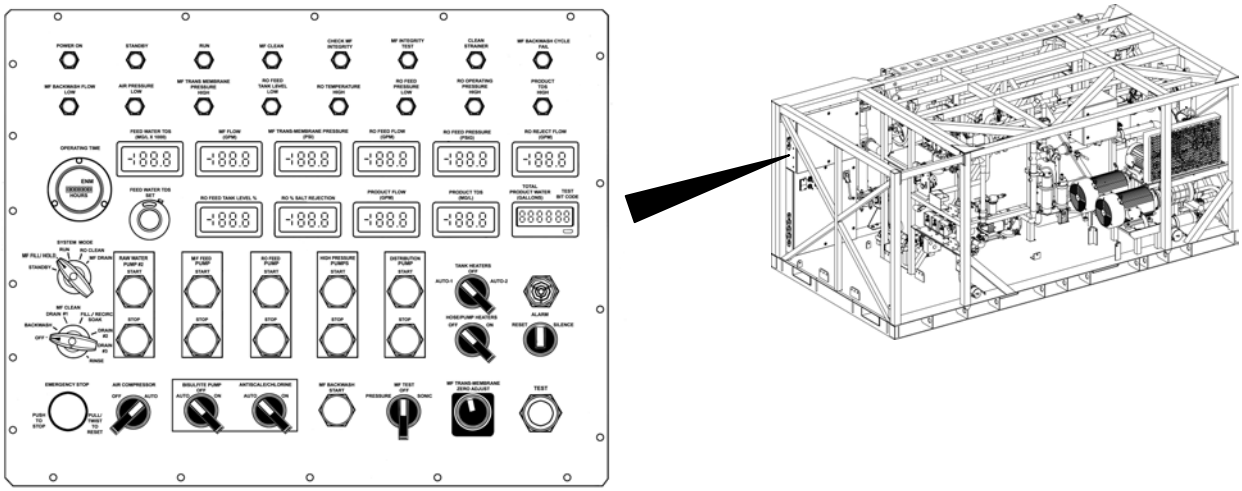

Figure 30. Operator Control Panel (OCP).

The Feed Flow Control Panel (see Figure 31) controls the operation of Filtrate Flow Control Valve V-202 (see Figure 10), which controls the flow of filtrate from the MF system to the RO feed tank.

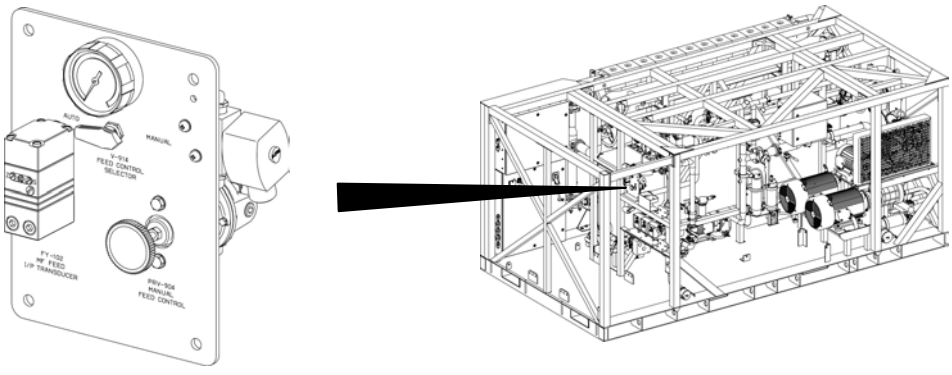

Figure 31. Feed Flow Control Panel.

The PLC provides automated control after operator startup and in response to operator switch selections. The indicators and controls off of the OCP provide the operator with local indications of system conditions and manual controls for certain operating functions of the TWPS. All the Operating Controls are identified and described in detail in WP 0011, Description and Use of Operator Controls and Indicators.

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Power Distribution System (see Figure 32)

The Power Distribution System distributes electrical power to components within the TWPS and to the pumps deployed off of the skid during operation. The power distribution system includes the following major components:

- **60 kW TQG (Tactical Quiet Generator).** Provided with the A-TWPS. The MC-TWPS comes without the TQG and may be powered by a separately provided TQG or by an alternative 416 Volt AC, 3-phase power source.
- **Power Distribution Panel (PDP).** Contains the circuit breakers and motor starters needed to provide power to all of the electrical devices included in the TWPS.

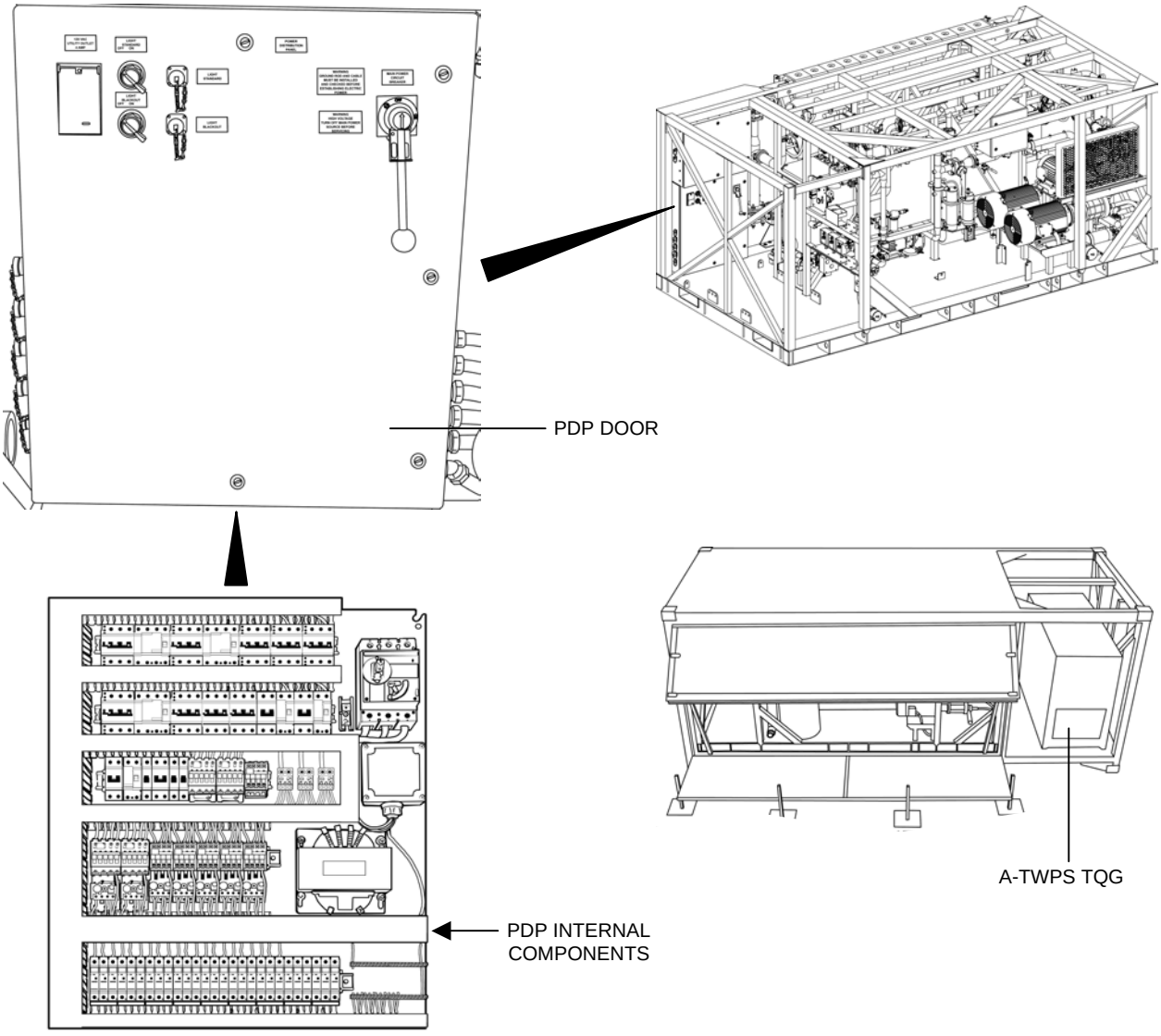

Figure 32. Major Components of the Power Distribution System.

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Cold Weather Kit

The Cold Weather Kit is employed during cold weather operations (temperatures below 32° F to -25° F) to prevent water in the TWPS from freezing. The Cold Weather Kit is provided with the A-TWPS or as an extended capability module for the MC-TWPS. The following components are provided with both the A-TWPS and the Cold Weather Kit for the MC-TWPS (see Figure 33):

- **Diesel-Fuel Fired Forced Hot Air Space Heater.** Produces heat to heat the enclosed TWPS.
- **General Purpose Transformer.** Provides the power required to run the electrical components of the diesel fuel-fired forced hot air space heater. The transformer is hung over the TWPS frame next to the eye-wash station and is plugged into the right side of the PDP.
- **12-in. x 20-ft. Duct.** Delivers warm air from the heater to the TWPS and returns cold air from the TPWS to the heater.
- **Main Plenum.** Distributes warm air from supply duct from heater to 3 locations on the TWPS.
- **Two 8-in. x 6-ft. Ducts.** Deliver warm air from the main plenum to the operator station and the compressor areas of the TWPS.
- **Right Plenum.** A heat register that distributes the warm air from the second 8-in. x 6-ft. duct to the compressor area of the TWPS.
- **Two Right Plenum Hanging Straps.** Hang the right plenum above the air compressor motor. The TWPS is provided with the straps installed and are left in place.
- **4-in. x 5-ft 8-in. Duct.** Connects to the right side of the right plenum and delivers warm air from the right plenum to the lower right end of the RO vessels and MF Assembly.
- **Pump Insulating Platforms.** Placed under the raw water, MF, and distribution pump skids to insulate the pumps/motors/engines from the ground.
- **24V DC Starting Cable.** Connects the TQG battery terminals to an electric starter on the diesel-driven pump skid. Used to start the diesel-driven pump in cold weather. Stays with the TWPS and is stored in Box #1 when not in use.
- **Pump Heating Collars.** Wrap around a pump. Contain electric heat trace that provides enough heat to prevent water from freezing in the pump.
- **Pump Insulating Covers.** Enclose the pump skids. Insulate and protect the pump skid components from the weather.
- **Diesel Engine Exhaust Hose.** Metal hose that directs diesel-driven pump engine exhaust through a fitting in the pump's insulating cover.
- **Adaptor A-02 Heating Blanket.** Insulating blanket that is wrapped around Adaptor A-02 (Adaptor A-02 is used for priming the first raw water pump.) The blanket contains electric heat trace that provides enough heat to prevent water from freezing in the adaptor.
- **Hose Heating Blankets.** Insulating blankets that are wrapped around raw water and distribution hoses. Contain electric heat trace that provides enough heat to prevent water from freezing in the hoses
- **P-1 Pump Power Cable.** Delivers electricity from the PDP to the P-1 pump skid to power Adaptor A-02 and hose heating blankets.
- **Ice Hole Auger and Handle.** Used to drill a hole in the ice to access frozen raw water source.
- **A-02 Collar.** Wraps around the discharge of adaptor A-02. Insulates the adaptor discharge.
- **Ice Intake Strainer.** Inserted with suction hoses through a hole in an iced-over water source. Used in place of the floating inlet strainer.
- **Heat Gun.** Electric heat gun used to blow hot air on hoses, pumps, or other components that may have iced up.
- **100-ft. Extension Cord.** Used with the heat gun to reach components that are off the main skid.

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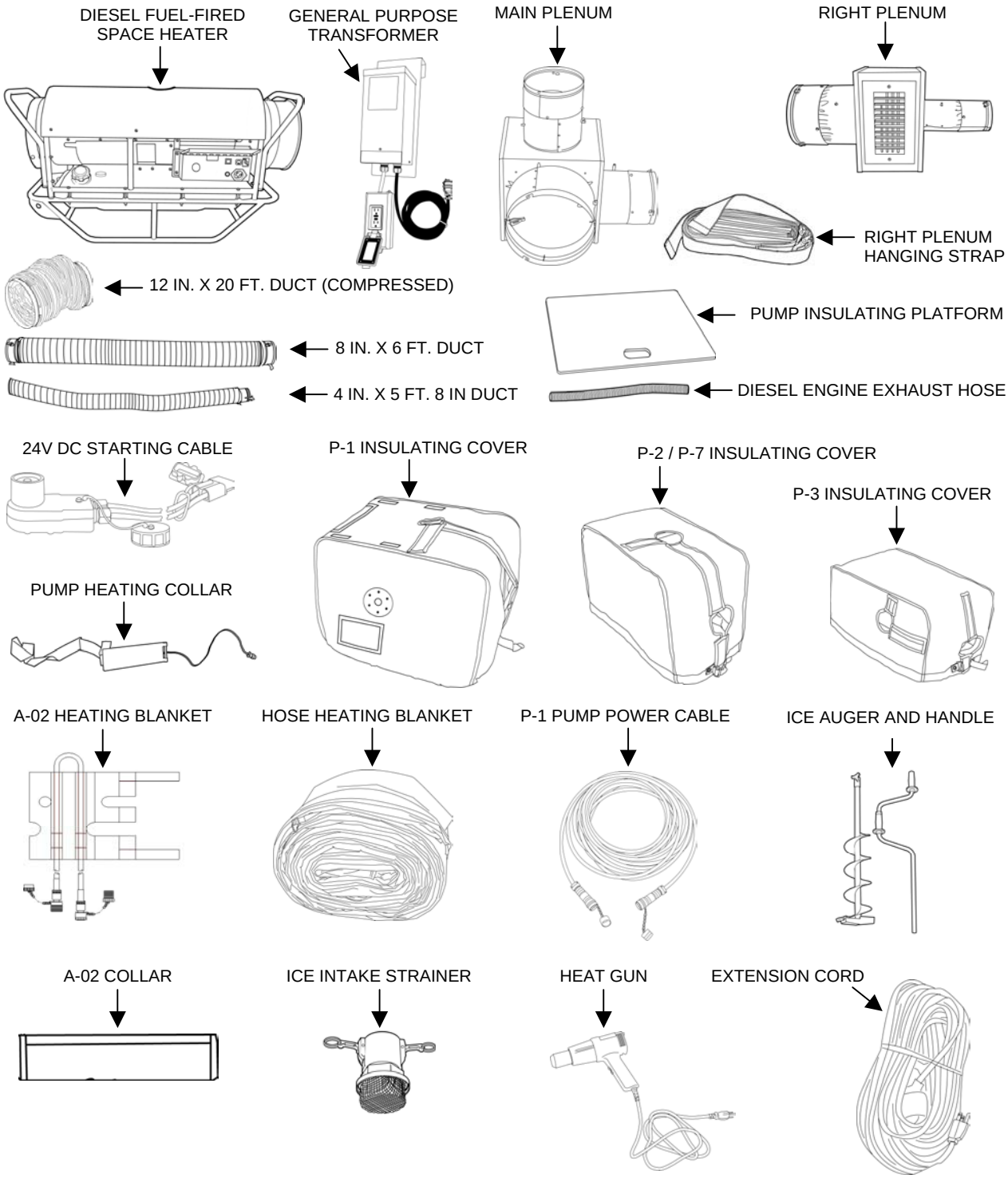

Figure 33. Major Components of the Cold Weather Kit.

The following cold weather components are provided only with the A-TWPS (see Figure 34):

- **Return Air Connector Assembly.** Connects the diesel heater cold air return duct to a flat rack panel on the operator side of the flat rack.
- **Pump Insulating Platform.** Platform for the diesel-driven pump in the extended distribution system.
- **P-8 Insulating Cover.** Cover for the diesel-driven pump in the extended distribution system.
- **Diesel Engine Exhaust Hose.** Exhaust hose for the diesel-driven pump in the extended distribution system.
- **P-8 Pump Power Cable.** Provides power for heating blankets that are connected at the P-8 skid.
- **Hose Heating Blankets.** Heating blankets for the hoses in the extended distribution system.
- **PDP Access Opening Cover.** Closes opening at the side of the PDP. Pump skid power cords are fed through a slit in the cover and connected to the PDP.
- **Product Water Door Access Cover.** Allows for the product hose and RO element drain tubes to extend outside the TWPS while closing the opening below the product water door in the flat rack panel at the right end of the TWPS.

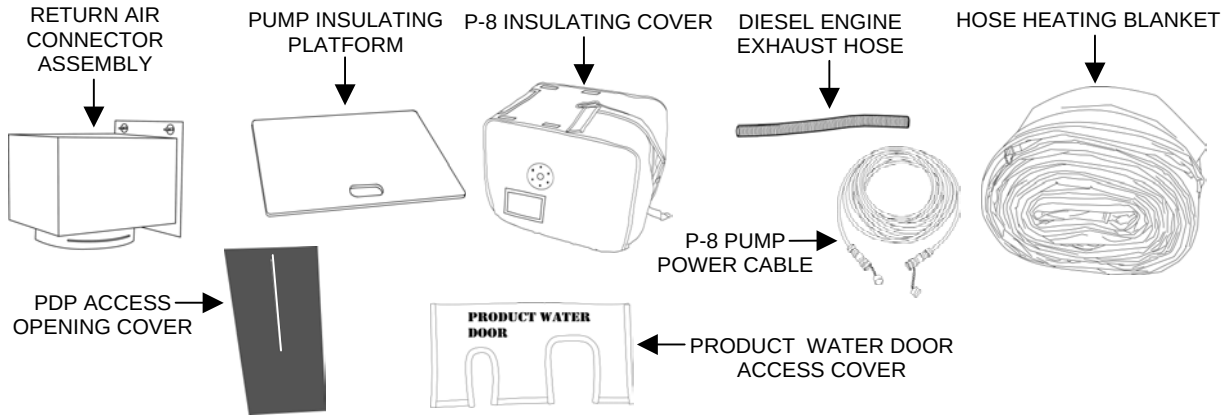

Figure 34. Additional Cold Weather Components for the A-TWPS.

The following cold weather components are provided only with the MC-TWPS (see Figure 35):

- **Return Air Adapter.** Provides a connecting point for the diesel heater cold air return duct at the operator end of the MC-TWPS.
- **Winter Cover.** Protects MC-TWPS and personnel from cold weather elements.

Figure 35. MC-TWPS Return Air Adapter and Winter Cover.

Cleaning Waste Discharge Components (see Figure 36)

The cleaning waste storage discharge components are use to discharge MF or RO element cleaning solutions and rinse water waste away from the TPWS. The following components are included as normal issue with both the A-TWPS and the MC-TWPS:

- **Adaptor A-10.** Replaces waste discharge Adaptor A-09. Connects the 4-in. x 5-ft. waste hose to a 2-in. x 10-ft., red-banded suction cleaning waste hose.
- **Three 2-in. x 10-ft. red-banded, suction cleaning waste hose.** Replaces the 6 x 50 waste out hose. Discharges cleaning wastes from the TWPS either to the ground or to a cleaning waste storage tank.
- **Hose End Valve Assembly Adaptor A-12**. Connected to the end of the 2 x 10 cleaning waste hose. The adaptor includes Cleaning Waste Outlet Valve V-705 that is closed after use to allow safe draining of the hose.

Cleaning Waste Storage Kit (see Figure 36)

The cleaning waste storage kit is used where required to store MF or RO element cleaning solutions and rinse water waste until the waste can be removed for discharge to a sanitary sewer or other designated point of waste discharge. All of the waste storage components are provided as standard issue with the A-TWPS and are available as an extended capability module for the MC-TWPS. The cleaning waste storage kit includes the following components:

- **One 1500-Gallon Cleaning Waste Storage Tank**. Used to store acid cleaning waste, caustic detergent cleaning waste, and the water that is used to rinse the MF fibers, the RO vessels, and the RO feed tank after certain cleaning procedures.
- **Three shutoff valve assemblies Adaptor A-16**. Used as tank shut-off valves to keep the waste in the tank when it is necessary to disconnect and reconfigure the cleaning waste hoses for waste neutralization and disposal procedures.

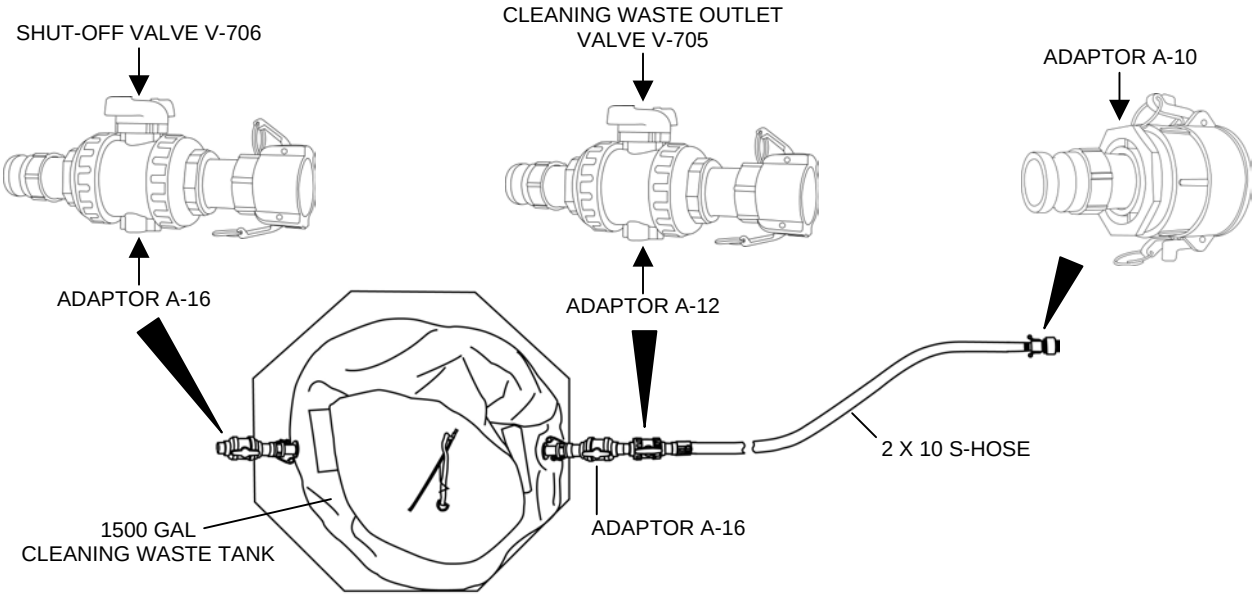

Figure 36. Cleaning Waste Discharge and Storage Components.

Ocean Intake Structure System (OISS) Kit (see Figure 37)

The OISS is used for seawater intake from beach locations when surf conditions or tide extremes make it difficult or impossible to use the floating inlet strainer. The OISS draws raw water from under the sand. It is provided as standard issue with the A-TWPS and as an extended capability module for the MC-TWPS. The OISS includes the following major components:

- **Four well points.** The well points are slotted and screened to keep sand out of the well points and risers.
- **Four 60-in. and four 24-in. riser pipes.**
- **Two end well point 90-degree elbow assemblies with gaskets for the female fittings.**
- **Two middle well point top 2-in. straight tee assemblies with gaskets for the female fittings.**
- **Six two-in., 10-ft. long yellow-banded suction hoses with gaskets for the female fittings.**
- **One middle 3-in. tee assembly with a gasket for the female fitting.**

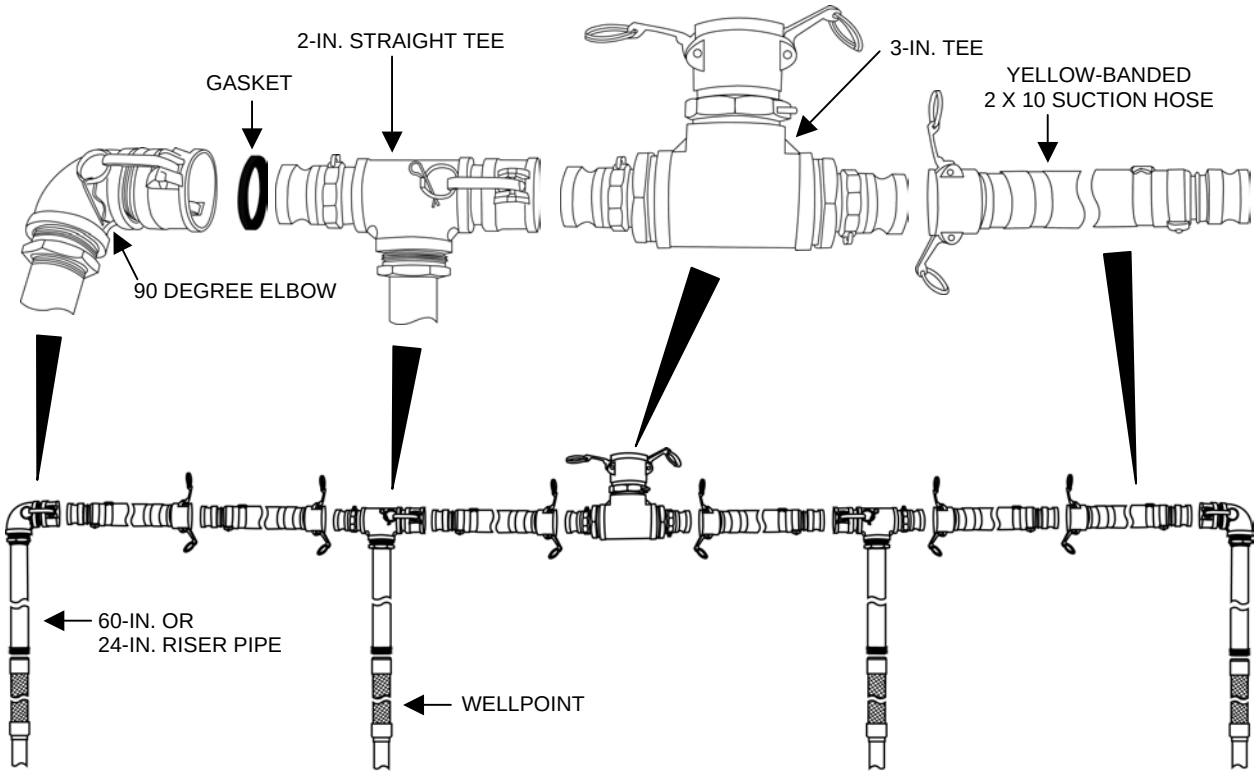

Figure 37. Major Components of the Ocean Intake Structure System (OISS) Kit.

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NBC Water Treatment System (see Figure 38)

The NBC (nuclear, biological, chemical) water treatment system is setup as a final product water treatment step when the raw water source is contaminated with nuclear, biological or chemical warfare agents. The NBC filter is set up in the product line between the TWPS and the product water storage tanks. The NBC water treatment system includes the following major components:

- **NBC filter tank.** Supplied as standard issue for both the A-TWPS and the MC-TWPS.
- **Hypochlorite injection tube, injector and straps.** The injection tube is used to connect the TWPS hypochlorite tube to the injection point on the NBC filter tank. The straps are used to secure the tube to the product water hose between the NBC tank and the TWPS product water outlet. Supplied as standard issue for both the A-TWPS and the MC-TWPS and is packed inside the NBC tank.
- **Six bags of ion exchange resin.** Used for removing nuclear and chemical agents. This filter media is packed inside the filter tank on the A-TWPS and is provided as an extended capability module for the MC-TWPS.
- **Four bags of carbon.** Used for removing chemical and biological agents. This filter media is packed inside the filter tank on the A-TWPS and is provided as an extended capability module for the MC-TWPS.

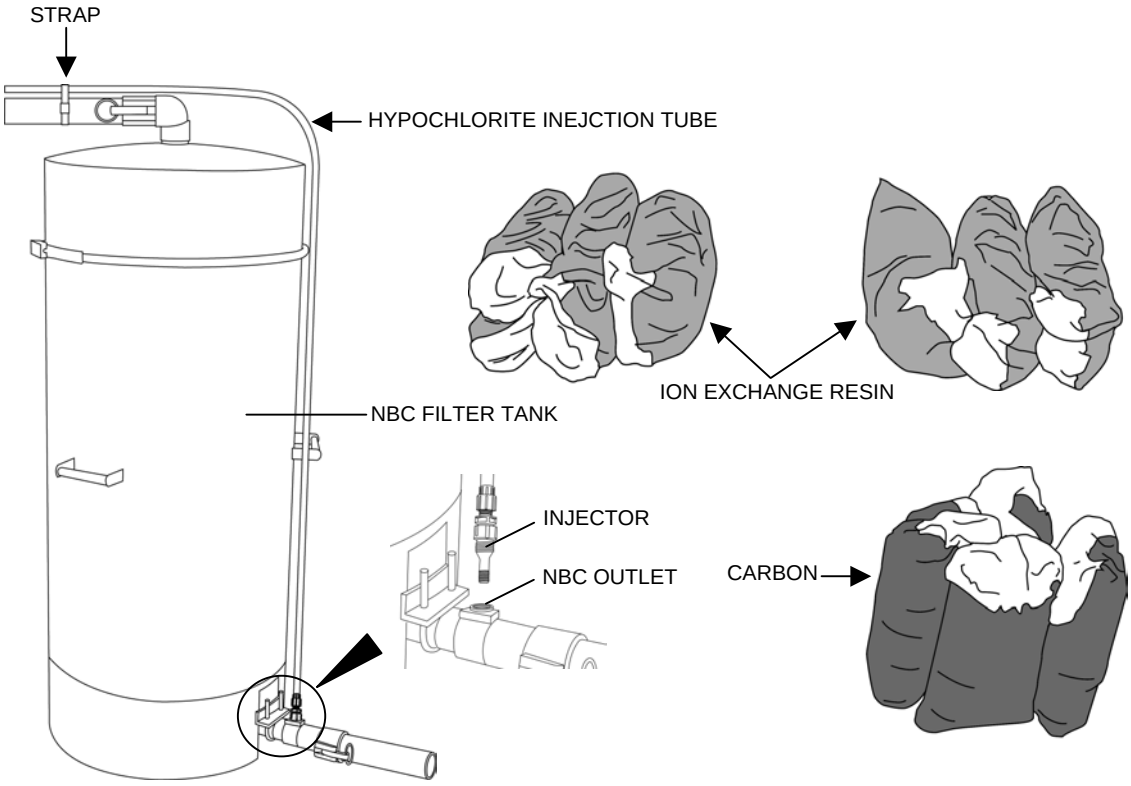

Figure 38. Major Components of the NBC Water Treatment System.

NBC Survivability Kit

The NBC survivability kit consists of a contamination avoidance cover (CAC) and three ropes with which to secure the CAC around the TWPS when it is deployed (see Figure 39). The CAC is deployed prior to NBC exposure to protect the TWPS from NBC warfare agent contamination. It is provided as standard issue on the A-TWPS or as an extended capability module for the MC-TWPS.

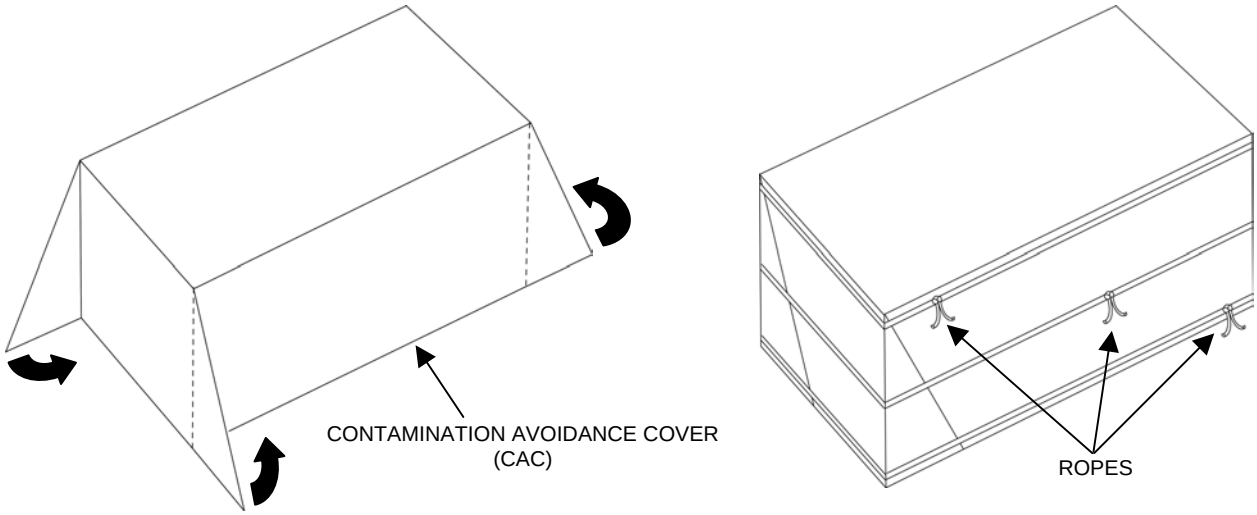

Figure 39. NBC Survivability Kit – CAC and Ropes.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0002 00**
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DIFFERENCES BETWEEN MODELS

The TWPS is fielded in two versions: a Marine Corps version designated MC-TWPS and an Army version designated A-TWPS. The differences between the two models centers primarily on the extended capability modules that are optional and packaged separately for the MC-TWPS but that are standard and packed with the A-TWPS. There are only minor differences in setup and no differences in operation of the TWPS between the two versions. The major differences between the MC-TWPS and the A-TWPS are identified in Table 2.

Table 2. Major Differences Between the MC-TWPS and the A-TWPS.

Feature	MC-TWPS Characteristic	A-TWPS Characteristic
Mounting	Basic skid	Basic skid in an ISO load handling shelter
Dimensions	13'9" L x 6' ½" H x 7'2" W	20' L x 8' H x 8' W
Weight	9,552 lbs. fully packed out less fuel (without extended capability modules)	22,588 lbs. fully packed out less fuel
Power Cable	50-ft. cable. Hard-wired to the Power Distribution Panel at one end. Stripped, soldered wires at the other end. Feeds out under the PDP into the Operator Station area.	24-ft. cable. Hard-wired to the Power Distribution Panel at one end. Stripped, soldered wires at the other end. Feeds out the right end of the TWPS into the TQG area of the flat rack.
Cold Weather Module	Optional; separately packaged in reusable box – 2191 lbs.	Standard; packaged with TWPS – 693 lbs.
Cleaning Waste Storage Module	Optional; separately packaged in reusable box – 220 lbs.	Standard; packaged with TWPS – 60 lbs.
Ocean Intake Structure System (OISS)	Optional; separately packaged in reusable bags – 206 lbs.	Standard; packaged with TWPS – 259 lbs.
NBC Water Treatment Module	Optional; separately packaged in reusable box – 500 lbs.	Standard; packaged with TWPS – 432 lbs.
NBC Survivability Module	Optional; separately packaged in reusable bag – 34 lbs.	Standard; packaged with TWPS – 58 lbs.
Extended Distribution Kit	Not Available	Standard; packaged with TWPS – 498 lbs.

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EQUIPMENT DATA

Performance:

Water Source	Water Production (minimum)
Surface water containing up to 20,000 mg/l TDS and up to 150 NTU @ 32 to 95 F	1500 GPH
Ground water containing up to 2500 mg/l TDS @ 32 to 95 F	1500 GPH
Ground water containing over 2500 mg/l TDS and up to 150 NTU, @ 50 to 95 F	1200 GPH
Normal Seawater containing 35, 000 mg/l TDS, 32 to 95 F	1200 GPH
Seawater containing 45,000 mg/l TDS, 50 to 95 F	1200 GPH
Seawater containing 45,000 mg/l TDS, 32 to 50 F	1000 GPH
Seawater containing 60,000 mg/l TDS @ 77 F	950 GPH

Dimensions:
MC-TWPS: 13'9" L x 6' ½" H x 7'2" W
A-TWPS: 20' L x 8' H x 8' W

Weight:
MC-TWPS: 9,552 lbs fully packed out for deployment less fuel (w/out extended capability modules)
A-TWPS: 22,588 lbs. fully packed out for deployment less fuel

Basic Metals:
MF System Piping: 70-30 Copper-Nickel
RO System:
Low Pressure Piping: 70-30 Copper-Nickel
High Pressure Piping: 254 SMO
Product Piping: 316L Stainless Steel
Air System Piping: 316 Stainless Steel
Skid: 6061 Aluminum
Flat Rack Frame: ASTM A500 Carbon Steel

Operating Temperature Range: -25° F to 120° F (cold weather kit required if operating temperature is below 32° F)

Storage temperature range: - 28° F to 160° F

Maximum water temperature: 100° F

Maximum slope of unit when deployed for operation: 2 degrees front to back, 1 ½ degrees side to side

Power source requirement: 416 VAC, 3 phase, 60 Hz, 60 kW

Fuel Type (60 kW TQG): DF2, DFA, JP8

Fuel Capacity (60 kW TQG): 43 gallons

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0003 00
DESCRIPTION AND THEORY OF OPERATION
THEORY OF OPERATION

INTRODUCTION

Raw water contains suspended solids, which make it look turbid (cloudy or muddy). Suspended solids include silt, dirt, small particles, microorganisms, algae, and plant and animal products. Raw water also contains dissolved solids, which cause poor taste and can make water unfit to drink. The Tactical Water Purification System (TPWS) removes all suspended solids and reduces the dissolved solids to produce water that tastes good and is safe to drink. The TWPS can also produce drinking water from seawater containing high concentrations of salt and freshwater contaminated with nuclear, biological, and chemical warfare (NBC) agents.

This section provides a detailed theory of operation of the Tactical Water Purification System including:

1. Raw Water System
2. Micro Filtration (MF) System
3. Reverse Osmosis (RO) System
4. Air System
5. Chemical Injection System
6. Standard Product Water Distribution System
7. Extended Product Water Distribution System
8. Nuclear, Chemical, and Biological (NBC) System
9. Operating Controls
10. Power Distribution System
11. Cleaning and Preservation Operations
12. Cold Weather Module

Both the Army A-TWPS and the Marine Corps MC-TWPS versions are set on the ground at the water point for operation. There are only minor differences in setup and no difference in operation of the TWPS between the two configurations.

The basic water flow through the TWPS is illustrated in Figure 1. Raw water is pumped from the water source and into a micro-filter (MF) feed tank. One or two pumps may be used depending on the distance and elevation change from the source to the MF feed tank. A cyclone separator is used at beach locations to remove sand and silt. Water is then pumped from the MF feed tank through strainer S-2 to the micro-filter (MF) assembly. Strainer S-2 removes material larger than 60 microns from the water stream. The MF assembly removes suspended solids (dirt) and microorganisms down to 0.2 microns. Filtered water, called “filtrate” flows from the MF assembly into the reverse osmosis (RO) feed tank. Every 15 minutes a “backwash” operation is automatically performed. The backwash operation forces air through the MF elements to blow accumulated dirt and material off the filter elements. The dirt is flushed out of the MF assembly to a waste outlet. Continuing with the water purification process, feed water is pumped from the RO feed tank to two high-pressure pumps. The high-pressure pumps force some of the water though membranes in the RO vessels. Salts are rejected by the RO membranes and the water that passes through the membranes exits the TWPS as product water. The product water is stored in 3000-gallon tanks. Water that does not pass through the RO membranes is discharged as “reject” water to the waste outlet. The reject water passes through a turbocharger which transfers energy from the reject water to boost the feed water pressure to the RO vessels. Product water is pumped from the 3000-gallon tanks as needed for distribution. Two 3000-gallon tanks are provided with the standard distribution system. Three additional 3000-gallon tanks and an additional pump are provided with the extended distribution system.

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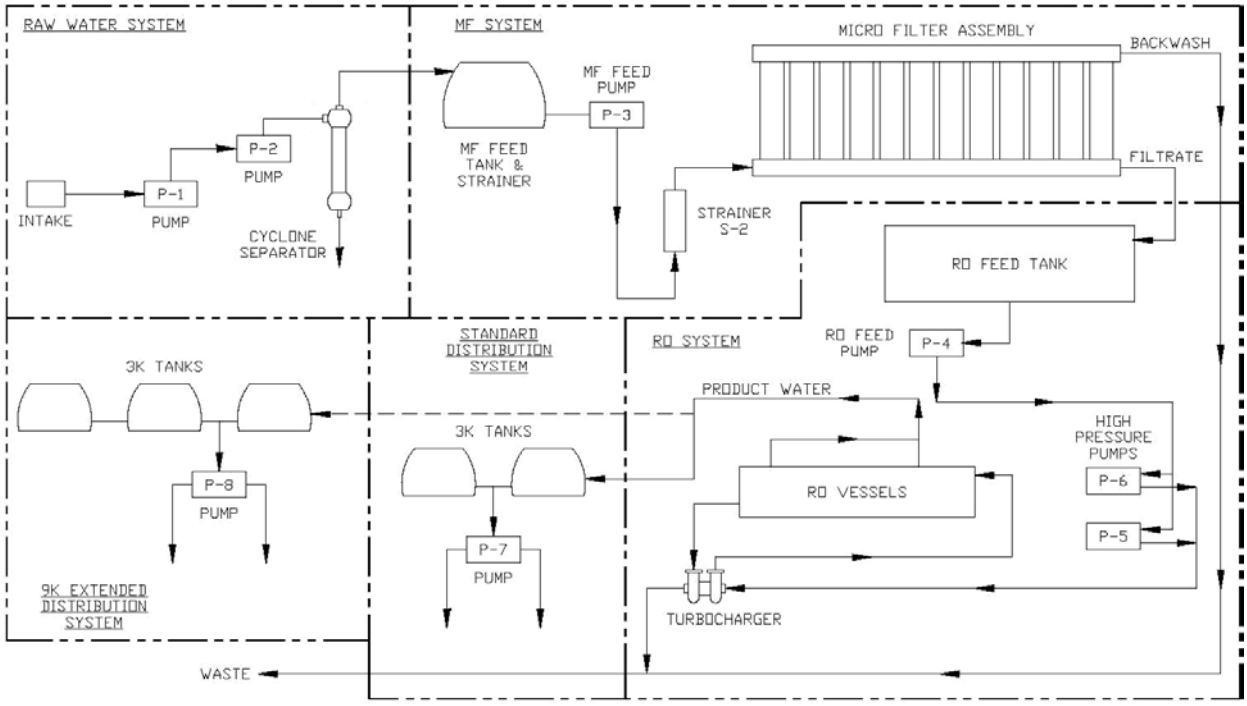

Figure 1. TWPS Flow Diagram.

The detailed information of the TWPS operational process in the following paragraphs provides process, control instrumentation and control logic information in a manner that will provide an understanding of the water purification process.

RAW WATER SYSTEM

The raw water system pumps raw water from the water source to the TWPS (see Figure 2). The main components of the raw water system are the floating inlet strainer with an anchor and rope, raw water suction and discharge hoses, a diesel engine-driven pump, an electric motor-driven pump, a cyclone separator, a static mixer, and various adapters that connect the hoses to the components of the raw water system. Some of the adapters also include a valve.

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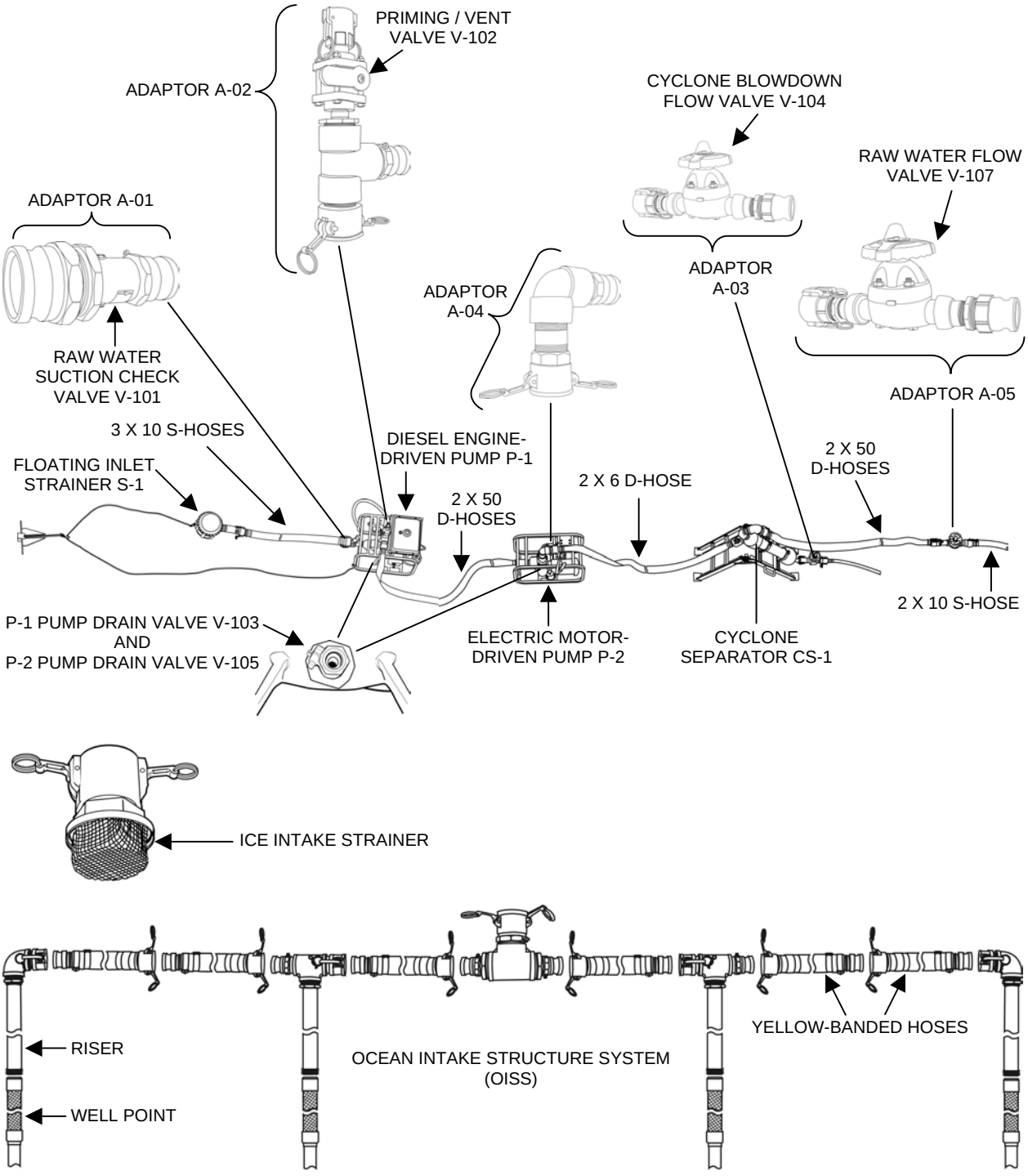

Figure 2. Main Components of the Raw Water System.

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The raw water inlet strainer is connected to the end of a green-banded suction hose. The strainer floats just under the water, but still above the bottom of the water source. This keeps the TWPS from picking up bottom mud. The strainer contains a perforated screen that keeps out large surface debris and fish. An anchor is used to deploy the strainer and hold it in place. A 300 ft. rope secures the anchor to the strainer and is used to deploy and retrieve the anchor and the inlet strainer. A second, non-floating strainer is included with the cold weather module for use with ice holes.

The ocean intake structure system (OISS) is used for drawing raw water through beach well point intakes for raw water sources with surf or extreme tidal conditions. The OISS consists of four well points with risers connected to a header by yellow-banded hoses. The well points are slotted and screened to keep the beach sand out of the well points and risers. The well points and risers are jetted into the sand using one of the raw water pumps to draw water from the source and discharge it through a riser and wellpoint. Once the riser/wellpoint assemblies are installed, the pumps are set up as usual with the suction attached to the header end of the OISS. Water is drawn up through the well points and pumped through the raw water system.

Thirteen sections of three-in. diameter, ten-ft. long suction (rigid) green-banded hose come with the TWPS. These hose sections are used as needed to transport raw water from the inlet strainer or OISS to one of the two raw water pumps. The number used depends on site conditions.

The TWPS is equipped with two raw water pumps: an Electric Motor-Driven Pump P-2 and a Diesel Engine-Driven Pump P-1. If the elevation of the MF feed tank is 25 ft. or less above the pump location and within 200 ft. of the source, the Motor-Driven Pump P-2 is normally deployed without the P-1 pump. The P-1 pump may also be used by itself in this situation. If the MF feed tank is more than 25 ft. above the pump location or further than 200 ft. from the source, then both the Diesel Engine-Driven Pump P-1 and the Motor-Driven Pump P-2 are deployed. The engine-driven pump is deployed closest to the source and the motor-driven pump is deployed between the engine-driven pump and the MF feed tank. Figure 2 shows both pumps deployed. Valve V-103 is connected at the bottom of the Diesel Engine-Driven Pump P-1 and is used to drain the pump when needed such as for transportation, storage, or maintenance. Valve V-105 is a drain valve at the bottom of the Electric Motor-Driven Pump P-2 and serves the same function as V-103.

Adaptor Assembly A-01 connects the three in., green-banded suction hose from the water source to the suction inlet of the first pump. Adaptor Assembly A-01 includes Raw Water Suction Check Valve V-101, which helps hold the prime when the pump is stopped. A strap on the adaptor is secured to the pump frame to support the adaptor and the hose that is connected to the adaptor.

The cyclone separator is used at ocean beach water sites when the floating strainer is used. Both Raw Water Pumps P-1 and P-2 are deployed when the cyclone separator is used. The separator is positioned at the discharge of Electric Motor-Driven Pump P-2. As water enters the cyclone separator, a high-speed swirl is formed. The heavier dirt and/or sand is thrown to the outside and drops to the bottom of the separator where it is carried out by a small amount of water underflow. The required underflow is 5 gallons per minute (gpm). The main water flow leaves the cyclone separator at the center of the top of the separator to a discharge hose.

Adaptor Assembly A-03 connects the cyclone separator underflow outlet to a one-in. diameter, five-ft. long, braided flexible hose. Adaptor Assembly A-03 includes Cyclone Blowdown Flow Valve V-104, which is manually set to provide an underflow of five gpm. The nominal TWPS flow requirement is 65 gpm. When the cyclone separator is deployed, the raw water pumps will deliver 70 gpm and the net flow from the raw water system will be 65 gpm.

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Adaptor Assembly A-02 connects the discharge outlet of the first pump to the appropriate discharge pressure (flexible) hose. The "appropriate" hose is determined by the deployment arrangement used. The list below identifies the possible raw water pump, cyclone, adaptor, and hose arrangements.

- Diesel Engine-Driven Pump P-1 → Adaptor Assembly A-02 → up to four sections of two-in. diameter, fifty-ft. long, discharge hose
- Electric Motor-Driven Pump P-2 → Adaptor Assembly A-02 → up to two sections of two-in. diameter, fifty-ft. long, discharge hose
- Diesel Engine-Driven Pump P-1 → Adaptor Assembly A-02 → up to four sections of two-in. diameter, fifty-ft. long, discharge hose → Electric Motor-Driven Pump P-2 → Adaptor Assembly A-04 → two-in. diameter, six-ft. long, discharge hose → cyclone separator → up to two sections of two-in. diameter, fifty-ft. long discharge hose

Adaptor Assembly A-02 includes Priming (Vent) Valve V-102 and a priming discharge hose.

Adaptor Assembly A-05 is connected to the discharge end of the last section of two-in. diameter, fifty-ft. long hose. A two-in. diameter, ten-ft. long, suction (rigid) hose is connected at the discharge end of Adaptor Assembly A-05 and discharges into the MF feed tank. Adaptor Assembly A-05 includes Raw Water Flow Valve V-107. Raw Water Flow Valve V-107 is manually set to adjust the flow of raw water to a rate that will maintain the proper MF feed tank level.

After the raw water system is deployed, the first raw water pump (the pump closest to the source) is primed by removing the priming hose from Adaptor Assembly A-02, opening the Priming Valve V-102, and filling the pump with water from the priming pitcher. The priming hose is then re-connected and the first pump is started. Depending on the suction lift and the condition of the pump, the pump will evacuate air from the suction hose and lift water from the source in as little as a few minutes to as long as 15 minutes. Once the air is evacuated from the suction hose and water is observed, Priming Valve V-102 is closed. If a second pump is used, the second pump is started after the first pump (P-1) has pressurized the discharge hose to the second pump (P2). Raw water flows from the pump discharge to the MF feed tank. The operator adjusts flow to the MF feed tank as needed to keep the tank at least half full, but not overflowing. Flow is set by adjusting Raw Water Flow Valve V-107. If flow is temporarily not needed, the motor-driven pump is stopped. If the engine-driven pump is used, this pump may be left running at idle, but the Priming (Vent) Valve V-102 at the discharge of the pump is opened to prevent the pump from overheating.

If raw water is drawn from a chlorinated water source, a static mixer is installed between the suction hose and the inlet of Adaptor Assembly A-05. The static mixer becomes the injection point for sodium bisulfite from a chemical injection system. Chlorinated water will rapidly damage the MF filter membranes and slowly degrade the RO elements. Sodium bisulfite is injected into and thoroughly mixed with the raw water in the static mixer before the water is discharged into the MF feed tank. Sodium bisulfite neutralizes chlorine and protects the MF filters and RO elements. The chemical injection system is described in more detail in this WP under the heading **Chemical Injection System**.

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MICROFILTRATION (MF) SYSTEM

The Micro-Filtration system removes suspended solids (dirt) and microorganisms down to 0.2 micron, which would foul the RO membranes possibly leading to mission failure. The MF system consist of the MF feed tank, the MF feed tank strainer bag, the MF feed pump, the basket strainer, the MF assembly, automatic valves to direct and control the flow through the filters for normal filtration, backwash and cleaning and instrumentation. The MF assembly consists of 12 filter modules attached together to form a single assembly. All of the water discharged to the MF passes through the filter fibers and is filtered. The filtered water is called **Filtrate**.

The raw feed water discharges into the inside of the MF feed tank bag filter S-1 (see Figure 3). This is a cloth-type filter that is sized to trap seaweed fragments, which would quickly plug the basket strainer if not removed first. The MF Feed Pump (P-3) is a motor-driven pump deployed off of the skid near the MF feed tank. Connected at the bottom of the pump P-3 is Drain Valve V-108, which is used to drain the pump for maintenance or at the end of the mission. The MF feed pump draws water from the tank through the bag filter and discharges the water to the TWPS skid connection at the inlet to basket strainer S-2.

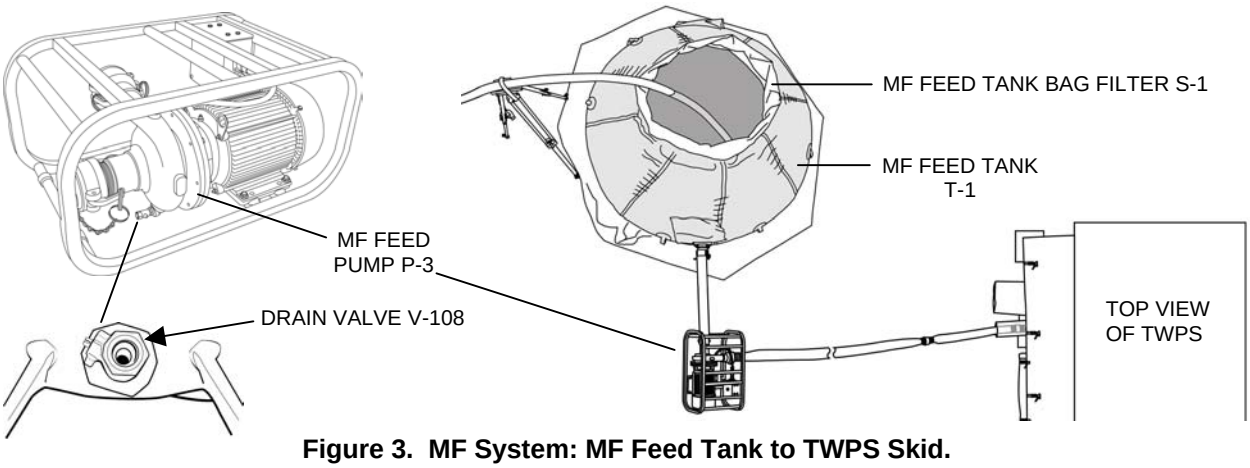

Figure 3. MF System: MF Feed Tank to TWPS Skid.

From the skid inlet connection, the MF feed water passes through the basket strainer S-2, which removes material larger than 600 micron (see Figure 4). The need to clean the strainer is indicated by the clean strainer alarm which is activated by low-pressure or low flow during the high flow shell sweep step of backwash. Vent Valve V-110, mounted between the strainer S-2 and valve V-111, is used as a vent when draining the basket strainer. Valve V-110 is also used as a sample valve for measuring the raw water conductivity. From the strainer, water flows through Automatic Valve V-111, which is open during normal processing to provide water flow as required. Pressure Gauge PI-101 measures the feed pressure to the MF assembly. Flow Element, FE-101, measures the MF feed flow. MF Feed Flow Transmitter FT-101 (see Figure 5) receives the flow element output and sends flow information for display on the Operator Control Panel (OCP). The MF feed flow splits to the upper and lower MF Feed Valves V-112 and 113 and into the MF assembly feed channels. During operation, the Upper Feed Valve V-112 is de-energized full open while the Lower Feed Valve V-113 is de-energized closed to an adjustable stop. The stop is set to provide similar flow rates to the top and bottom feed channels.

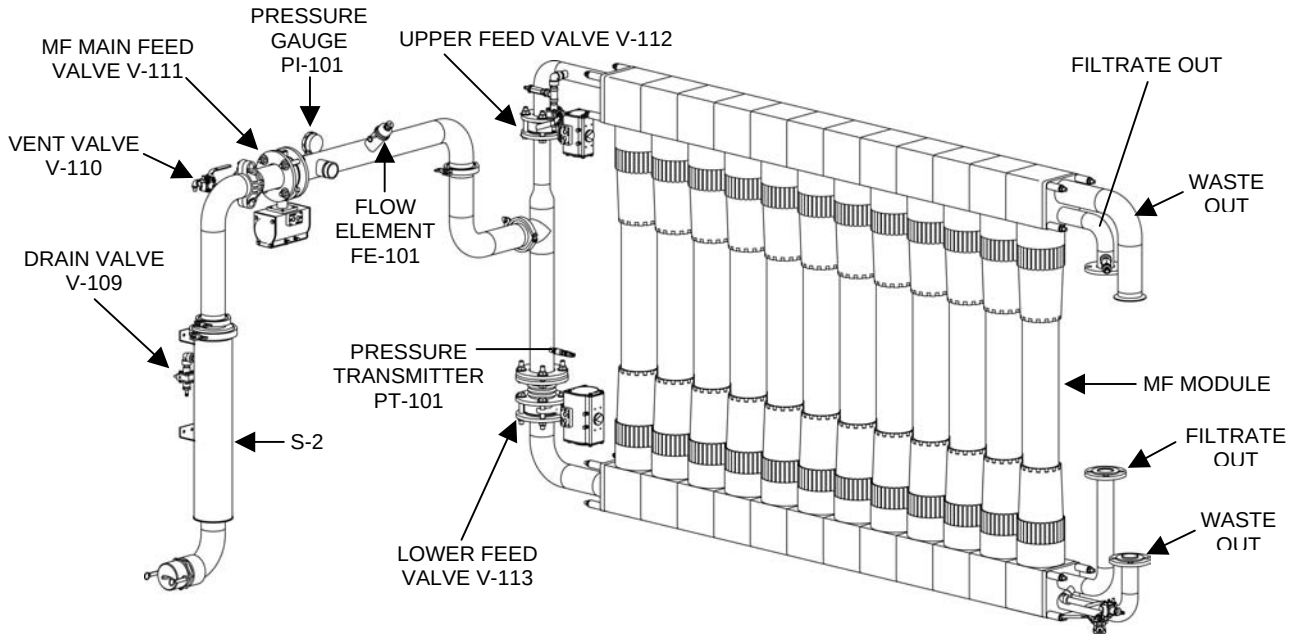

Figure 4. MF System: Strainer S-2 to MF Modules.

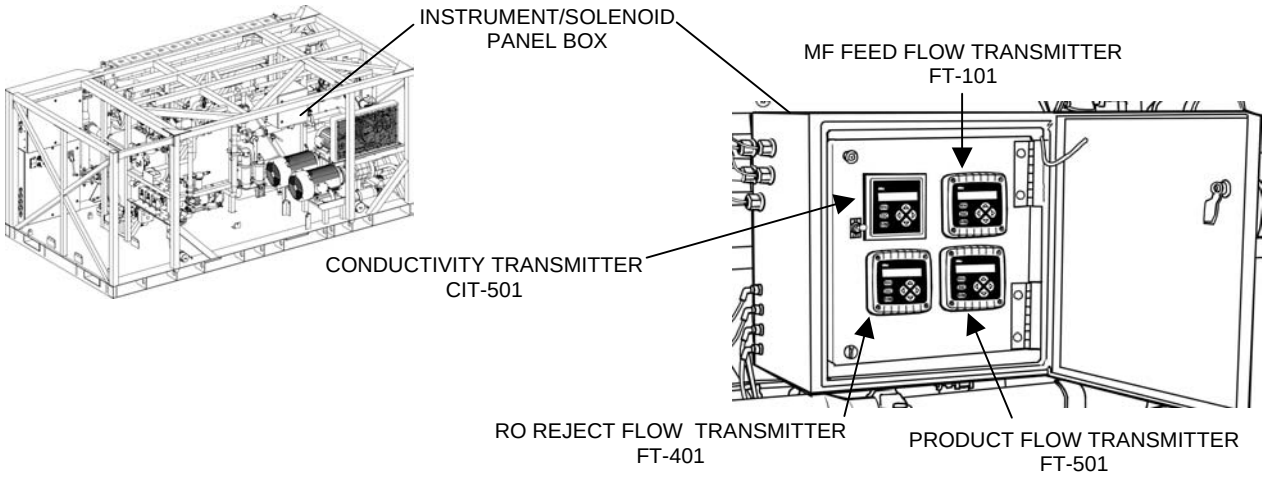

Figure 5. Instrument/Solenoid Panel Box.

The feed water flows into the top and bottom shell of each of the 12 MF elements and around the outside of the MF filtration fibers contained within each element (see Figure 6). The feed water then flows through the fiber pores and into the hollow center of each fiber. Dirt and organic materials in the feed water build up on the outside of the fibers until removed through the waste outlets by the next backwash. The filtered feed (filtrate) flows out the hollow center of the MF fibers and into filtrate collection channels. The channels collect the filtrate from the modules and direct the flow out the upper and lower filtrate outlets of the MF assembly.

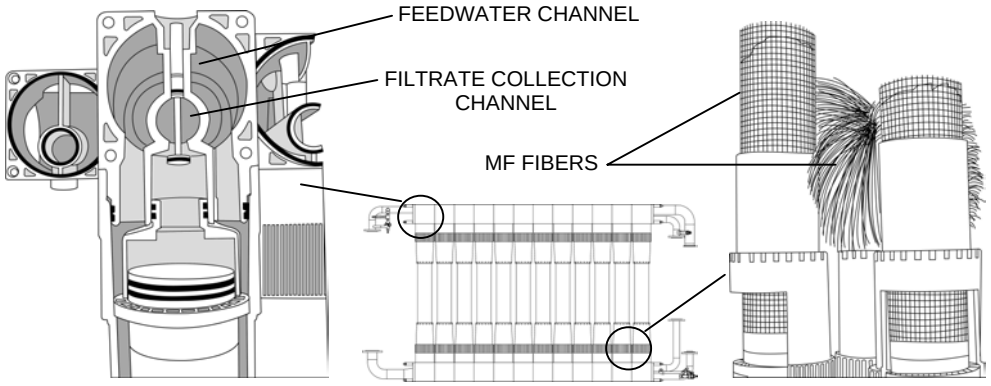

Figure 6. Micro-Filtration (MF) Process.

Filtrate that flows out the upper end of the MF assembly flows through Upper Filtrate Outlet Valve V-201 (see Figure 7). During normal operation V-201 is de-energized open to allow normal flow to Filtrate Flow Control Valve V-202. Filtrate that flows out the lower end of the assembly flows directly to Valve V-202. MF Filtrate Pressure Gauge PI-201 measures the filtrate pressure in the line between the Micro-filter (MF) assembly and Filtrate Flow Control Valve V-202. Piping directs the filtrate through the automatic Filtrate Flow Control Valve (V-202) and into the RO feed tank.

Pressure Transmitters PT-101 (see Figure 6) and PT-102 (see Figure 7) measure the feed and filtrate pressures. The difference between the feed pressure and the filtrate pressure is the trans-membrane pressure (TMP; pressure drop across the membranes, or filter element fibers, of the MF assembly). TMP (pressure drop) is displayed at the operator control panel (OCP) and is an indication of how clogged the fibers are. A high TMP indicates that the MF fibers are becoming clogged with material and need to be cleaned. A high alarm indicates the need to clean the MF. The Operator can also compare the PI-101 feed pressure gauge reading with the PI-201 filtrate pressure gauge reading as a manual check against the automatically measured and calculated TMP.

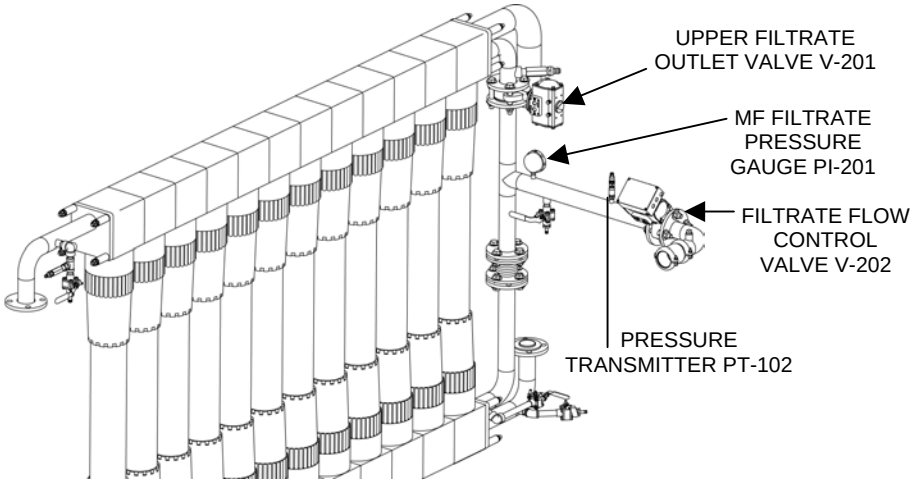

Figure 7. MF System: MF Modules to Discharge to RO Feed Tank.

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MICROFILTRATION SYSTEM BACKWASH OPERATION

Valve sequencing for backwash is handled by the PLC (Programmable Logic Controller). The PLC program fixes the frequency at 15-minutes intervals. If the RO Feed Tank level has not reached 100%, the tank will fill to 100% before backwash begins. **THE OPERATOR MUST MANUALLY START THE FIRST BACKWASH SEQUENCE.**

The backwash operation is run automatically through the following stages (see Figure 8; also refer to **AIR SYSTEM** for air system/solenoid valve theory of operation and illustrations):

1. Drain fibers: 15 psig air pushes water out of the MF fibers to the RO feed tank
    a. Valves V-111, V-112, and V-201 close. Valves V-113 and V-202 open.
    b. Air System Solenoid Valve XV-902 opens to allow low-pressure air through Check Valve V-912 and into the upper filtrate outlet channel of the MF system. This low-pressure air purges the filtrate out of the MF fibers to the RO feed tank.
2. Pressurize fibers: 100 psig air pressurizes the inside of the MF fibers
    a. XV-902 and V-202 close.
    b. With all valves now closed, including MF Upper Filtrate Valve V-201, Solenoid Valve XV-901 opens allowing 100 psig air through Check Valve V-912 to pressurize the filtrate side (inside) of the MF fibers.
3. Blow-back: the MF shell outlet valves are opened to allow the100 psig air in the MF fibers to blow suddenly through the fibers to the MF shell
    The Shell Backwash Upper and Shell Lower Outlet Valves V-401 and V-402 open quickly to provide a sudden release of pressurized air. This rapid expansion of air through the fiber pores blows the dirt layer from the outer surfaces of the fibers.
4. Scrub: air and feed water flushes dirt out of the MF shell
    With the backwash air still on, Main Feed Valve V-111 de-energizes open. This allows feed water to flush the dirt out of the MF shell, through the Backwash Upper Outlet Valve V-401 and out the TWPS waste outlet.
5. Sweep (or shell sweep): feed water only flushes dirt out of the MF shell
    Backwash Air Valve XV-901 closes and the feed water continues to sweep the dirt out of the MF shell.
6. Fill fibers: feed water flows into the MF shell and into the fibers
    a. Normal flow conditions are reset.
    b. Upper and Lower Feed Valves V-112 and V-113, Upper Filtrate Valve V-201, and valve V-111 are all de-energized open.
    c. Upper and Lower Backwash Valves V-401 and V-402 de-energize closed and the feed water is pushed into the fiber walls and into the fiber cores.
7. Rewet 1: air is used to force water into the fibers, then the air pressure is released
    a. The Feed Valve V-111 and the Main Filtrate Valve V-202 close.
    b. The Upper Backwash Valve V-401 opens to exhaust pressure from the shell.
    c. The Upper Backwash Valve closes and the Backwash Air Valve XV-901 opens to pressurize the water in the fibers through Check Valve V-912.
    d. XV-901 closes, the Main Filtrate Valve V-202 opens and, after a momentary delay, the Upper Backwash Valve V-401 opens to blow off the air pressure. This step is noted by the sound of air and water discharge into the RO feed tank.
8. Rewet 2
    The Rewet 1 stage is repeated.
9. Return to normal
    The MF filtration system returns to normal operation.

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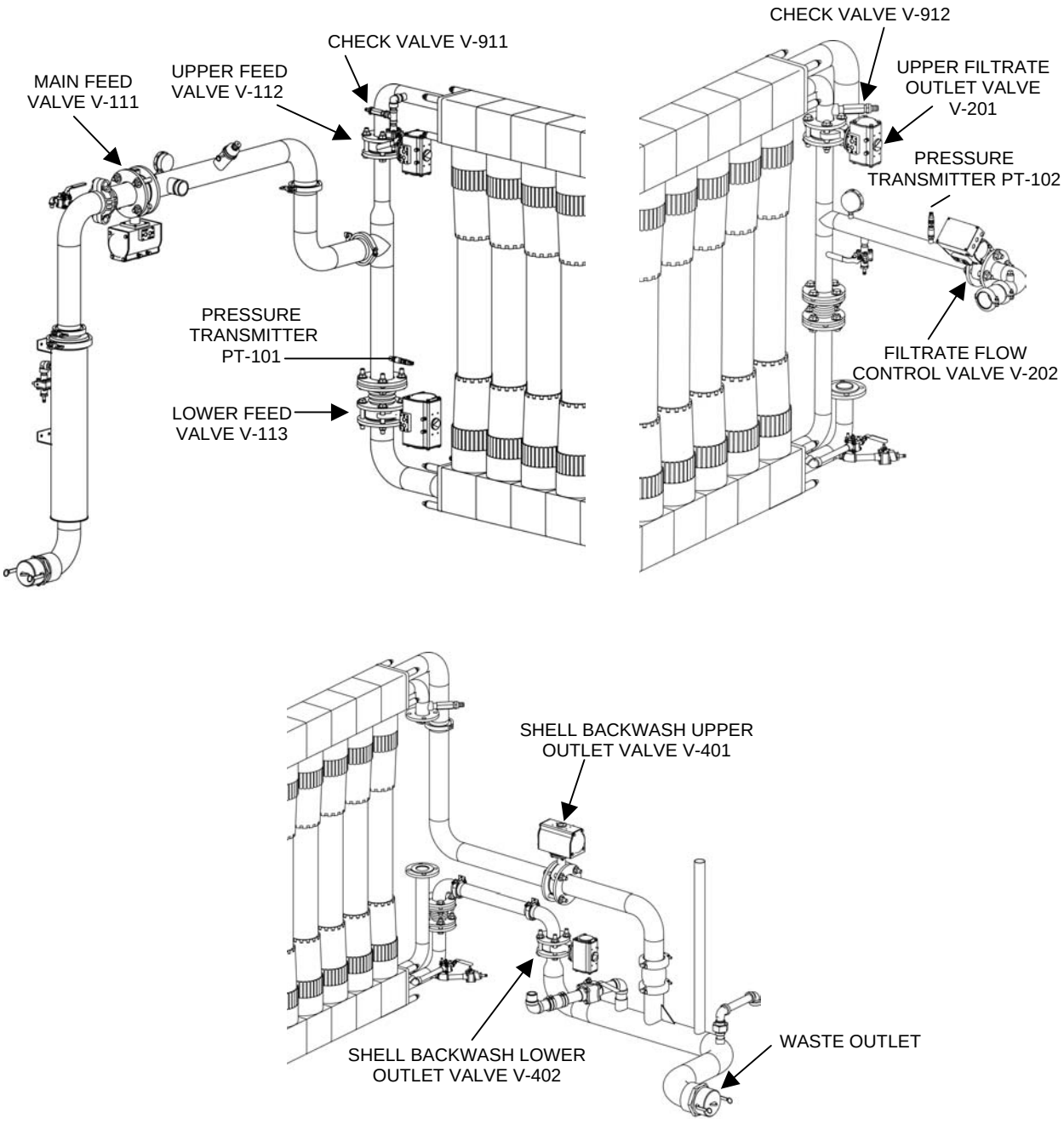

Figure 8. MF Backwash Operation.

The total time off-line for backwash and rewet is 3 minutes. During this time water continues to be drawn from the RO feed tank and processed through the rest of the TWPS to provide a continuous flow of product water. Since filtrate is temporarily stopped from flowing to the RO feed tank during backwash, the RO feed tank level drops to approximately 1/4 full during this time. The MF feed tank level will drop approximately 125 gallons during the shell sweep stage and will be low by approximately 90 gallons after backwash is completed. If Flow Control Valve V-107 is properly adjusted, the raw water flow will replace this loss by the next backwash. The MF feed tank holds 1000 gallons full and is normally kept between half and three quarters full by adjusting the raw water flow.

The blow-back stage results in a sudden and very high velocity surge in the waste out piping and hose, which must be allowed to pass easily. The red-banded, waste out hose is a 6-in. discharge hose, large enough that it will not be fill with water and can expand to pass the blow-back air. This hose should be set to slope steadily back to the water source.

The backwash removes all of the loose dirt. However, some material sticks or gets trapped inside the pores of the fibers. As a result, the pressure drop (TMP) across the fibers increases over time. To measure this, pressure transmitters PT-101 and PT-102, measure the MF feed water and filtrate pressures. The pressure drop, trans-membrane pressure (TMP) is calculated by the PLC and displayed at the OCP. When it reaches a set maximum, a high TMP alarm indicates the need to schedule cleaning within the next 40 hours. Typically, the interval between cleanings will be at least 300 hours of operation and could be as long as 1000 hours.

The filtrate typically is very low in suspended solids content and is free of micro-organisms. Broken fibers, however, may allow a flow of raw water directly into the filtrate. A high number of broken fibers will lead to enough material in the filtrate to foul the RO elements with dirt and bacterial slime. Broken fibers can be detected by a pressure hold (integrity) test, which is conducted automatically after operator selection. A test fail light indicates that the leakage detected is too high. The alarm is set well below the point where serious RO fouling would occur. The air test is conducted at the beginning and end of each mission to indicate fiber condition and the need for scheduled maintenance. The distribution of broken fibers among the 12 elements is determined by using a sound probe leak detector to determine the point of leakage. Defective elements can be individually replaced and may also be individually isolated by closing the individual module filtrate valves.

REVERSE OSMOSIS (RO) SYSTEM

The RO process is pressure driven. Pressure moves water through the pores of the RO membranes while most of the salts are rejected by molecular level electrical charges in the pores. Only a portion of the feed water is forced through the membranes, becoming product water. The water that does not pass through the membranes contains concentrated salts and is discharged as reject. Increasing the pressure increases the product water flow. Feed water with a higher salt content requires higher pressure to force water through the RO membranes and produce water than feed water with a lower salt content. For example, low salt river water may require only 300 pounds per square inch gauge (psig) to produce 25 gpm, while normal seawater may require 800 psig to produce 20 gpm. The maximum pressure available is 1200 psig. Colder feed water also requires higher pressure than warmer feed water. Fouling, biological films, and salt scale also restrict water flow through the membrane and force operation at higher than normal pressures.

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Filtrate from the MF system is stored in the RO Feed Tank T-2 (see Figure 9). The RO feed tank stores a sufficient supply of filtrate to allow the production of product water to continue uninterrupted during the intervals when the MF modules are being backwashed. This tank is also used for cleaning solutions when cleaning the RO and MF.

Level Transmitter LT-201 provides the level measurement for PLC control of the tank level. After a backwash, the filtrate flows at approximately 62 gpm to refill the tank until the level reaches the high-level point. After reaching the high level point, the level is controlled to remain at this point until the next backwash. The tank level is displayed on the OCP as percent of high level.

Temperature Indicator TI-202 is a dial thermometer threaded into the RO feed tank.

Tank Heaters H-1 and H-2 are used for heating cleaning solutions and, if needed, to provide added generator load to avoid wet stacking during normal operation.

Strainer S-3 sits inside the tank over the RO feed pump suction to prevent objects, which may fall into the tank, from entering the pump.

RO Feed Pump P-4 draws filtrate from the tank as RO feed water and provides the pressure needed by the HP Pumps. With cleaning bypass valves properly set, this pump also circulates the cleaning solutions used when cleaning either the MF or RO.

Antiscalant Injection Check Valve V-623 is connected between the RO Feed Pump and V-212. The injection check valve injects a measured amount of antiscalant into the RO feed water leaving the feed pump. This antiscalant inhibits salt scale formation on the RO membranes. (See Chemical Injection System for further explanation.)

High Pressure Pump (HPP) Feed Valve V-212 is open for normal operation and is manually closed for cleaning and when removing the Inline Strainer S-4.

Strainer S-4 protects the HP pumps by removing sand and dirt, which may blow into the RO feed tank. S-4 Drain Valve V-213 at the bottom of Strainer S-4 is used to drain the strainer.

RO Feed Pressure Gauge PI-202 indicates the pressure from the RO feed pump for operator reference. Usual pressure is 40 to 45 psig.

RO Feed Pressure Transmitter PT-201 provides a pressure measurement that is used by the PLC to protect the HP pumps. The transmitter and PLC set off an alarm and shut down the HP pumps when the pressure from the RO feed pump drops below 35 psig.

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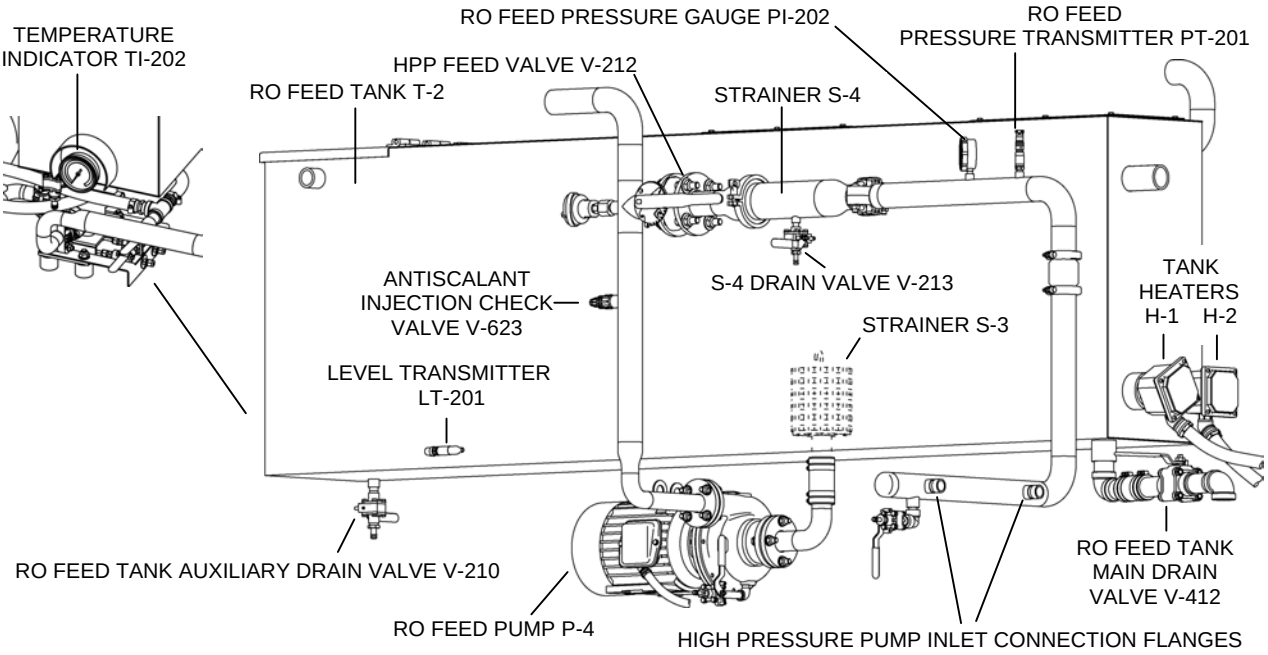

Figure 9. RO System: RO Feed Tank to High Pressure Pump Inlets.

Two High Pressure Pumps (HPP) P-5 and P-6 provide the operating pressure required by the RO elements to produce the desired product water flow (see Figure 10). A portion of the feed water to the pumps acts as a lubricant and is discharged at low pressure back to the RO feed tank near the pumps.

HPP Discharge Pressure Gauge PI-301 shows the High Pressure Pump discharge pressure. HPP Outlet Pressure Relief Valve RV-301, set at 1050 psig, protects the HP pumps from over pressure.

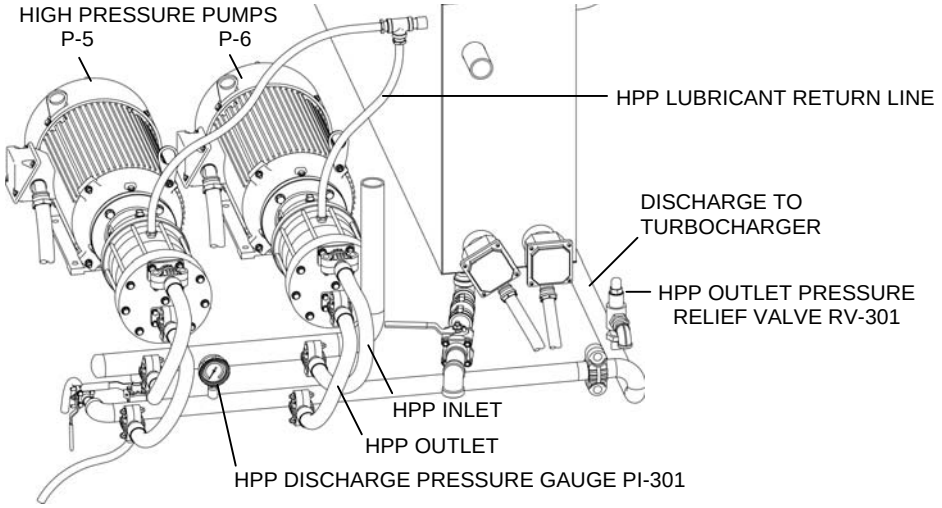

Figure 10. RO System: High Pressure Pumps.

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The Pressure Recovery Turbocharger PRT-1 consists of a pump and a turbine connected together on a common shaft within a common casing (see Figure 11). RO feed water from the HP pumps is received at the turbocharger pump inlet. The turbocharger pump boosts the water pressure and discharges to the RO vessels. RO reject from the RO vessels passes through the turbocharger turbine. Pressure energy from the RO reject water is transferred from the turbocharger turbine to the turbocharger pump through the common shaft.

RO Feed Pressure Transmitter PT-302 provides RO feed pressure (pressure to the RO vessels) display at the OCP and a high-pressure alarm if the pressure exceeds 1225 psig. RO Feed Pressure Gauge PI-304 provides a direct alternative reading of the pressure.

RO Feed Pressure Relief Valve RV-302, set at 1250 psig, protects the RO vessels from over pressure and Air Purge Valve V-913 is opened to purge water or cleaning solution from the RO system.

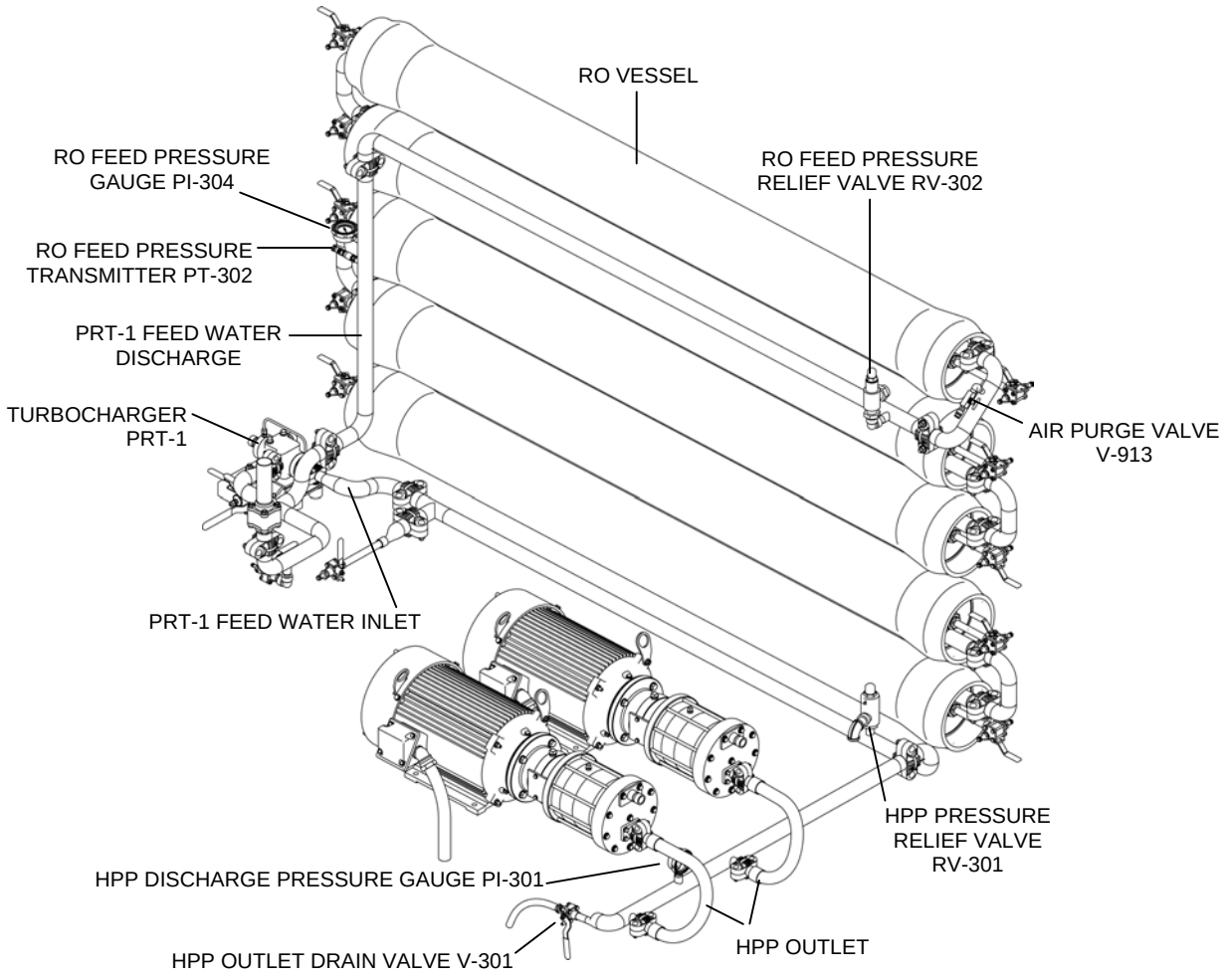

Figure 11. RO System: High Pressure Pumps to RO Vessels.

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Five RO vessels, each containing two RO elements, remove dissolved solids (salts) to produce the product water through a process called reverse osmosis. In this process, pressurized RO feed water is delivered to the RO elements in the RO vessels. In the RO elements, the feed water flows across sheets of membrane material (see Figure 12). Some of the water passes through the membrane sheets and is collected to become product water. Most of the dissolved solids (salts) are blocked from passing through the membranes. Only 1/3 to 1/2 of the RO feed water passes through the membrane sheets to become product water. The rest of the water containing most of the dissolved solids continues flowing past the membranes and exits the RO vessels as reject. The RO feed water enters the top vessel and flows through each of the vessels in series and exits the bottom RO vessel as reject. The portion of feed water that passes through the RO membranes exits as product water from the outer end of both elements in each RO vessel. The product water collects in a manifold and flows out to the distribution system.

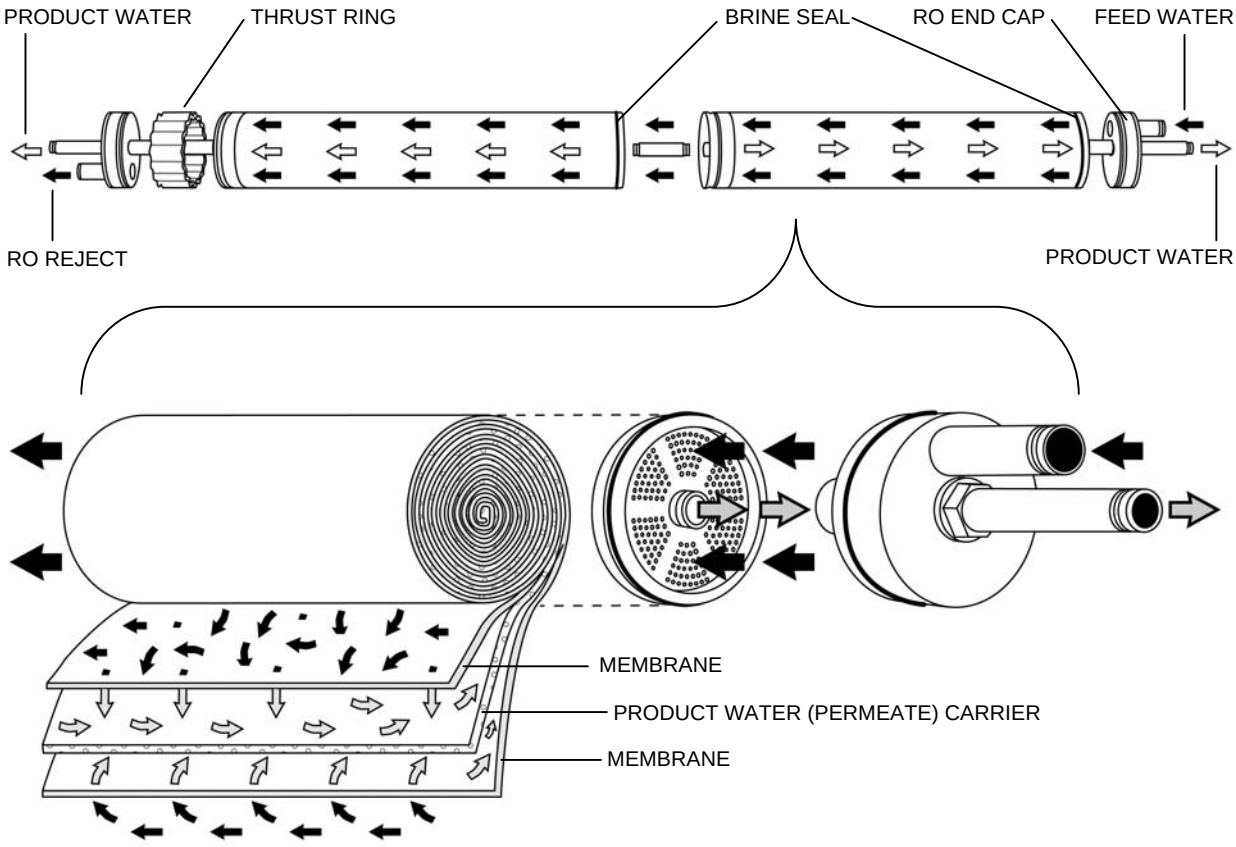

Figure 12. Reverse Osmosis Process.

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Main Pressure Control Valve HCV-401 and Auxiliary Pressure Control Valve HCV-401A are used to bypass some of the reject flow around the turbocharger and directly to waste (see Figure 13). This enables the operator to reduce the flow of reject through the turbocharger and, in turn, reduce the pressure boost that the turbine delivers to the RO feed.

RO Reject Pressure Gauge PI-401 indicates the reject pressure leaving the RO vessels.

Reject Check Valve V-411 prevents back flow into the RO elements when cleaning the MF.

Reject Flow Element FE-401 measures the reject flow. RO Reject Flow Transmitter FT-401 (see Figure 5) receives the flow element output and sends flow information for display on the Operator Control Panel (OCP).

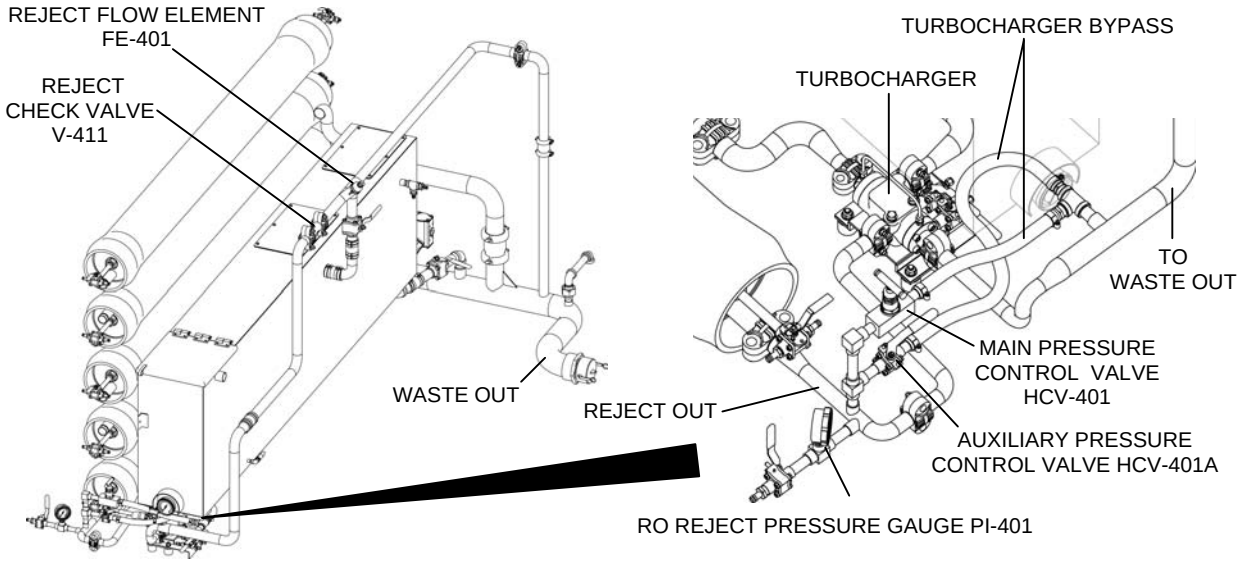

Figure 13. RO System: RO Vessels to Waste Out.

At both ends of each RO vessel, three-way valves direct product flow from each element to the product manifold or to the sample/drain hose for flow rate and conductivity measurement or for draining (see Figure 14). A Low Range Conductivity Element, CE-501A, and a High Range Conductivity Element, CE-501B, measure the product water conductivity. These are connected to the Conductivity Analyzer CIT-501, which is mounted in the instrument/solenoid panel (see Figure 5). The conductivity analyzer provides an output to the PLC which displays the measurement as mg/l total dissolve solids TDS on the OCP. This indicates how much salt is in the product water. A high alarm indicates when the TDS is greater than 1000mg/L or when the calculated % Salt Rejection is too low.

Product Pressure Gauge PI-501 reads the product pressure. Product Relief Valve RV-501 is set to relieve if pressure exceed 20 psig.

Product Vacuum Breaker VB-501 eliminates siphoning, which could pull chlorinated product water back into the RO when not in operation.

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Product Flow Element FE-501 (mounted in the piping) and Product Flow Transmitter FT-501 (mounted in the instrument/solenoid panel; see Figure 5) measure product flow. This flow is displayed at the OCP.

Product Utility Valve V-511 is used for filling chemical buckets and general use.

Hypochlorite Injection Check Valve V-633 injects a measured amount of calcium hypochlorite into the product water flowing to the product water distribution system. This chemical chlorinates the product water to kill and prevent the growth of algae and bacteria in the product water. (See Chemical Injection System for further explanation.)

Product Water Check Valve V-512 prevents the flow of chlorinated product water back into the RO when not in operation.

Four 10-ft. sections of blue-banded suction hose are connected to the product water outlet to discharge product water to a distribution tank.

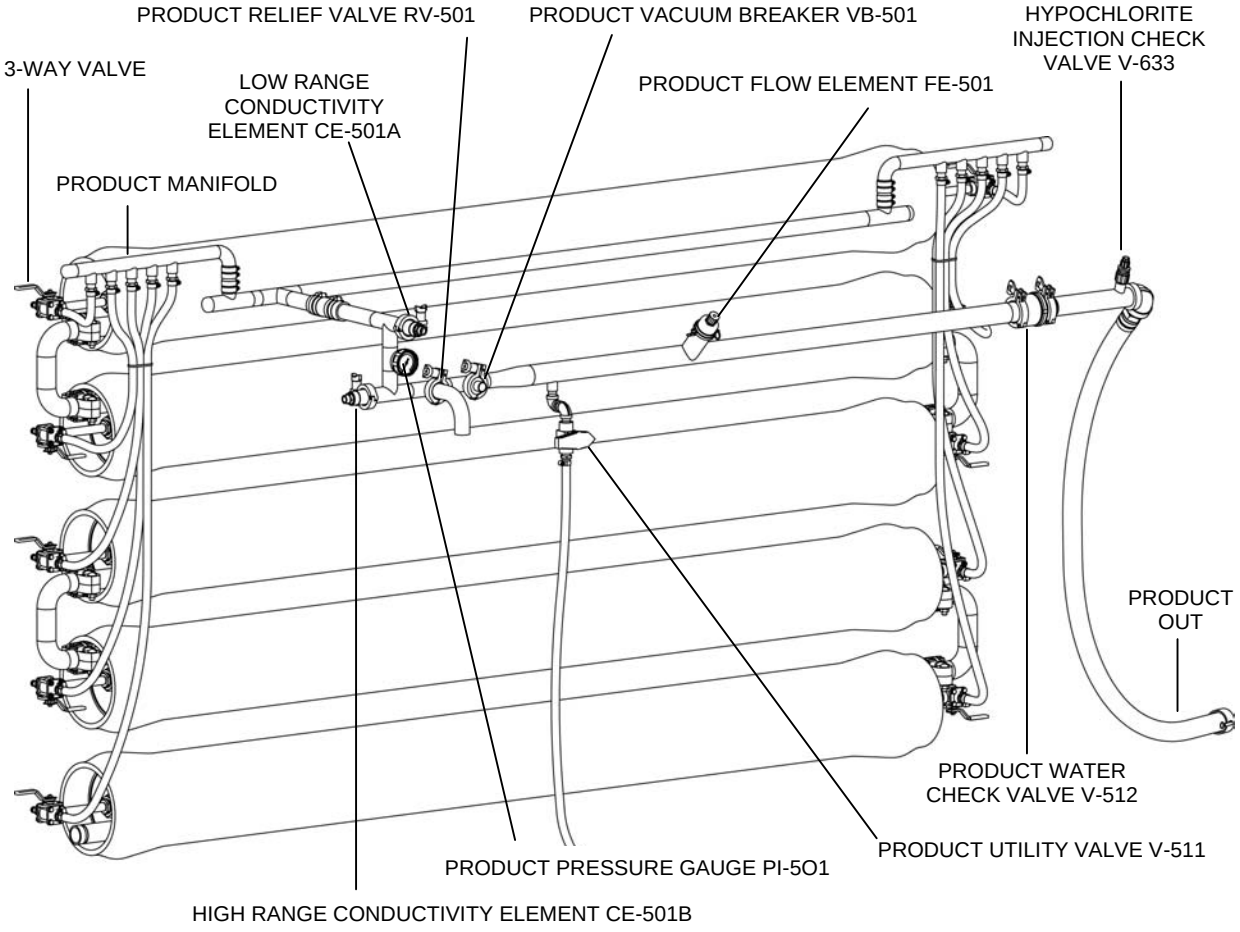

Figure 14. RO System: RO Vessels to Product Out.

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AIR SYSTEM

Air System Operation Overview

The air system provides air needed to backwash and drain the MF (micro-filter) and to operate the TWPS Automatic Valves. The air system is composed of a high-pressure, three-stage compressor assembly, a two-stage outlet air filtration system, an air receiver tank, and a series of safety valves and regulating valves that are either manually or solenoid-operated. A simplified representation of the air system is illustrated in Figure 15.

The compressor supplies high pressure air, up to 1800 psig, through a two-stage air filtration system to Air System Section 1. From Air System Section 1, Air Receiver Tank R-1 is charged to about 800 to 1000 psig so that the air system has a sufficient reserve of pressurized air when needed for various TWPS operations. Pressure switch assembly PSL/PSH-901 turns the compressor on when the pressure falls below 800 psig and turns the compressor off when the pressure exceeds 950 psig. The high-pressure air is reduced to 100 psig as it flows through Air System Section 1 to Air System Section 3.

Air System Section 3 further reduces the air pressure to 15 psig that is used for draining the MF fibers before backwash and for draining the MF assembly shell during drain-down. As indicated in Figure 15, 15 psig air flows from point A in Section 3 to point B at the upper feed inlet of the MF Assembly and from point C in Section 3 through Air System Section 4 to point D at the filtrate outlet of the MF Assembly. To backwash the MF fibers, 100 psig air flows from point E in Section 3 through Air System Section 4 to point D at the filtrate outlet of the MF Assembly.

One-hundred psig air also flows from Section 3 to Air System Section 6. Any remaining oil/water is removed from the air as it flows through Section 6 to the Feed Flow Control Panel, to Filtrate Flow Control Valve V-202, and to an air manifold assembly in the Instrument/Solenoid Panel Box.

The Feed Flow Control Panel controls the operation of Filtrate Flow Control Valve V-202, which controls the flow of filtrate from the MF system to the RO feed tank. The Feed Flow Control Panel is described in more detail in WP 0011, Description and Use of Operator Controls and Indicators.

The Air Manifold Assembly is described in more detail a little later in this work package under the heading **Air Manifold Assembly**.

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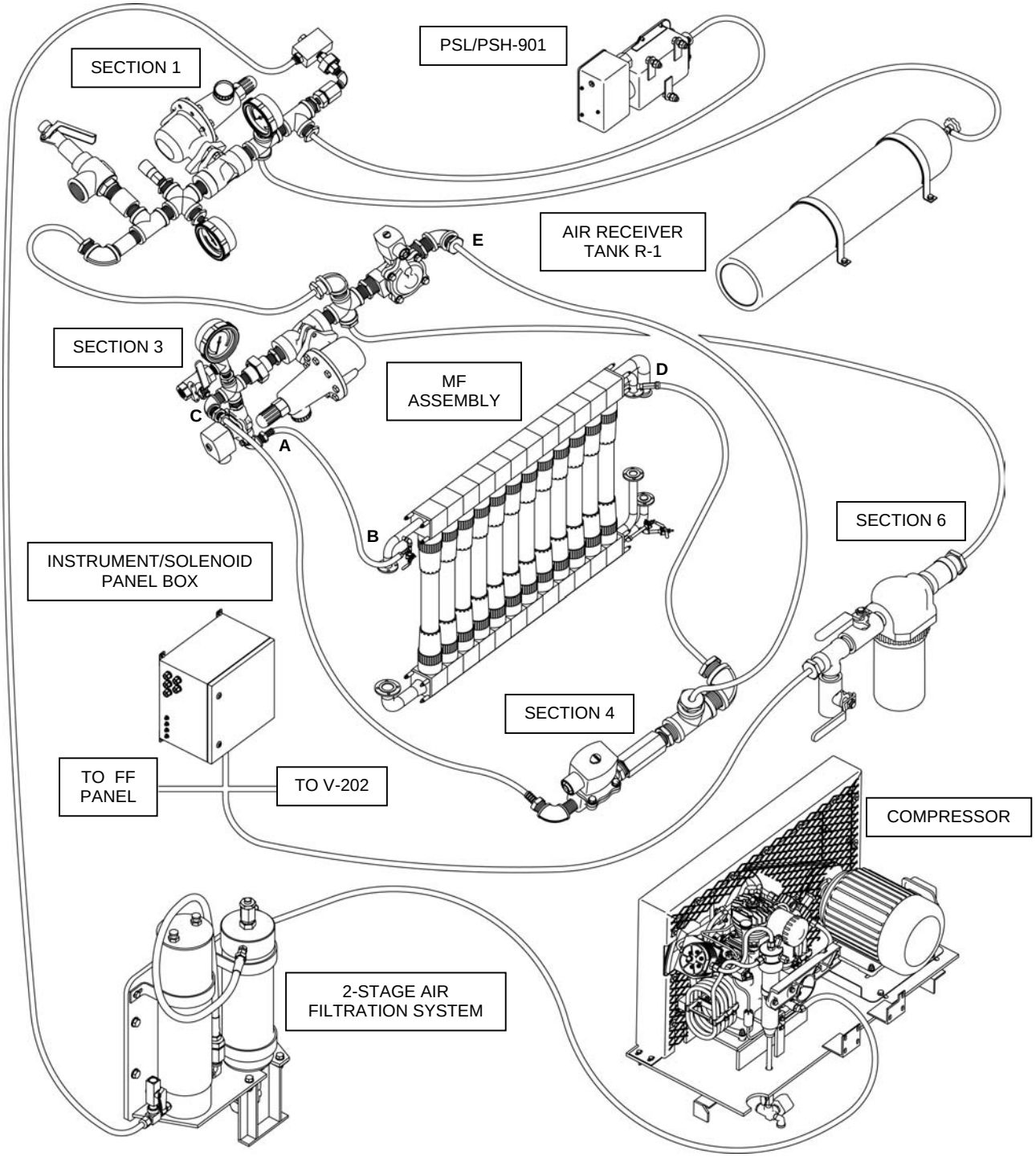

Figure 15. Air System Overview.

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Air Compressor and PSL/PSH-901 Assembly

During operation the belt-driven, three-stage compressor is powered by a five horsepower, 416 vac, 60Hz motor (see Figure 16). Low-Pressure Switch PSL-901 turns the compressor motor on through the PLC (programmable logic controller) in the OCP (operator control panel) when air pressure falls below 800 psig. High-Pressure Switch PSH-901 turns the compressor motor off through the PLC when pressure exceeds 950 psig. PSL-901 and PSH-901 are parts of a single pressure switch device. A safety valve on the air compressor first stage head and on the intermediate filter protect the 1st and 2nd stage compressor valves from over pressurization. Automatic Drain Valve XV-910, which is located between the second and third stages of the compressor and which is controlled by the PLC, removes oil and water from the compressor intermediate filter at 15-minute intervals. Temperature Switch TSH-901 shuts down the compressor if the compressor third-stage temperature is too high.

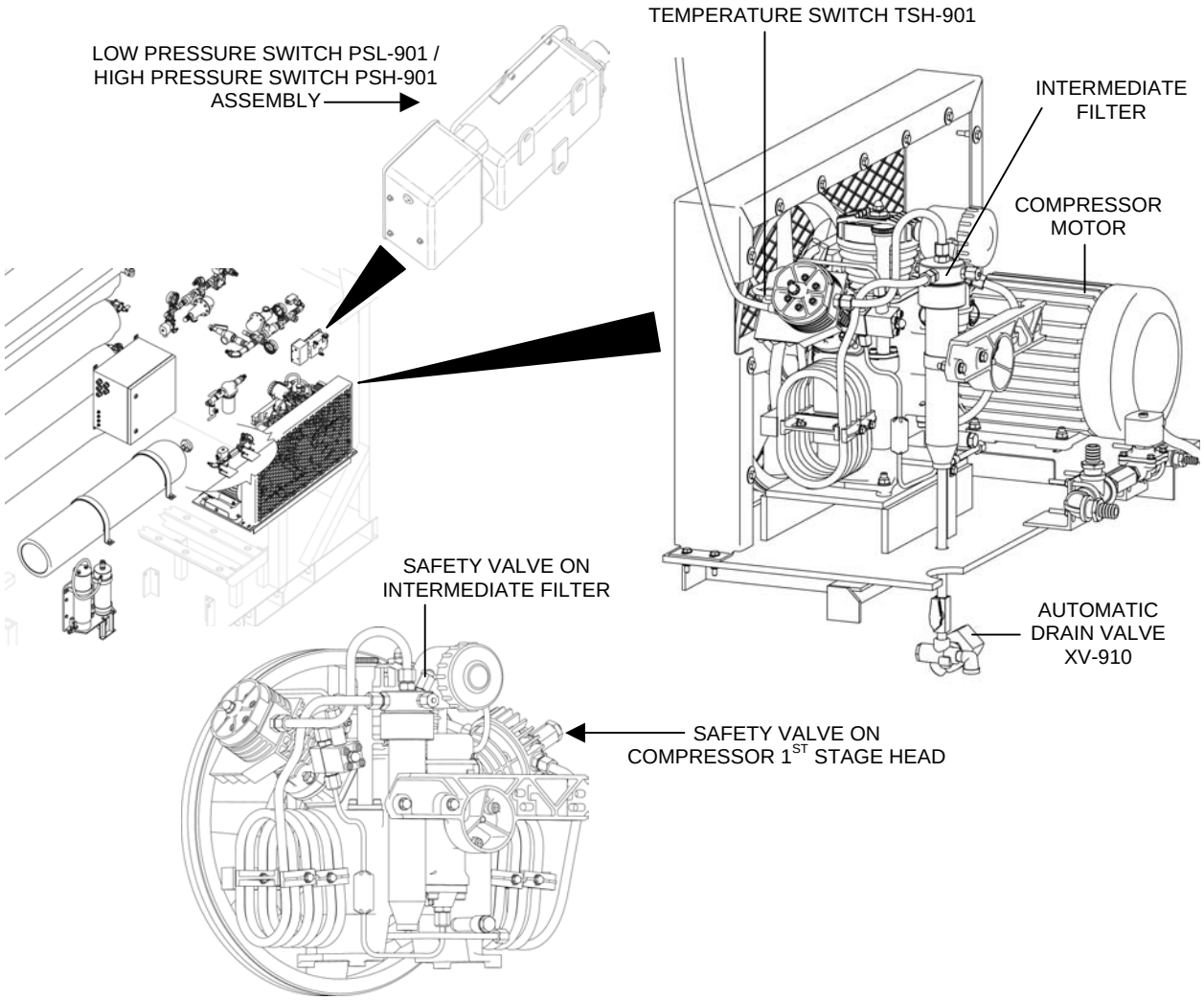

Figure 16. Air Compressor Assembly and High and Low Pressure Switch Assembly.

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Two-Stage Air Filtration System

The high-pressure air, up to 1800 psig, produced by the compressor is sent to the two-stage filtration assembly. The filtration assembly consists of the following components (see Figure 17):

- Coalescer CO-1
- Drain Shutoff Valve V-902
- Automatic Drain Valve XV-911
- High Pressure Air Relief Valve RV-901
- Check Valve V-903
- Air Purification Filter AF-2
- High-Pressure Air Vent Valve V-904.

Coalescer CO-1 removes oil and water from the high-pressure air. The oil and water is automatically drained from the coalescer at 15-minute intervals by Automatic Drain Valve XV-911, which is controlled by the PLC. Relief Valve RV-901 is mounted on the coalescer and relieves air pressure if pressure in the coalescer exceeds 2200 psig. The high-pressure air then passes through a one-way Check Valve, V-903, and into Air Purification Filter AF-2, which removes additional oil and water from the air. High-Pressure Air Vent Valve V-904 is used to drain the high-pressure air from the air system for maintenance.

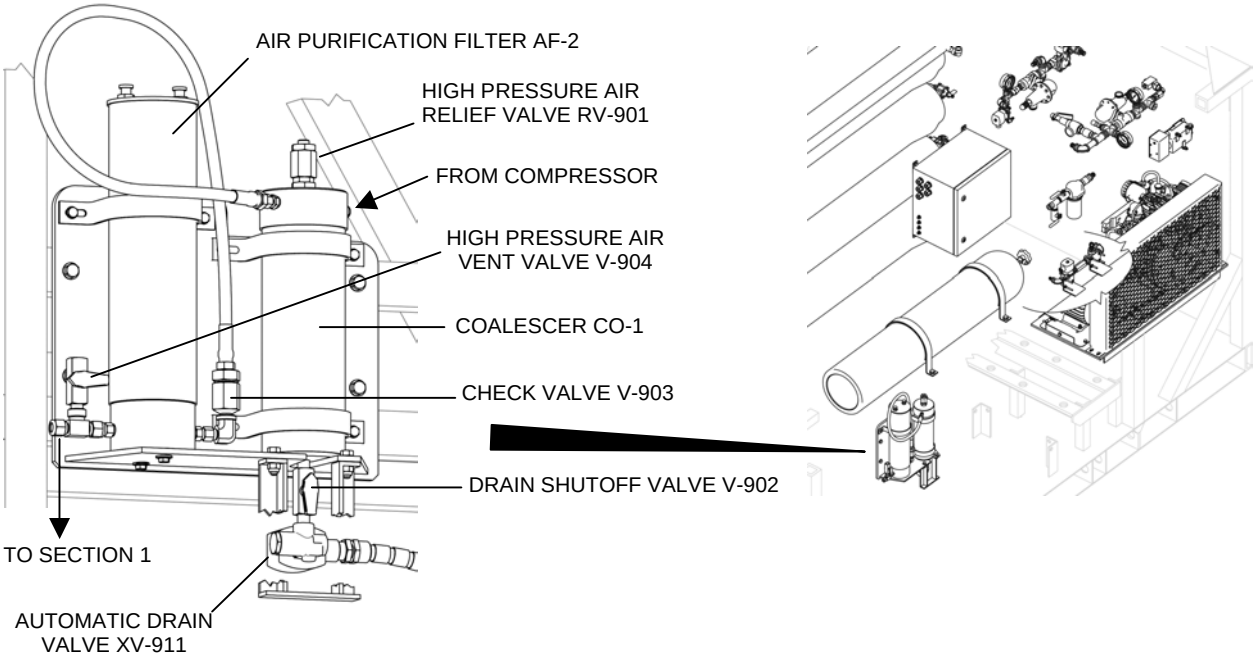

Figure 17. Coalescer CO-1 and Air Purification Filter AF-2.

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Air System Section 1

Air System Section 1 contains the following main components (see Figure 18):

- Pressure Maintaining Valve V-905
- Check Valve V-906
- Pressure Gauge PI-901
- Pressure Regulating Valve PRV-901
- Pressure Gauge PI-902
- Relief Valve RV-902

Pressure Maintaining Valve V-905 maintains a pressure of approximately 1800 psig in the system between the compressor and itself to ensure proper loading of the compressor cylinder valves. One-way Check Valve V-906 maintains pressure to the input side of Pressure Regulating Valve PRV-901. Pressure Gauge PI-901 indicates the air pressure in Air Receiver Tank R-1. Pressure Regulating Valve PRV-901 reduces the high-pressure air from the air compressor to 100 psig. The reduced pressure is indicated by Pressure Gauge PI-902. Relief Valve RV-902 will relieve system pressure on the reduced-pressure side of Pressure Regulating Valve PRV-901 if the system pressure exceeds 125 psig.

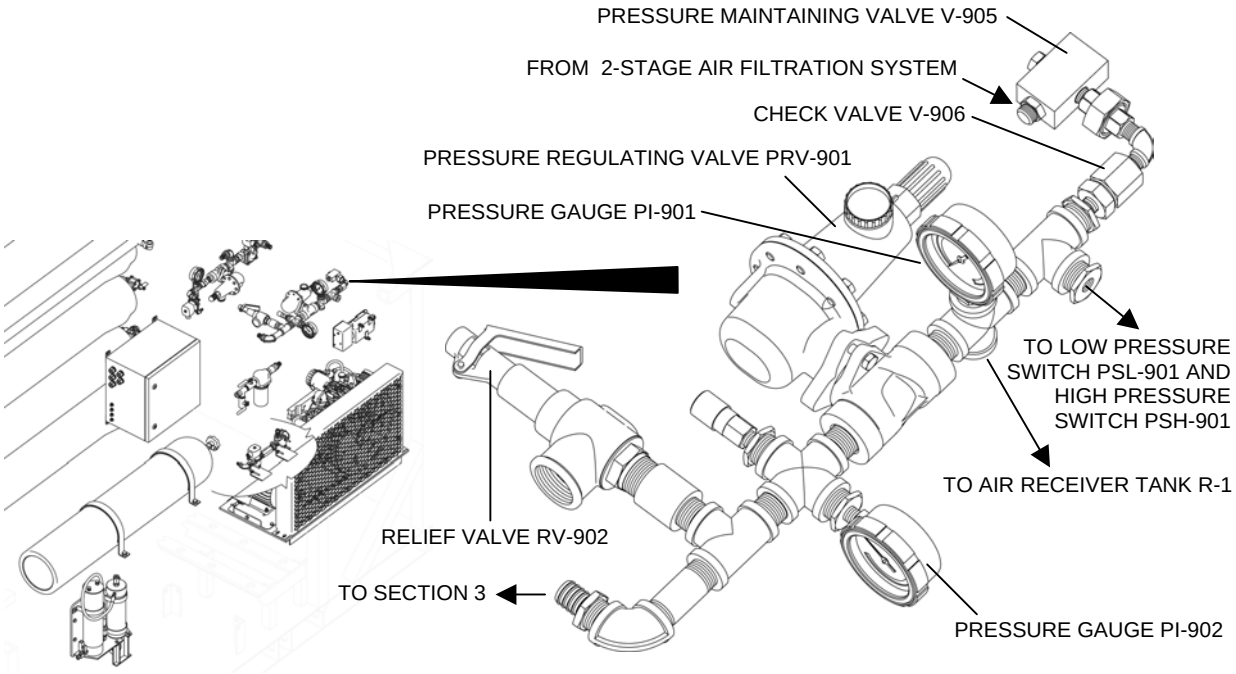

Figure 18. Air System Section 1.

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Air System Section 3

Air System Section 3 contains the following components (see Figure 19):

- Pressure Regulating Valve PRV-902
- Pressure Gauge PI-903
- Low Pressure Air Vent Valve V-915
- Solenoid Valve XV-903
- Solenoid Valve XV-901

Pressure Regulating Valve PRV-902 reduces the 100 psig air to 15 psig air that is used for draining the MF fibers before backwash and for draining the MF assembly shell during drain-down. The reduced pressure is indicated by Pressure Gauge PI-903. Low Pressure Air Vent Valve V-915 is opened manually to vent air when it is necessary to adjust pressure PRV-902 to provide a 15 psig reading at PI-903. Solenoid Valve XV-903 is activated by the PLC to control the flow of 15 psig air to the MF feed inlet for draining the MF assembly shell during drain-down. Solenoid Valve XV-901 is activated by the PLC to control the flow of 100 psig air through Air System Section 4 to the MF filtrate outlet to backwash the MF fibers.

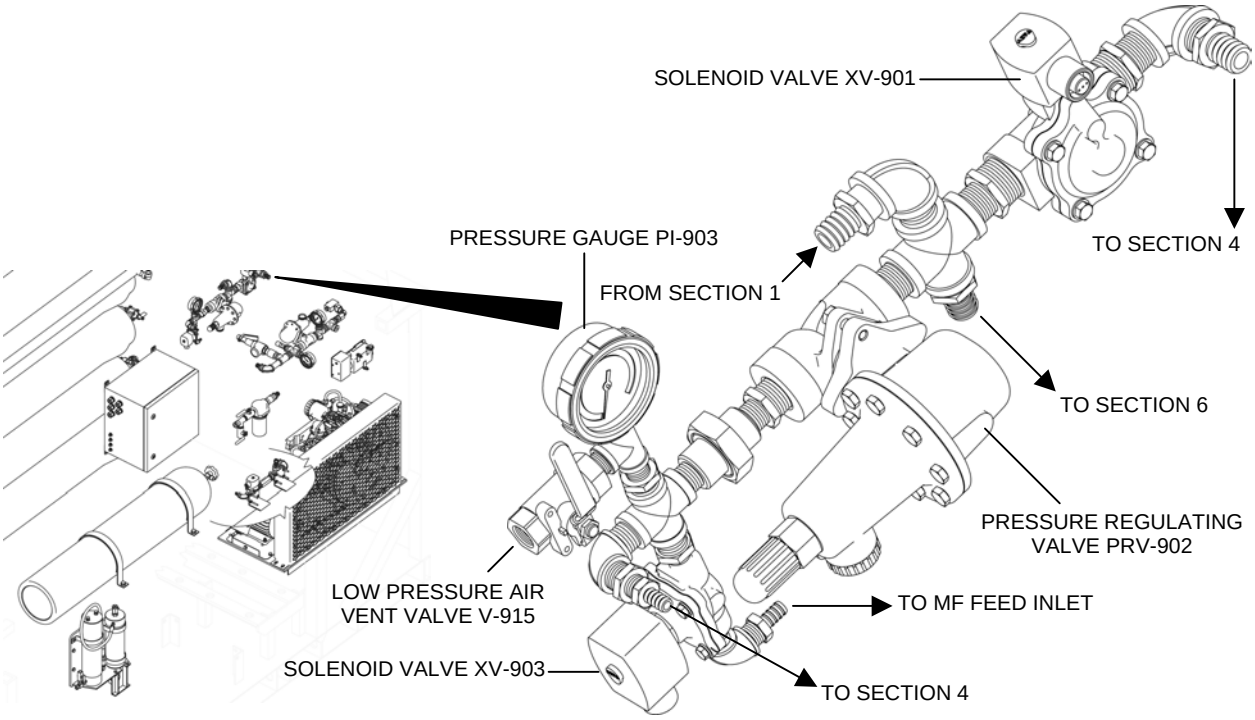

Figure 19. Air System Section 3.

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Air System Section 4

Air System Section 4 contains the following components (see Figure 20):

- Solenoid Valve XV-902
- Check Valve V-908

Solenoid Valve XV-902 is activated by the PLC to control the flow of 15 psig air to the MF filtrate outlet for draining the MF fibers before backwash. One-way Check Valve V-908 prevents 100 psig backwash air from flowing through Solenoid Valve XV-902 and the 15 psig air system.

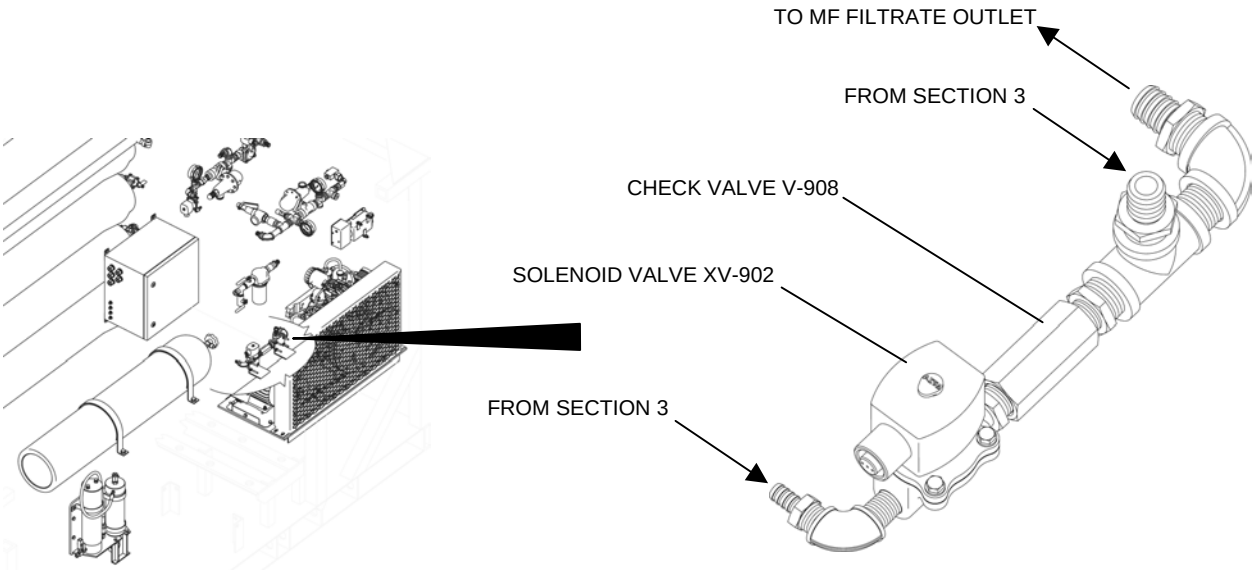

Figure 20. Air System Section 4.

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Air System Section 6

Air System Section 6 contains the following components (see Figure 21):

- Coalescer CO-2
- Low Pressure Air Shut-Off Valve V-909
- Low Pressure Air Vent Valve V-910

Oil/Water Coalescer CO-2 removes any remaining oil/water from the 100 psig air before it reaches the Feed Flow Control Panel, Filtrate Flow Control Valve V-202, and the Air Manifold Assembly. Low Pressure Air Shut-Off Valve V-909 is used to shut off the 100 psig air so that maintenance can be performed on the Feed Flow Control Panel, Filtrate Flow Control Valve V-202, or the Air Manifold Assembly. Low Pressure Air Vent Valve is used to V-910 bleed the air from the air system.

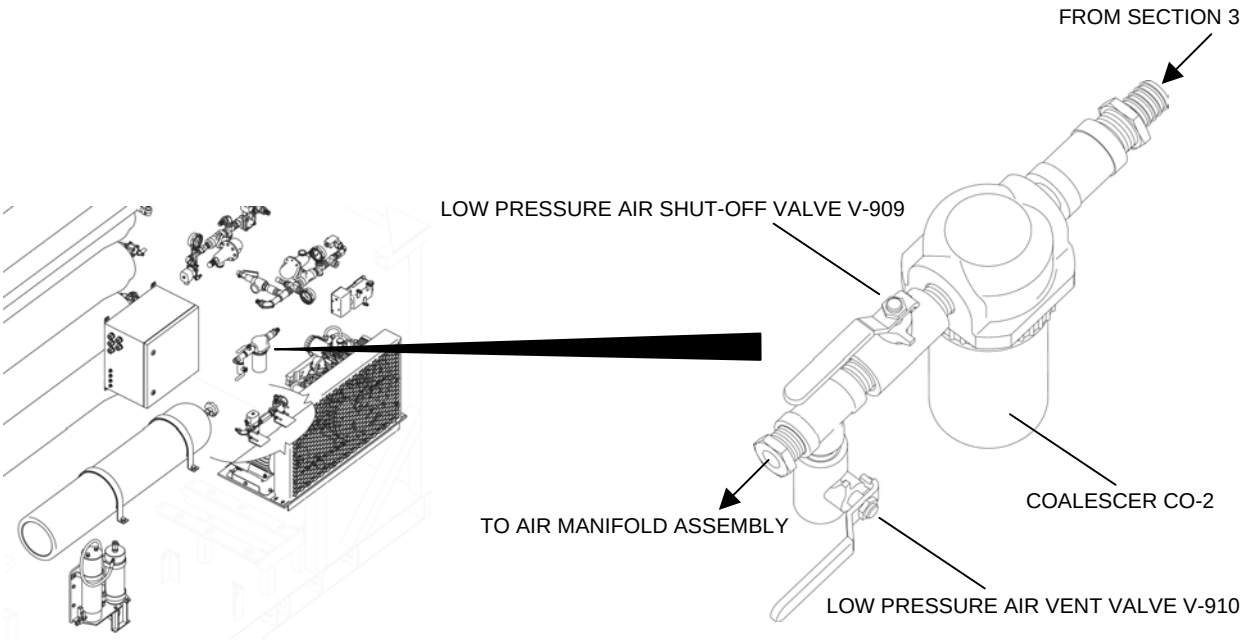

Figure 21. Air System Section 6.

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Air Manifold Assembly

The Air Manifold Assembly is located in the Instrument/Solenoid Panel Box. The manifold is comprised of six solenoid valves that are activated by the PLC to operate automatic valves in the TWPS. The solenoid valves and the automatic valves that they control are as follows (see Figure 22):

- Solenoid Valve XV-904 controls 100 psig air to MF Main Feed Valve V-111
- Solenoid Valve XV-905 controls 100 psig air to MF Upper Feed Inlet Valve V-112
- Solenoid Valve VX-906 controls 100 psig air to MF Lower Feed Inlet Valve V-113
- Solenoid Valve XV-907 controls 100 psig air to MF Upper Shell Outlet Valve V-401
- Solenoid Valve XV-908 controls 100 psig air to MF Lower Shell Outlet Valve V-402
- Solenoid Valve XV-909 controls 100 psig air to MF Upper Filtrate Outlet Valve V-201

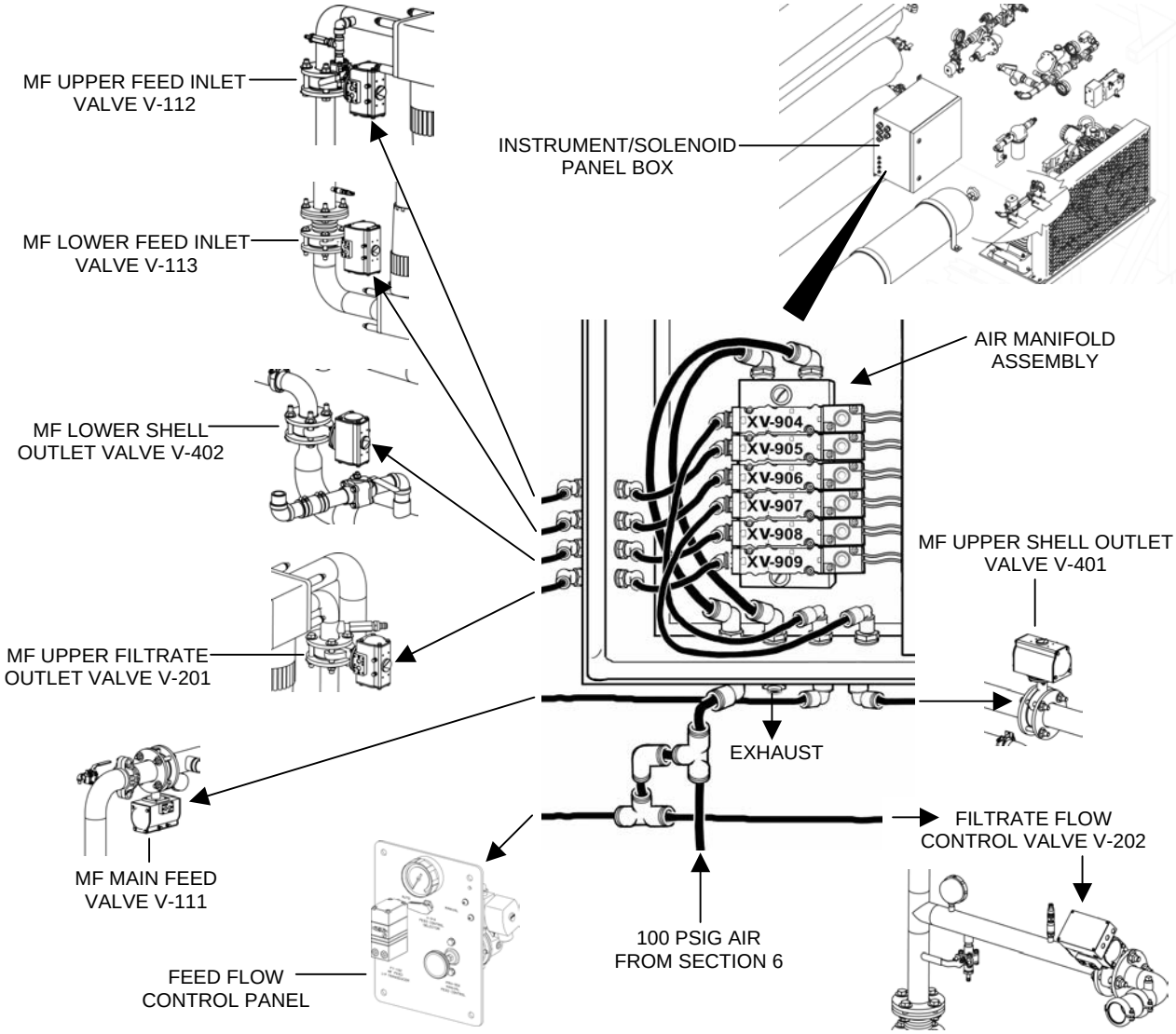

Figure 22. Air Manifold Assembly.

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CHEMICAL INJECTION SYSTEM

The chemical injection system is composed of three independent chemical systems: the sodium bisulfite chemical injection system, the antiscalant chemical injection system, and the calcium hypochlorite chemical injection system.

The sodium bisulfite chemical injection system is used only if the raw water source is chlorinated water. Chlorinated water will rapidly destroy the fibers in the micro-filter elements and the membranes in the reverse osmosis elements. Sodium bisulfite is injected into chlorinated raw water before the water is discharged into the MF Feed Tank to neutralize the chlorine.

The antiscalant chemical injection system inhibits salt scale formation on the RO membranes.

The calcium hypochlorite chemical injection system prevents microbial growth and contamination in the product water.

Each of the three chemical systems consists of (see Figure 23):

- Chemical Injection Pump CP-1, CP-2, or CP-3
- Four Function Valve V-612, V-622, or V-632
- Refillable five gallon bucket to hold the chemical solution
- Foot Valve (V-611, V-621, or V-631), strainer, and ceramic weight
- 3/8 in. suction tubing
- 3/8 in. discharge tubing
- 1/4 in. return/priming tubing.
- Injection Check Valve V-613, V-623, or V-633

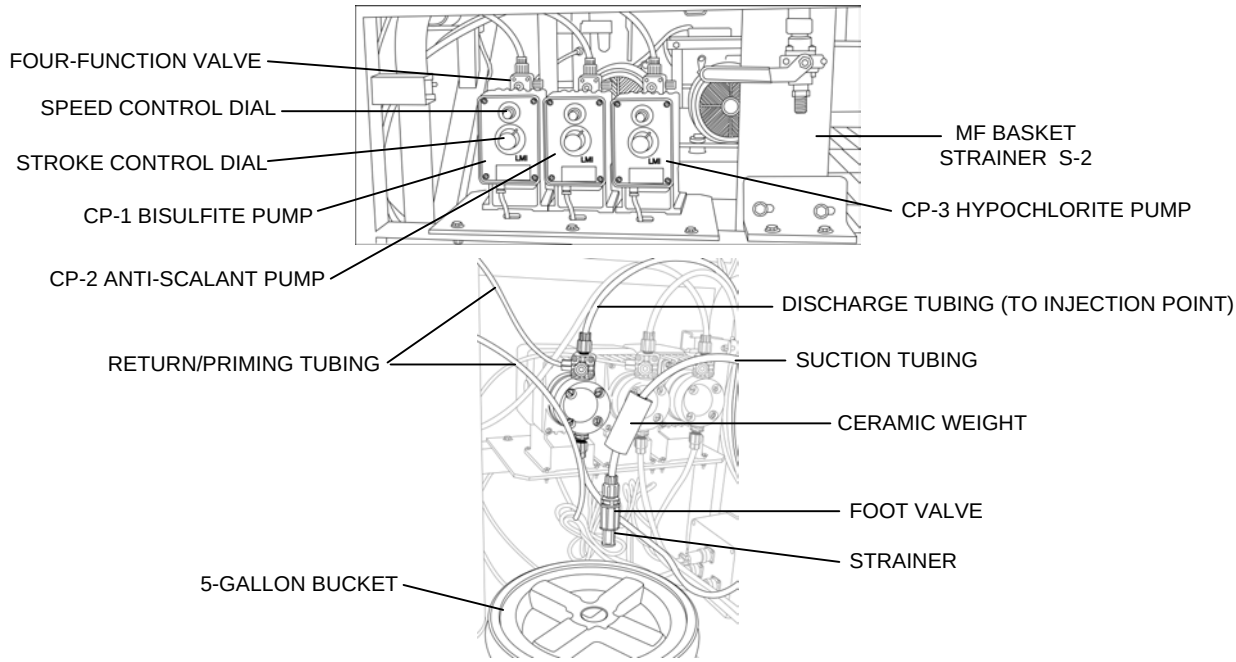

Figure 23. Chemical Injection System Components.

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The refillable five-gallon buckets have a different color cover for each of the three chemical systems to help ensure that the right chemical is used with the right system,

1. Sodium bisulfite chemical injection system has a refillable five gallon bucket with BLUE COVER
2. Antiscalant chemical injection system has a refillable five gallon bucket with YELLOW COVER
3. Calcium Hypochlorite chemical injection system; refillable five gallon bucket with RED COVER

The three chemical pumps are mounted next to the MF Basket Strainer S-2. The operation of all three pumps is the same. Only the type of chemical pumped, rate of injection and location of injection differs. The sodium bisulfite and antiscalant pumps are set to pump approximately 4 gallons every 10 hours of operation. This allows refilling of these chemical buckets at the beginning of each shift. The calcium hypochlorite pump is set according to the product flow rate and the desired amount of free chlorine.

During process operation, chemical from the refillable bucket is drawn up the suction line to the chemical pump. From the suction side of the pump the chemical passes to the discharge side through the four-function valve. The four-function valve prevents anti-siphoning of the chemical when the pump is not running, allows for priming of the discharge line if the prime has been lost during maintenance or shutdown, and allows for draining of the discharge line for maintenance or disassembly. From the four-function valve the chemical is pumped into the discharge line and then injected into the system by the injection check valve. The purpose of the check valve is to prevent water in the piping from entering the injection system.

Sodium bisulfite is injected into Adaptor A-11 (see Figure 24), which contains a static mixer. The static mixer uses non-moving baffles to thoroughly mix the sodium bisulfite solution into the raw water stream before the raw water is discharged into the MF feed tank.

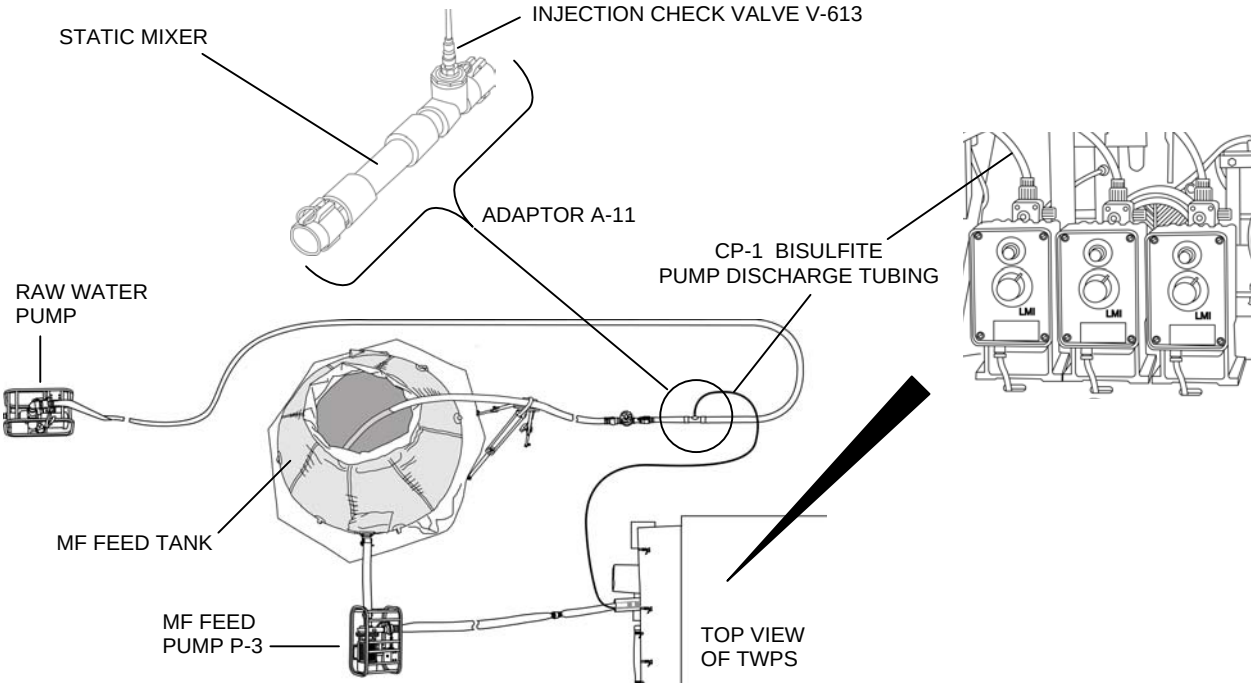

Figure 24. Adaptor A-11 Sodium Bisulfite Injection Point.

Antiscalant is injected into the RO feed water just after if discharges from the RO feed pump and before it reaches the HP pumps (see Figure 9).

Calcium hypochlorite is injected into the product water just after Check Valve V-512 and before the product water enters the distribution tanks (see Figure 14). When the NBC System is deployed, the calcium hypochlorite is injected in the product water after it discharges from the NBC tank and before the product water enters the distribution tanks (see Figure 26). This is accomplished by disconnecting the normal operation discharge tube and connecting the NBC discharge tube, that is then connected to the outlet of the NBC filter.

STANDARD PRODUCT WATER DISTRIBUTION SYSTEM

The standard distribution system stores potable product water in two 3000-gallon self-supporting fabric Storage Tanks T-3 and T-4 (see Figure 25). The tanks are connected together using Adapter A-07 and one two-in. diameter, five-ft. long suction hose at the lower output side of the storage tanks. A two-in. diameter, five-ft. suction hose connects from the adapter to Electric Motor-Driven Pump P-7. Product water is delivered to the inlet of one of the tanks through the 1½-in. diameter suction hoses connected to the tank by Adaptor A-15. Pump P-7 draws the product water from the storage tank outlets and discharges it through Adaptor A-08 and two 2-in. diameter, 65-ft. long discharge hoses to two distribution Nozzles V-523A and V523B. A 5/8-in. x 50-ft. Auxiliary Hose and Valve V-522 can be connected to pump outlet Adapter A-08 in place of one of the distribution hoses to provide water back to the TWPS for MF and RO cleaning and general purpose potable water use. The distribution system provides up to 125 gpm total distribution capacity through the two distribution nozzles. The raw water pumps and the distribution pump are interchangeable by changing the pump suction fittings.

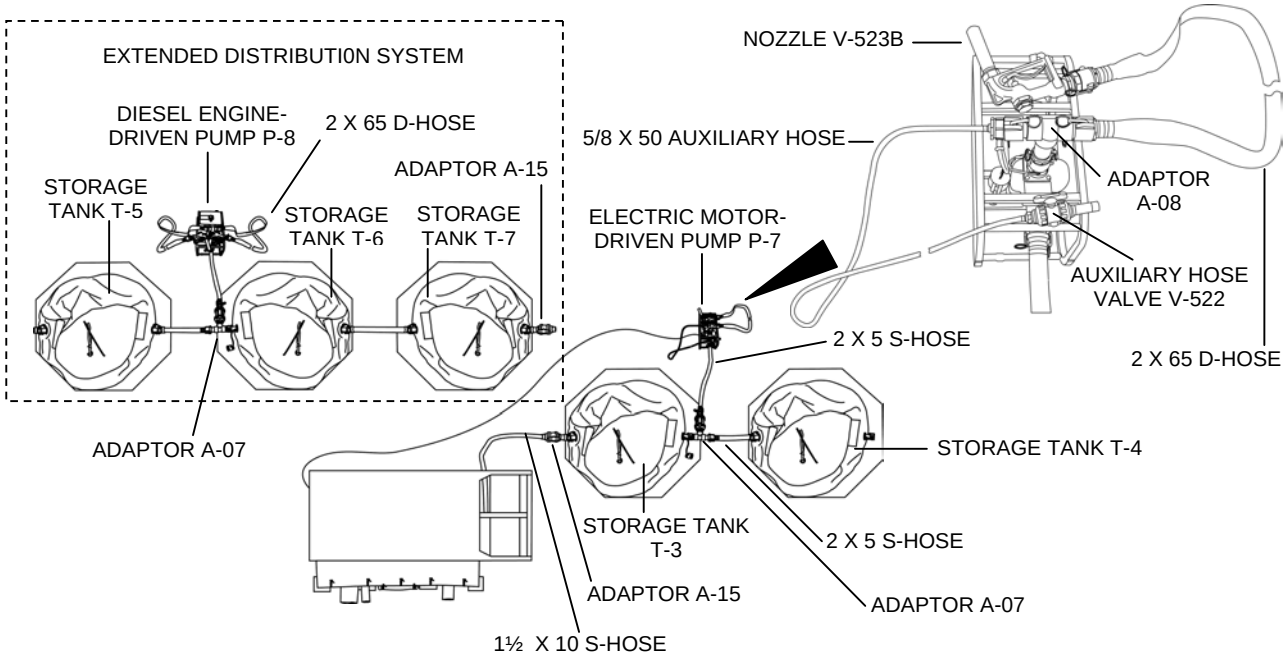

Figure 25. Product Water and Extended Product Water Distribution Systems.

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EXTENDED PRODUCT WATER DISTRIBUTION SYSTEM (A-TWPS ONLY)

The extended product water distribution system provides an additional 9000 gallons of product water storage with the use of three additional 3000-gallon Storage Tanks T-5, T-6 and T-7 (see Figure 25). The tanks are connected together using 2-in. diameter, 5-ft. long, blue-banded hoses. Adapter A-07 is installed in line between two of the three tanks. A 2-in. diameter, 5-ft., blue-banded suction hose connects from Adaptor A-07 to Diesel Engine-Driven Pump P-8. Product water is delivered to the inlet of one of the tanks through the 1½-in. diameter suction hoses that are disconnected from the standard distribution system storage tank and connected to an extended distribution system storage tank by Adaptor A-15. Pump P-8 draws the product water from the storage tank outlets and discharges it through Adaptor A-08 and two 2-in. diameter, 65-ft. long discharge hoses to two Distribution Nozzles V-523C and V-523D. The extended product water distribution system, combined with the standard product water distribution system, provides up to 250 gpm total distribution capacity through the four distribution nozzles.

NUCLEAR, BIOLOGICAL, CHEMICAL (NBC) SYSTEM

The NBC system is deployed as a final product water treatment step when the water source is contaminated with nuclear, biological, or chemical warfare agents (see Figure 26). The RO system will remove most, if not all, of the NBC agent material. The NBC system provides final removal and added assurance that all NBC agents have been removed from the water. The system consists of an NBC filter tank and media consisting of ion exchange resin and carbon. When used, it is removed from the TWPS skid and deployed near the distribution tanks. The media is loaded after the filter tank is in place. Product water is directed to the top of the filter. The water flows down through the media, out the bottom of the filter, and to the distribution tanks. The calcium hypochlorite is injected in the product water after it discharges from the NBC filter outlet. The injector is located in the filter outlet pipe. After one hundred hours of water production, the resin and carbon will be exhausted. The tank is disconnected and left for later disposal. A new tank, resin and carbon are used to continue the mission.

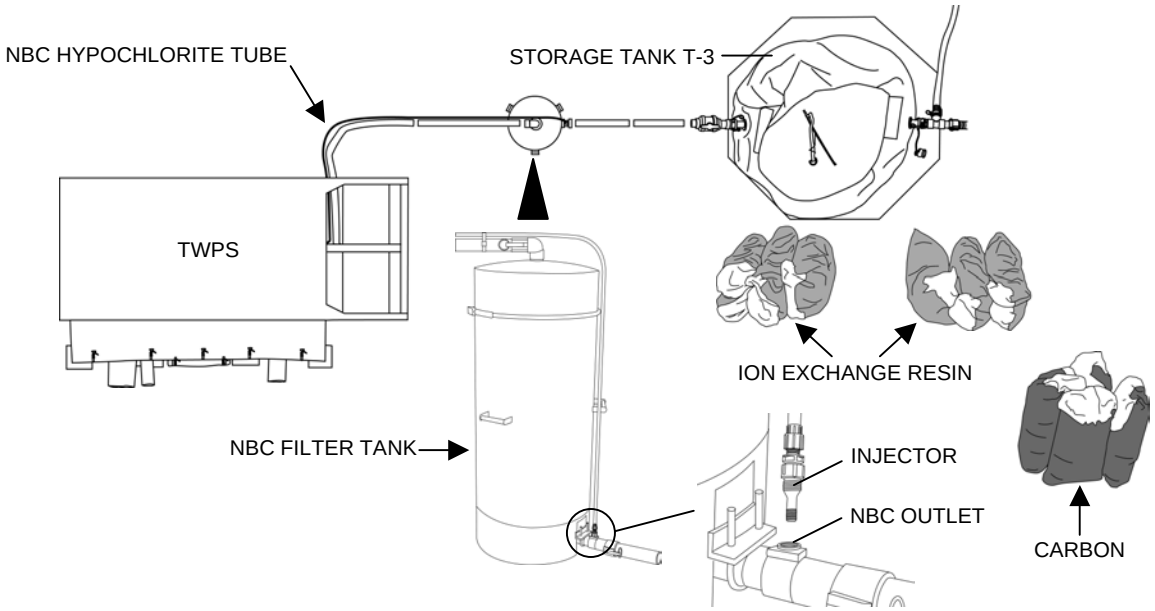

Figure 26. NBC System.

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OPERATING CONTROLS

The Operating Controls include the Operator Control Panel (OCP), the Feed Flow (FF) Control Panel, the Programmable Logic Controller (PLC) (see Figure 27). It also includes several indicators and controls off of the OCP that require occasional adjustment and monitoring for manual operation. The OCP provides all of the push buttons, switches, alarm lights and displays needed for operator control and monitoring of the system. The Feed Flow Control Panel controls the operation of Flow Control Valve V-202, which controls the flow of filtrate from the MF system to the RO feed tank. The PLC provides automated control after operator startup and in response to operator switch selections. Indicators and controls throughout the TWPS MF and RO systems provide the operator with local indications of system conditions and manual controls for certain operating functions of the TWPS.

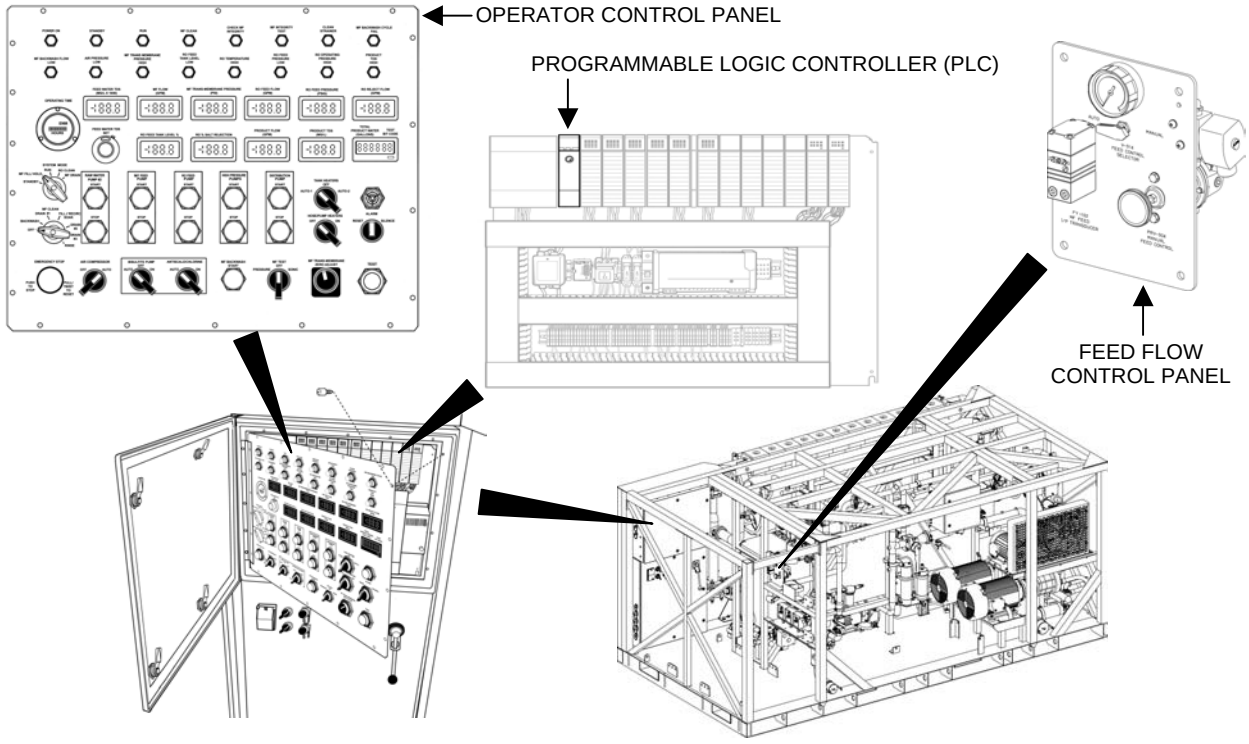

Figure 27. Operator Control Panel and Feed Flow Control Panel.

POWER DISTRIBUTION SYSTEM

The Power Distribution System distributes electrical power to components within the TWPS and to the pumps deployed off of the skid during operation. The power distribution system includes the following major components:

- **60 kW TQG** (Tactical Quiet Generator) or (for the MC-TWPS) alternative 416 Volt AC, 3-phase power source. The TQG is provided with the A-TWPS. The MC-TWPS comes without the TQG.
- **Power distribution panel.** The power distribution panel is located below the operator control panel and behind the lower panel door (see Figure 28). It contains the circuit breakers and motor starters needed to provide power to all of the electrical devices included in the TWPS.

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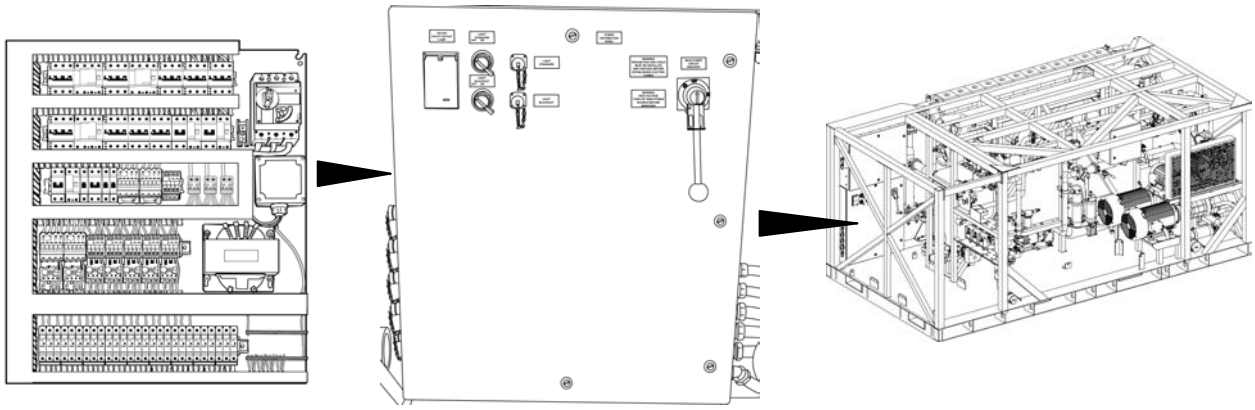


Figure 28. Power Distribution Panel.

CLEANING AND PRESERVATION OPERATIONS

The MF element fibers require periodic chemical cleaning to remove dirt and organic material that is not fully removed by the backwash. The need to clean is indicated by the “Clean MF” alarm. The MF fibers are always cleaned first with the low pH citric acid and then with the high pH detergent membrane cleaner. The RO feed tank is used to mix and store the cleaning solutions and the RO feed pump is used to circulate the solutions. Heaters mounted to the RO feed tank heat the cleaning solutions to improve their effectiveness. Cleaning valves direct the cleaning solution as required for mixing, circulation and pump out to waste. The 6-in., red-banded waste out hose is removed and replaced with 2 x 10 cleaning waste hoses that are normally connected to a cleaning waste storage tank. Adaptor A-12 with Cleaning Waste Outlet Valve V-705 is connected to the end of the cleaning waste hoses (see Figure 29). A 1500-gallon cleaning waste storage tank holds the cleaning and rinse wastes. Connected to both sides of the waste tank is Adaptor A-16 with Shut-Off Valve V-706.

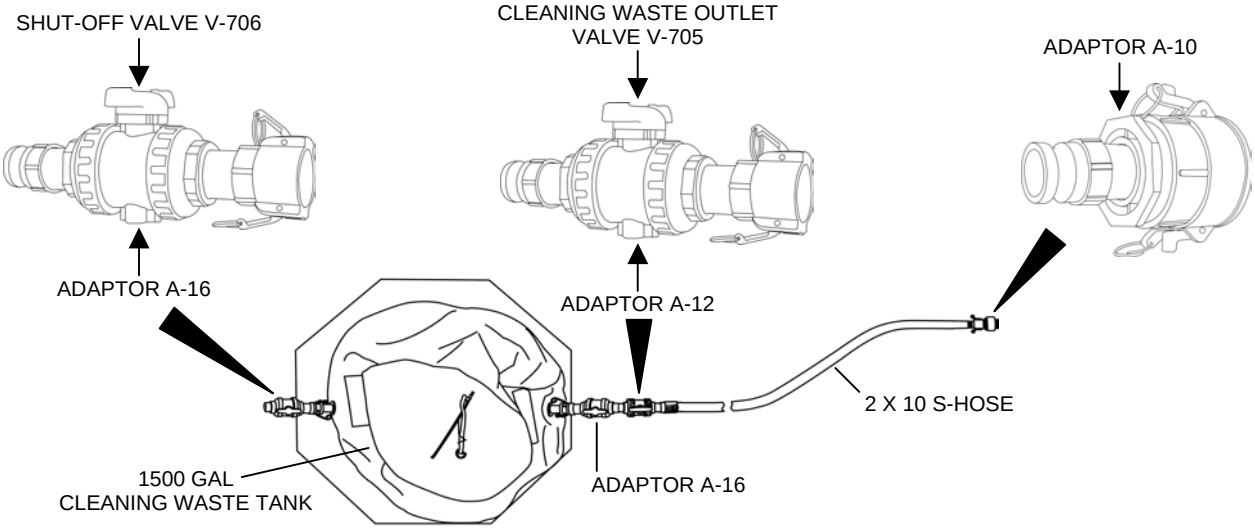


Figure 29. Cleaning Waste Storage Tank Set-Up.

Cleaning of the MF is summarized below (see Figure 30):

1. Install 2 x 10, red-banded, cleaning waste hoses with Adaptor A-10 Cleaning Waste Outlet Valve V-705 closed (see Figure 29) and cleaning waste tank with Adaptors A-16 shut-off valves V-706 closed.
2. Mixing the cleaning solution.
    a. The RO feed tank is partially filled with product water.
    b. HP Pump Feed Valve V-212 is closed and Clean Mixing Valve V-703 is opened.
    c. With the RO feed pump on, the water circulates from the RO tank and back in again through the mixing valve. The membrane cleaner is slowly added through the open tank cover and mixes with the water as the solution circulates.
3. Circulation and rinse.
    a. Clean Mixing Valve V-703 is closed. MF Clean Feed Valve V-704 and Clean Return Valve V-702 are opened. This directs the circulation through the MF assembly and back through the waste out piping and the Clean Return Valve V-702 to the RO feed tank.
    b. When cleaning is complete, Cleaning Waste Outlet Valve V-705 and the Shut-Off Valve V-706 next to V-705 are opened to direct the cleaning waste to the cleaning waste tank.
    c. The element fibers are rinsed with product water that is added to the RO feed tank. The rinse water is directed to the cleaning waste tank.

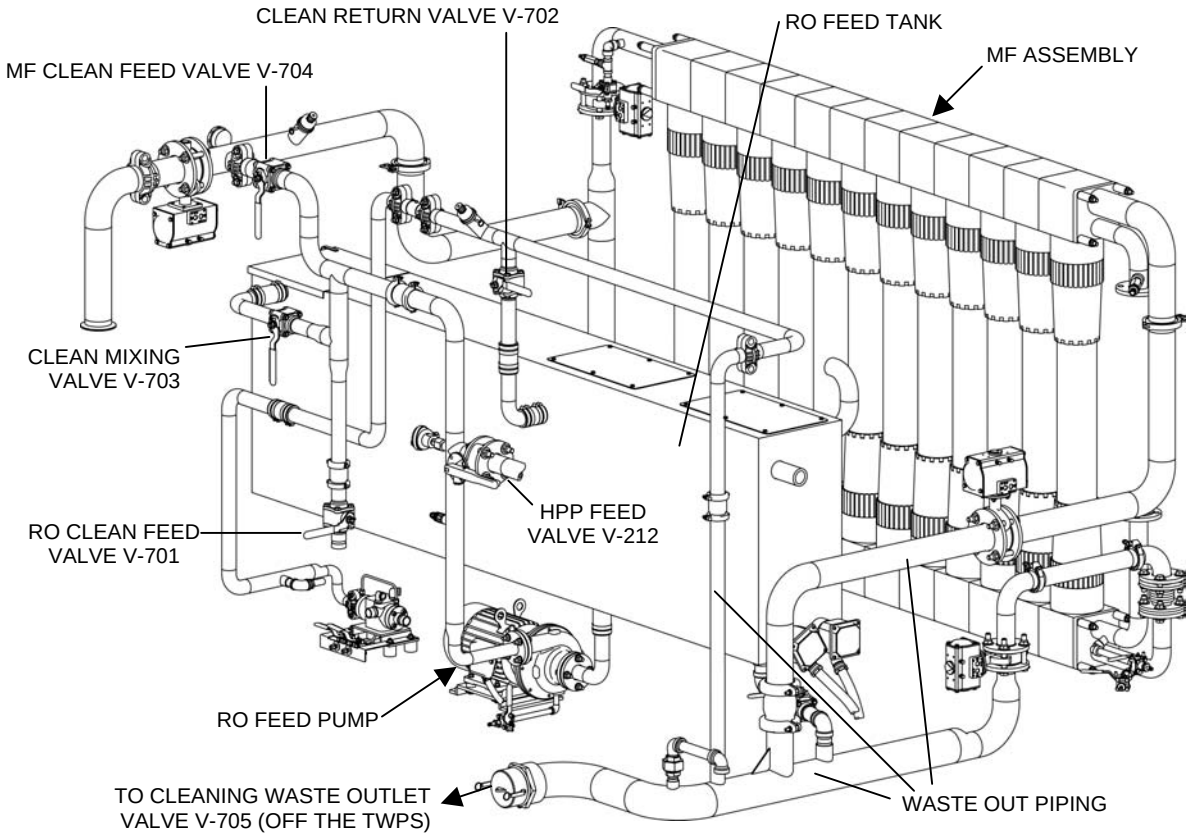


Figure 30. MF Cleaning Operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0003 00**
DESCRIPTION AND THEORY OF OPERATION
THEORY OF OPERATION

The RO membranes do not require regular cleaning. When required, cleaning is similar to that for the MF. For RO cleaning, the RO Clean Feed Valve V-701 is opened to direct the circulation through the RO.

When shut down for more than 54 hours, both the MF fibers and RO membranes require preservation to avoid growth of biological material on the fiber and membrane surfaces. The MF fibers are preserved with caustic (or the high pH cleaning solution which includes detergent and the caustic). The RO membranes are preserved with sodium bisulfite, which is either flushed through the RO elements, or circulated as a cleaning solution. These solutions are drained, but not flushed.

COLD WEATHER MODULE

The Cold Weather Module is employed during cold weather operations (temperatures below 32°F to -25°F) to prevent water in the TWPS from freezing. The Cold Weather Module is provided with the A-TWPS or as an extended capability module for the MC-TWPS and includes the following main components (see Figure 31) (see WP 0002 for a complete listing and illustrations of all the major parts):

- Diesel-fired forced hot air space heater provides heat to the enclosed TWPS.
- General purpose transformer provides power for the electrical components of the heater.
- Motor-driven raw water pump heating collars wrap around the pumps that are deployed off the TWPS skid and keep the water in the pump from freezing.
- Insulating pump covers cover the pump skids that are deployed off the TWPS skid and insulate the pumps and motors/diesel engines from the elements.
- Non-floating ice intake strainer. This strainer is used for ice hole operation in place of the floating inlet strainer.
- Ice hole auger. Used to drill a hole in the ice
- Insulating platforms are placed under each pump skid that is deployed off the TWPS skid.
- Electric hose heating blankets cover each hose that is deployed off the TWPS skid and prevent the water in the hoses from freezing.
- A winter cover is provided as an extended capability module for the MC-TWPS. The cover encloses the TWPS skid and protects the TWPS from the elements. The A-TWPS comes supplied with a fabric wall that encloses the front of the flat rack containing the TWPS skid.

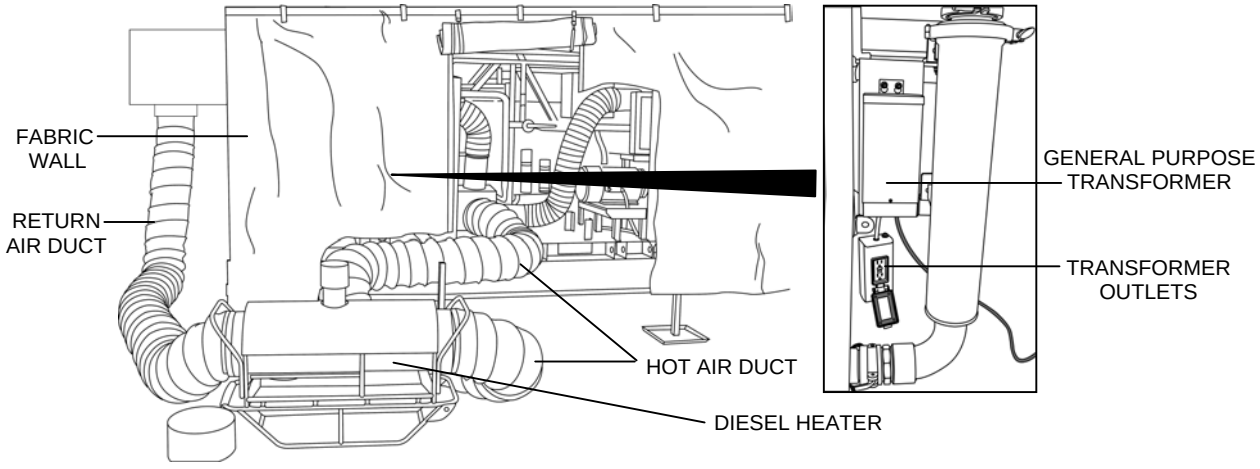


Figure 31. A-TWPS Cold Weather Diesel Heater Deployment.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0004 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SITE SELECTION AND COMPONENT LOCATION

SITE SELECTION

The site selection of TWPS must be carefully planned to assure the safety of crew members and the reliable operation of water production. The following items must be considered in selecting a site for TWPS operations:

- Source of water
- Operating space
- Local ordinances

If a stream is to be used as the raw water source, pick a site for the TWPS upstream from the general population and ensure that the site provides downstream wastewater drainage away from the water source. Avoid wells which are encased with steel or which use steel piping. Iron will rapidly foul the RO elements. Also avoid wells that smell of sulfur. Any well water observed to leave significant residues of salts should, if possible, be avoided.

If the raw water source is from a sandy beach location and if surf conditions or tide extremes make it difficult or impossible to use the floating inlet strainer, the OISS should be deployed instead of the floating inlet strainer. For OISS setup see WP 0008.

Consider variable weather conditions when choosing the site and avoid areas subject to flash flooding, high tides, etc. In hot weather take advantage of available forest cover. In freezing weather take advantage of existing shelters and windbreaks.

NOTE

Before setup, refer to manuals FM10-52-I Water Supply Point Equipment and Operations and TB MED 577 Occupational and Environmental Health for specifications covering water reconnaissance and water source and water point development.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS SITE SELECTION AND COMPONENT LOCATION

0004 00

TWPS COMPONENT LOCATION

Table 1 provides a list of site considerations and site dimensions for each consideration. Figure 1 provides a graphic illustration of typical TWPS work site dimensions and a sample layout. Use the Table and Figure as a guideline for selecting a site and for laying out the TWPS components at that site.

Table 1. TWPS Site Consideration and Dimension Guidelines.

SITE CONSIDERATION	SITE DIMENSION
Drive-in access for on-road equipment.	At least 12 ft. wide
Work area required for equipment maneuvering and set-up.	At least 75 ft. x 100 ft.
Ground fairly smooth, level, and clear.	Grade not to exceed 2° crosswise (front to back) and 1½° lengthwise (side to side)
Cleared path to water source.	At least 12 ft. wide
Work area elevation above water source with P-1 and P-2 pumps.	73 ft. maximum (limited by total pump capacity)
Elevation of 1st raw water pump above water source.	23 ft. maximum (limited by pump capacity)
Distance of 1st raw water pump from inlet strainer location in water source.	130 ft. maximum (limited by thirteen 10 ft. hoses)
Distance of cyclone separator from raw water pump.	About 6 ft. (limited by 6 ft. hose)
Distance of diesel-driven raw water pump from TWPS skid.	200 ft. max (limited by four 50 ft. hoses & pump capacity)
Water depth from the inlet strainer to the bottom of the raw water source.	3 ft. minimum; 5 ft. or more preferred
Distance of motor-driven raw water pump from TWPS.	100 ft. maximum (limited by power cord length)
Distance of MF feed pump (P-3) from TWPS.	About 20 ft. (limited by 20 ft. hose)
Distance of MF feed tank from MF feed pump.	About 3 ft. (limited by 3 ft. hose and adaptor)
Distance of distribution tanks from TWPS.	15 to 30 ft. (limited by four 10 ft. hoses)
Distance of distribution tank from adjacent distribution tank.	About 5 ft. (limited by 5 ft. hose and adaptor)
Distance of distribution pump (P-7 and P-8) from tee adaptors.	About 5 ft. (limited by 5 ft. hose)
Cleaning waste storage tank (if used).	At an elevation below the TWPS Less than 30 ft. from the waste out connection

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0004 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SITE SELECTION AND COMPONENT LOCATION

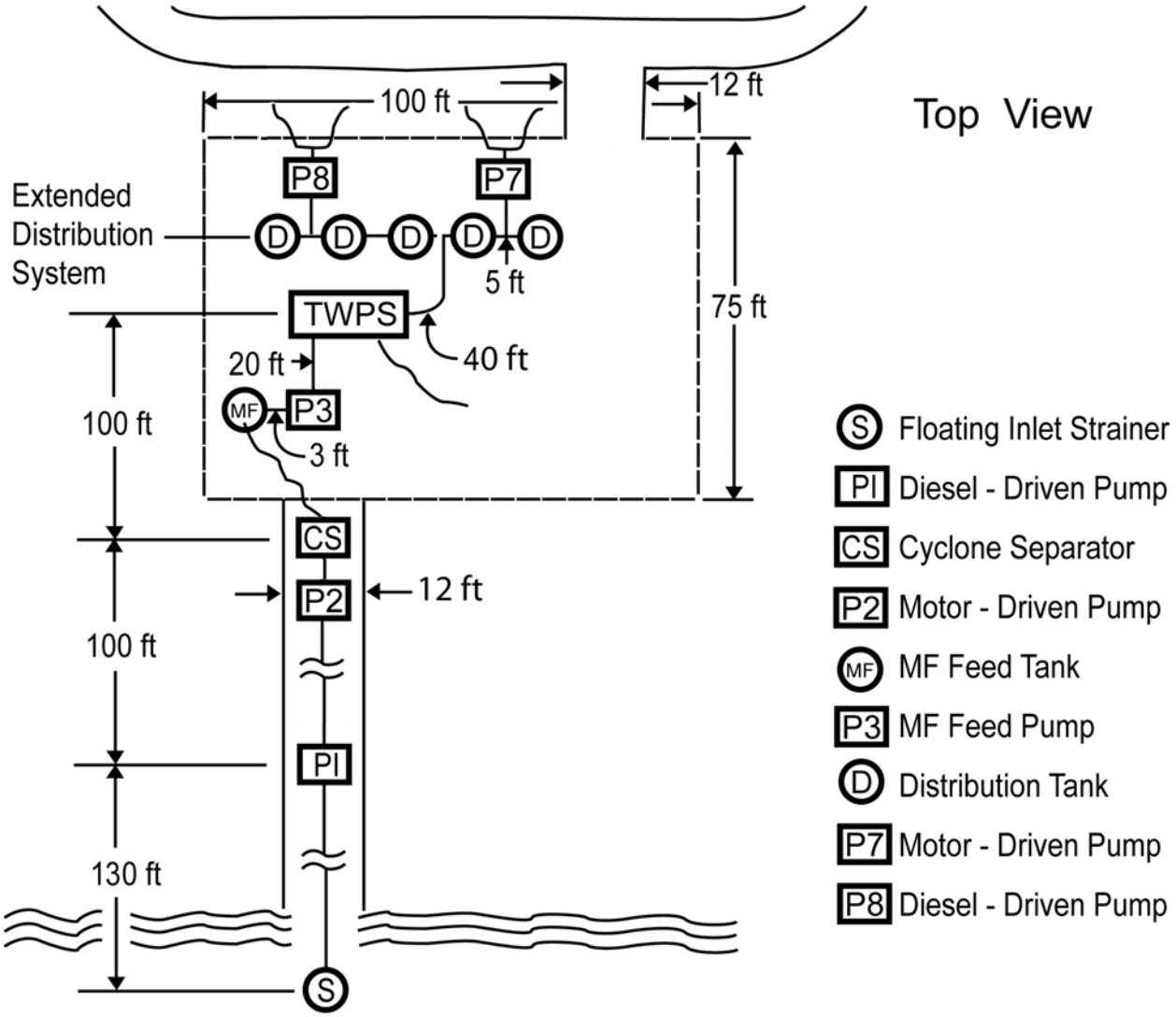


Figure 1. Typical TWPS Work Site Dimensions.

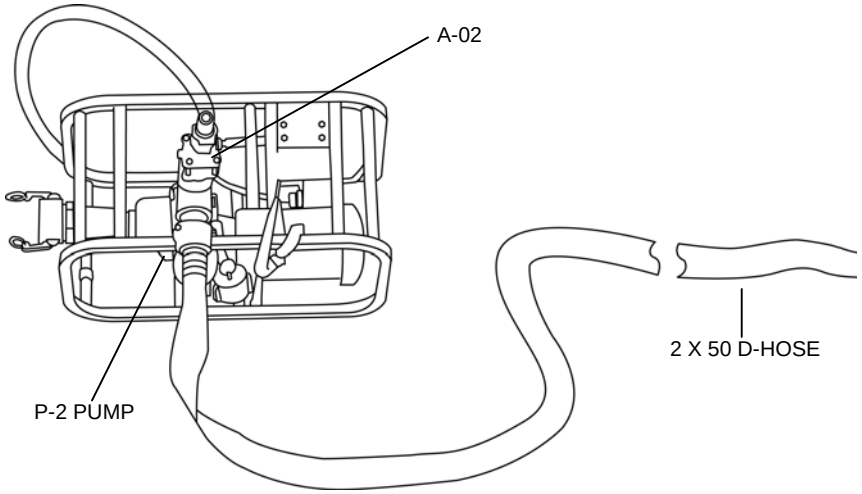
The use and placement of the raw water pumps and the cyclone separator in the raw water system depends on the distance of the TWPS platform from the water and the height above the water. Three possible raw water pump, cyclone, adaptor, and hose configurations are shown in Figure 2 through Figure 4 along with general rules for determining when to use the given configuration. Use these Figures to help you determine where to place the raw water pumps and cyclone separator (if used) for the elevation and distance characteristics of your site.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0004 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SITE SELECTION AND COMPONENT LOCATION

P-2 Pump Only Raw Water System Configuration (see Figure 2)

Motor-driven pump P-2 can be used by itself when the elevation from the pump to the TWPS platform is less than 25 ft. and the distance from the TWPS platform to the pump is less than 100 ft. The P-2 electrical power cable restricts the location of the motor-driven pump to no more than 100 ft. from the TWPS platform. The main components used in this configuration include the Motor-Driven Pump P-2, Adaptor Assembly A-02, and up to two sections of 2 in. diameter by 50 ft. long discharge hose.

TOP VIEW



SIDE VIEW

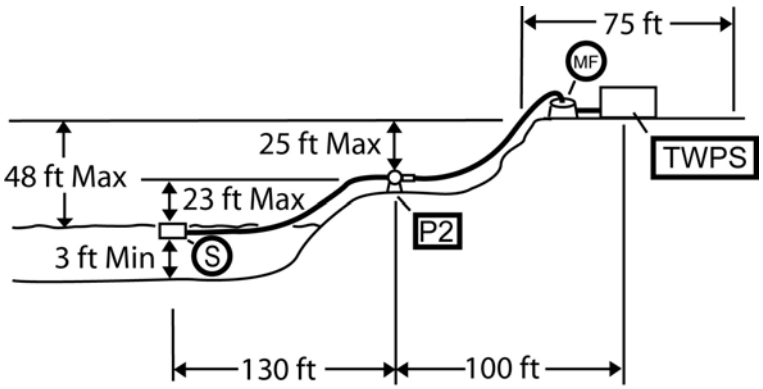


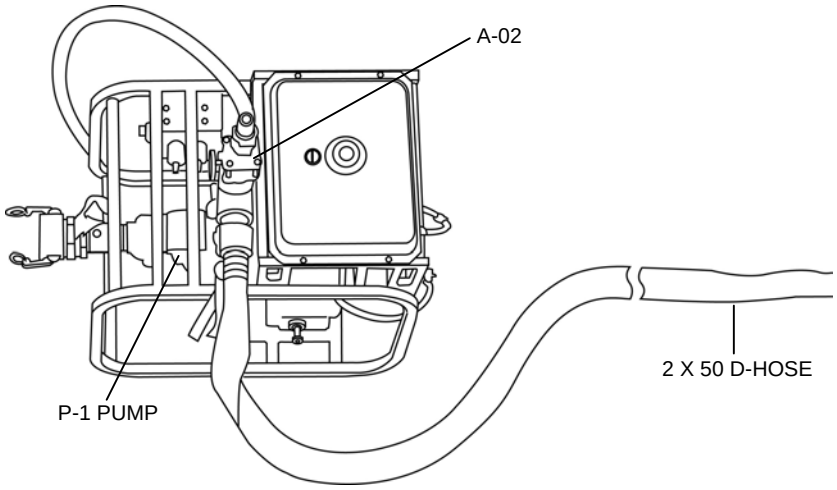
Figure 2. P-2 Pump Only Raw Water System Configuration.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0004 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SITE SELECTION AND COMPONENT LOCATION

P-1 Pump Only Raw Water System Configuration (see Figure 3)

Diesel-driven pump P-1 can be used by itself when the elevation from the pump to the TWPS platform is less than 25 ft. and the distance from the TWPS platform to the pump is less than 200 ft. The suction lift is reduced below 23 ft. at temperatures above 70 degrees F. The main components used in this configuration include the Diesel-Driven Pump P-1, Adaptor Assembly A-02, and up to four sections of 2 in. diameter by 50 ft. long discharge hose.

TOP VIEW



SIDE VIEW

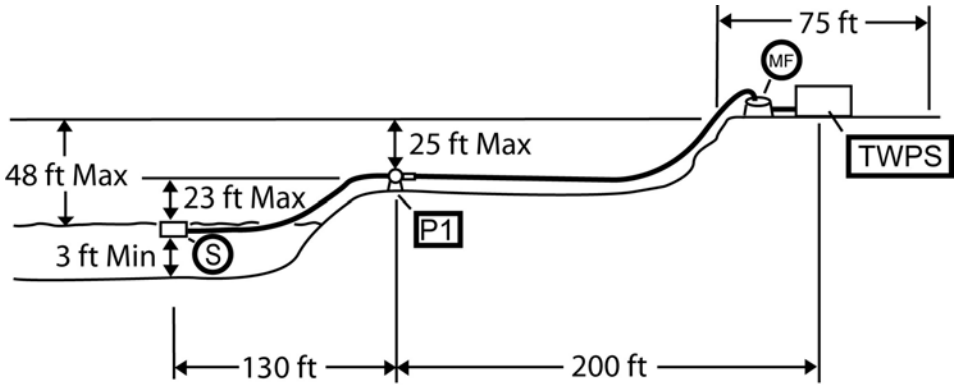


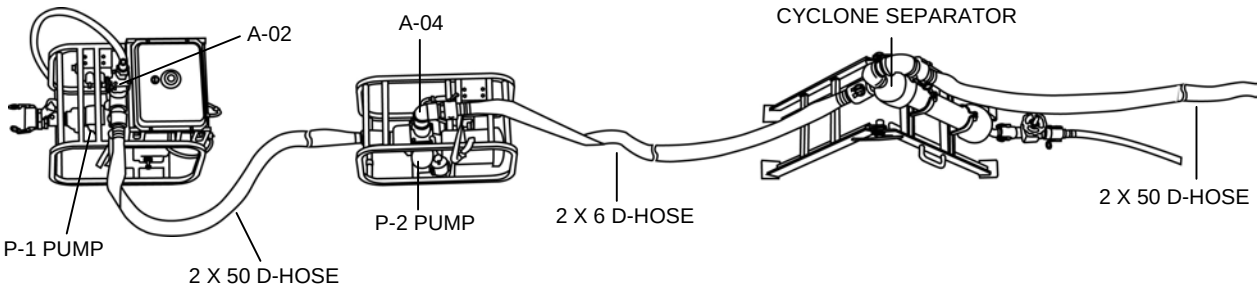
Figure 3. P-1 Pump Only Raw Water System Configuration.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0004 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SITE SELECTION AND COMPONENT LOCATION

P-1 Pump to P-2 Pump to Cyclone Separator Raw Water System Configuration (see Figure 4)

When both raw water pumps and the cyclone separator are used, the cyclone separator should be placed at the discharge of the second raw water pump. The main components used in this configuration include Diesel-Driven Pump P-1, Adaptor Assembly A-02, two 2 in. diameter, 50 ft long discharge hoses, Motor-Driven Pump P-2, Adaptor Assembly A-04, one 2 in. diameter, 6 ft. long discharge hose, the cyclone separator, and two 2 in. diameter, 50 ft long discharge hoses.

TOP VIEW



SIDE VIEW

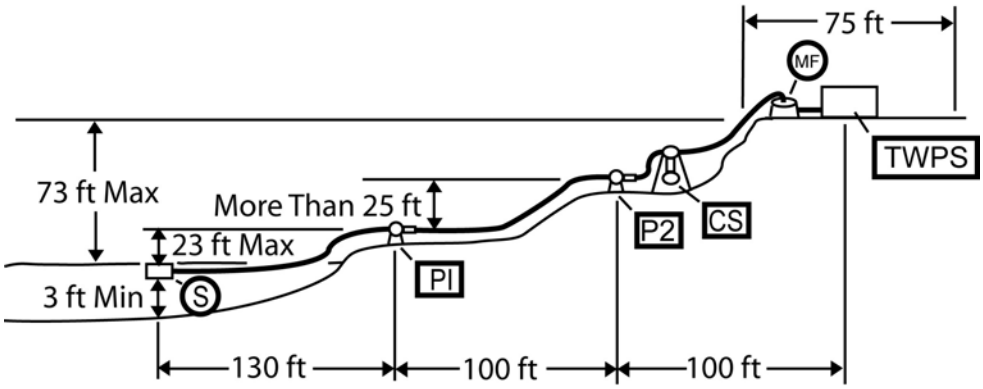


Figure 4. P-1 Pump to P-2 Pump to Cyclone Separator Raw Water System Configuration.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0004 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SITE SELECTION AND COMPONENT LOCATION

The location of the MF feed tank, the MF feed pump skid, and the components used in the product water distribution system is dependent primarily on the length of the hoses used with these components. The following general rules apply for planning the MF tank, MF feed pump, and product water distribution system layout:

- Locate the MF feed tank within 20 ft. of the TWPS platform and in a position where the water level of the tank can be observed during operation (see Figure 1).
- Locate the MF feed pump skid within 3 ft. of the MF feed tank.
- Locate the distribution tank that is closest to the TWPS 15 to 30 ft. from the TWPS product water discharge. (Note: the A-TWPS set-up must allow the product hose to reach one tank of the standard 6K distribution system and one tank of the 9K extended distribution system.)
- Locate additional distribution tanks about 5 ft. apart from each other.
- Locate the product water distribution pump about 5 ft. from the tee and hose that connect two distribution tanks.

ADDITIONAL COMPONENT LOCATION CONSIDERATIONS

Check that the ground is solid and fairly level. Clear the area as needed. Take advantage of finished roads. They can provide a solid level surface.

Locate the MF feed tank in a position where the water level of the tank can be observed during operation.

Locate the product water distribution storage tanks in an area where the distribution nozzles will be accessible to water trucks and other vehicles.

If the TWPS is deployed on an NBC decontamination mission, locate the NBC tank in the discharge line between the TWPS product water discharge and the first distribution tank.

If the cleaning waste storage tank is to be used, it should be positioned within 30 ft of the TWPS waste out connection. Since the waste out flow is gravity fed, the waste tank should be at an elevation below the TWPS if at all possible.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS EQUIPMENT OFF-LOADING – ARMY UNIT

0005 00

INITIAL SETUP:

Personnel Required:
Three
Equipment Condition:
TWPS packed out and container (flat rack) closed

GENERAL

This work package provides instructions for setting up the container (flat rack), and off-loading equipment and components for operation at a deployed site. Before performing setup and off-loading procedures, the site and its terrain must be evaluated and the component locations and layout established as described in WP 0004.

Depending on the operating configuration and the existing or expected environmental conditions at the deployment site, many packed-out components may not be used. For example, none of the components of the Cold Weather Kit will be needed unless freezing conditions are expected. However, most of the unused components must still be off-loaded so they are not in the way during operation. Only the following items should be left on the skid:

- Ocean Intake Structure System (OISS) wellpoint assemblies, riser assemblies, and hoses (stored on top of the skid frame)
- Nuclear, Biological, and Chemical (NBC) tank
- OISS tee assembly, ice intake strainer, adaptor A11, ice auger and handle, and operator station entry overhead support beam (stored under the high pressure pumps)
- RO element pusher (strapped to the vertical pipe to the left of the MF filters)
- Bisulfite and citric acid chemical buckets (stored in the equipment area)
- Operator's tool kit

Before starting off-load, select an area at the deployment site for storing the unused components so they are readily available, if needed, and are all together to reduce the chance of items being lost. The area should be nearby but out of the way so it doesn't interfere with operation or personnel and vehicle traffic. If possible, the unused items should be stored in a tent or covered with a tarp so they are protected.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

A-TWPS REMOVAL FROM PLS TRAILER

If the A-TWPS was transported on a PLS Trailer, rollers were installed on the flat rack in order to roll the A-TWPS onto the trailer from the PLS Truck. After the PLS Truck is unloaded, the A-TWPS is rolled off the trailer and onto the truck using the arm on the PLS Truck. Before the A-TWPS is set on the ground from the PLS Truck, the rollers must be removed from their in-use brackets and installed in their storage brackets as follows:

1. Remove both rollers from their in-use brackets at the operator station end of the flat rack as follows (see Figure 1):
    a. Remove the retaining pins.
    b. Pull out the roller axle.
    c. Lift the roller out of the in-use bracket.
2. Install both rollers in their storage brackets at the bail bar end of the flat rack as follows (see Figure 1):
    a. Position the roller in the storage bracket.
    b. Slide the roller axle through the bracket and roller.
    c. Insert a retaining pin in both ends of the axle.

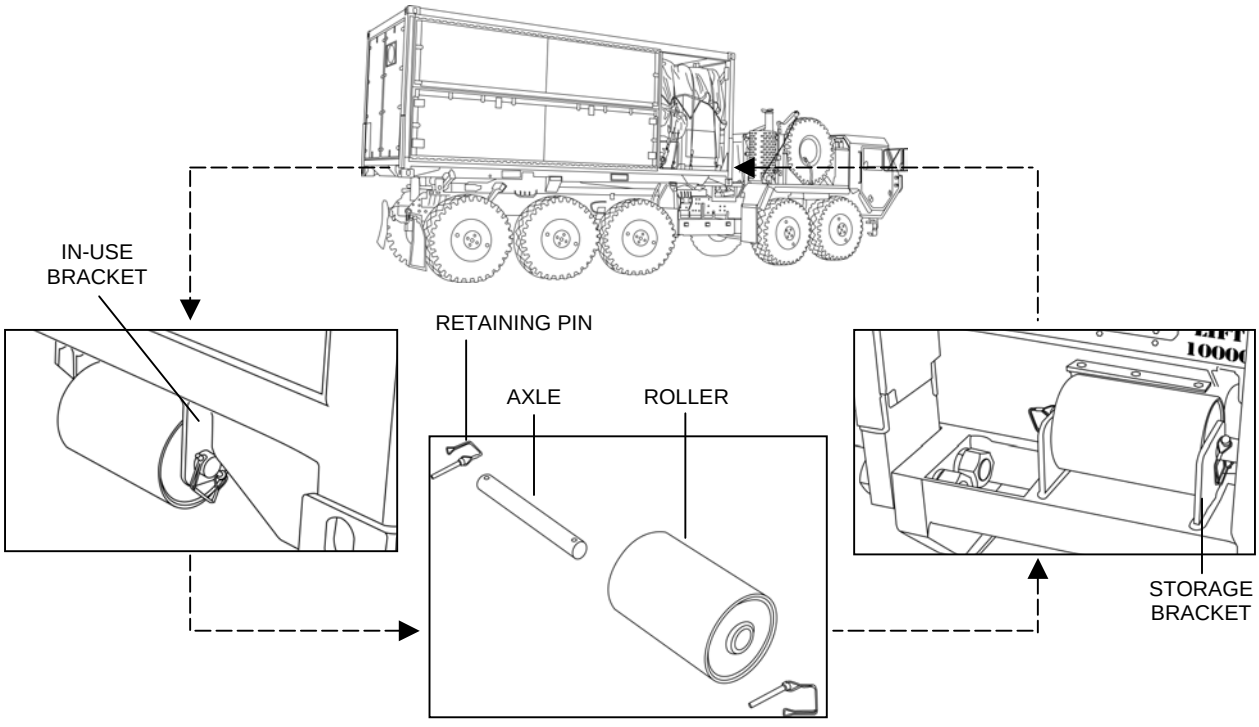

Figure 1. Flat Rack Roller Storage.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

EQUIPMENT OFF-LOAD

This section provides instructions for setting up the flat rack and off-loading equipment. As items are off-loaded, place them in the general locations where they will be deployed, as determined by the site selection and component location procedures in WP 0004 00. Once the flat rack has been set up, equipment can be off-loaded from the operator station, equipment area, and generator area at the same time if enough personnel are available.

NOTE

The figures in this work package show typical packout arrangements of the various areas. Some items may not always be packed out exactly as shown.

A-TWPS Placement

Place the A-TWPS unit on the ground as follows:

1. Using an appropriate lifting device, lift the A-TWPS unit off the transportation unit (e.g. truck or trailer) and set it on the ground in the desired location.
2. Remove the left, back end panel from the flat rack and remove the protractor (level) provided with the unit from its holder on the frame at the operator end of the TWPS unit (see Figure 2).
3. Place the protractor (level) on any horizontal surface of the TWPS and check the following levels:
    a. No more than 2 degrees cross-wise (front to back) (see Figure 2).
    b. No more than 1 ½ degrees length-wise (side to side) (see Figure 2).
4. If the levels exceed the recommended values, the site must be graded or the TWPS unit moved to a site that meets the level requirements.

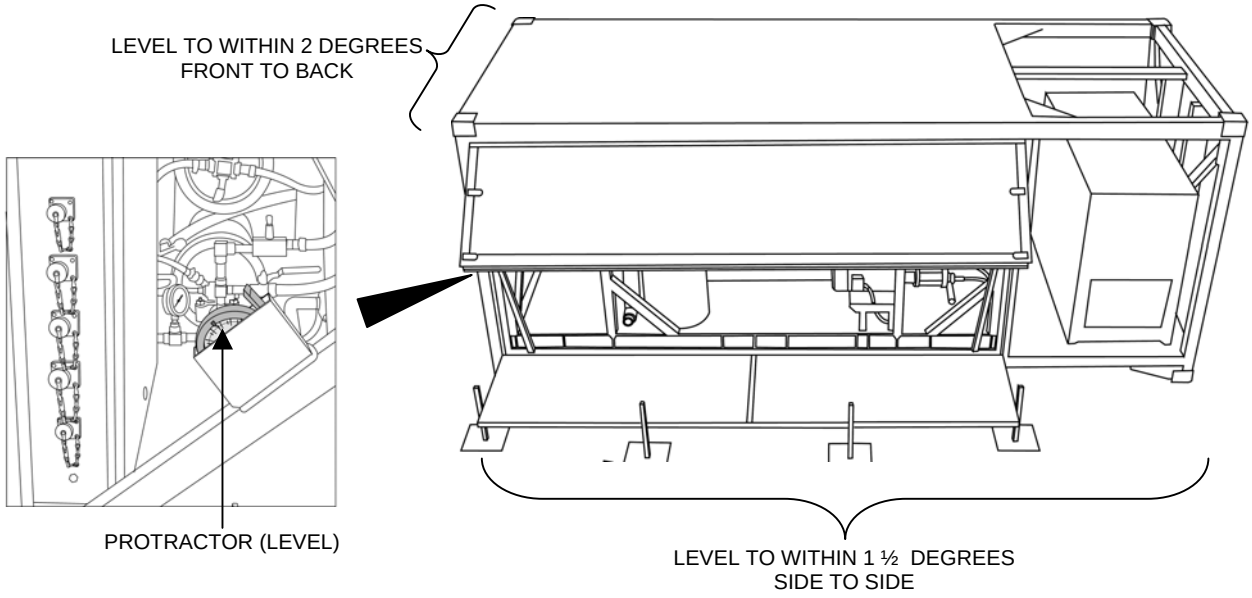

Figure 2. Leveling the A-TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

Preparation for Equipment Off-Load

WARNING

Two person lift. Two people are required to safely move the flat rack panels. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

1. Unlatch and remove flat rack rear panels #3 and #4 (Figure 3).

NOTE

Leave panel #5 in place so the folding steps can be used to climb onto the roof of the flat rack for off-loading items packed in the generator area.

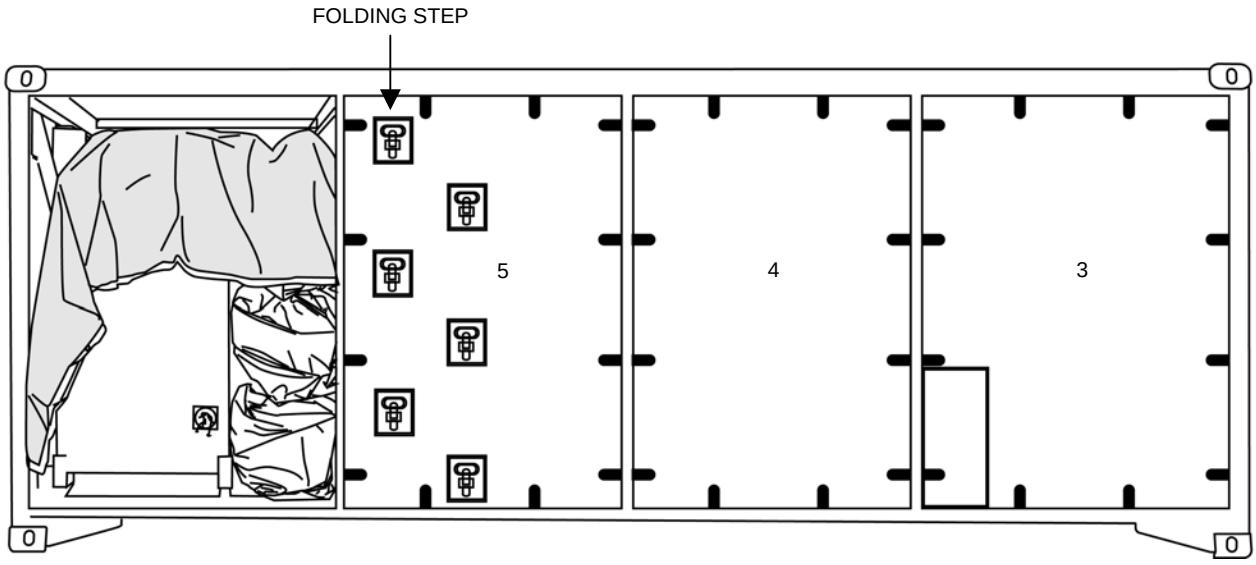

Figure 3. Flat Rack Rear Panels.

2. Unlatch and remove operator station end panels #1 and #2 (Figure 4).

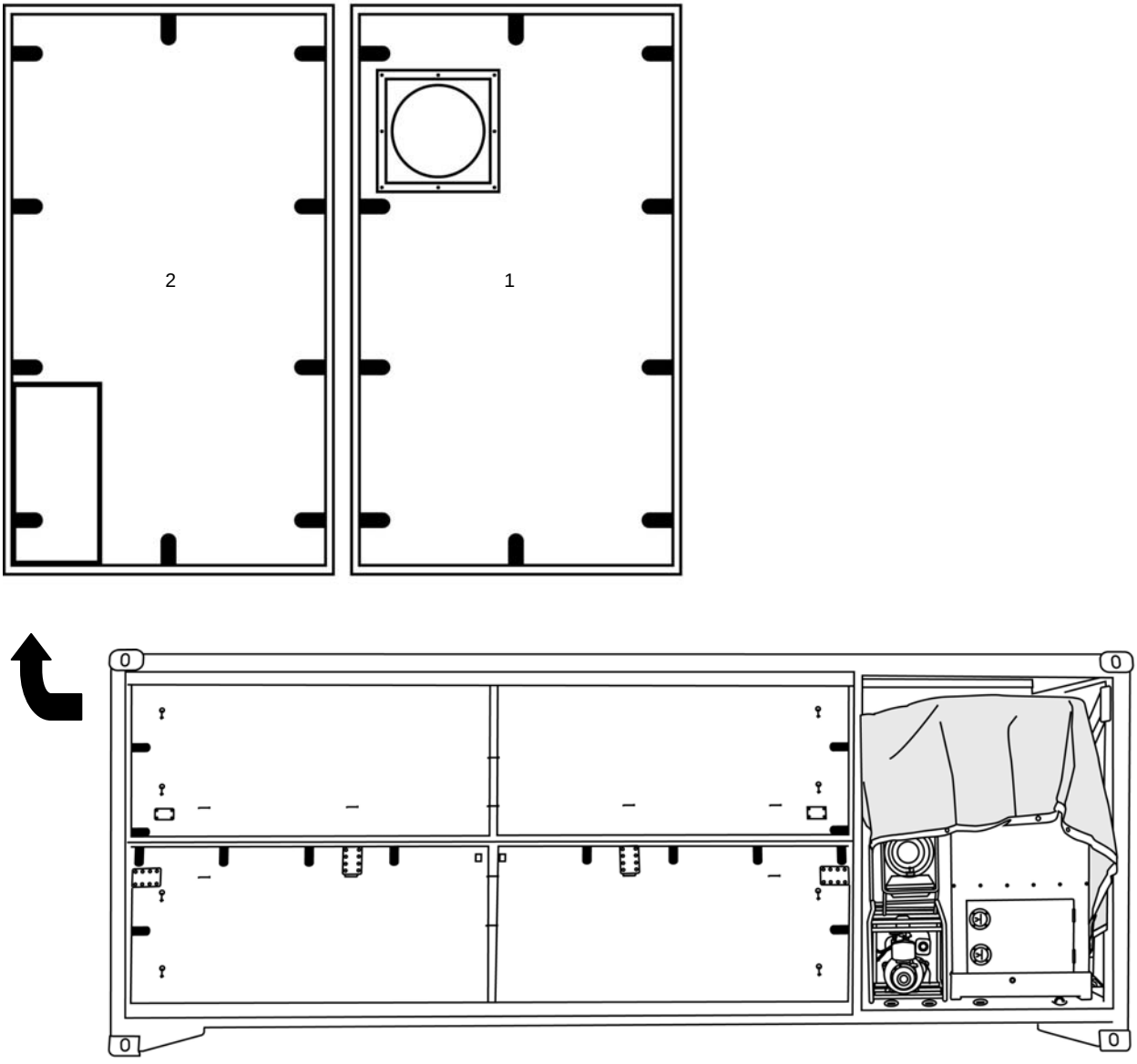

Figure 4. Operator Station End Panels.

CAUTION

Do not stand on the deck until all of the support assemblies are in place, or equipment damage may result.

3. At the front of the flat rack, unlatch the deck and carefully lower it to the ground (Figure 5).

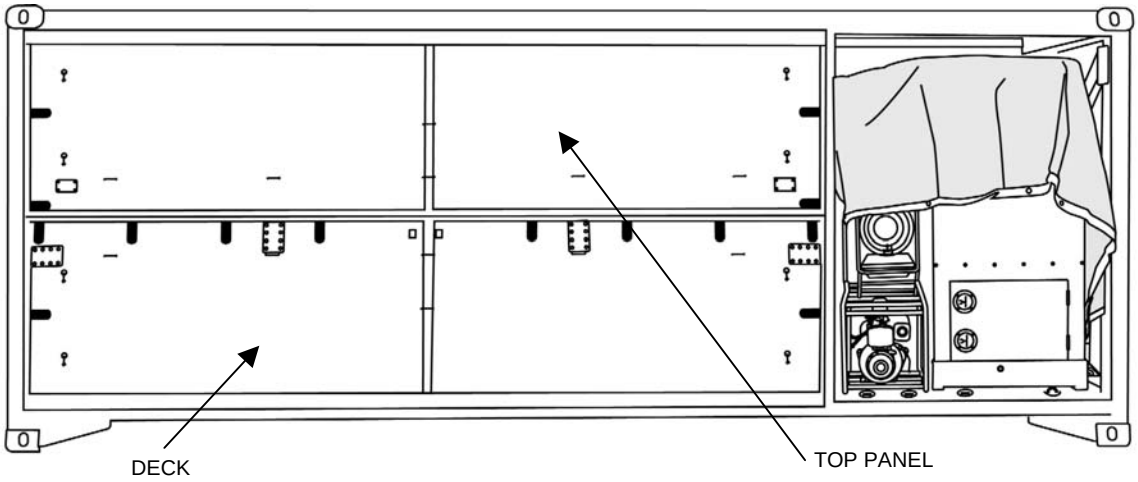

Figure 5. Flat Rack Top Panel and Deck.

4. Retrieve the four pad sections and four horizontal sections of the deck support assemblies from their storage locations in the equipment area (Figure 6).

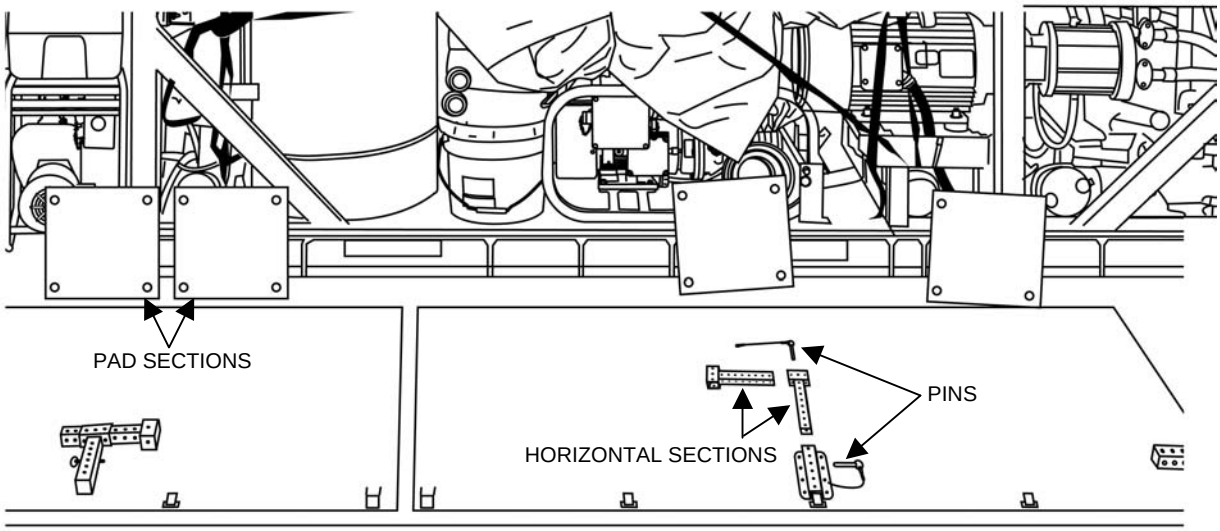

Figure 6. Deck Support Assembly Components.

5. Assemble the deck supports by sliding a horizontal section onto each pad section and securing it with the retaining pin (Figure 7).

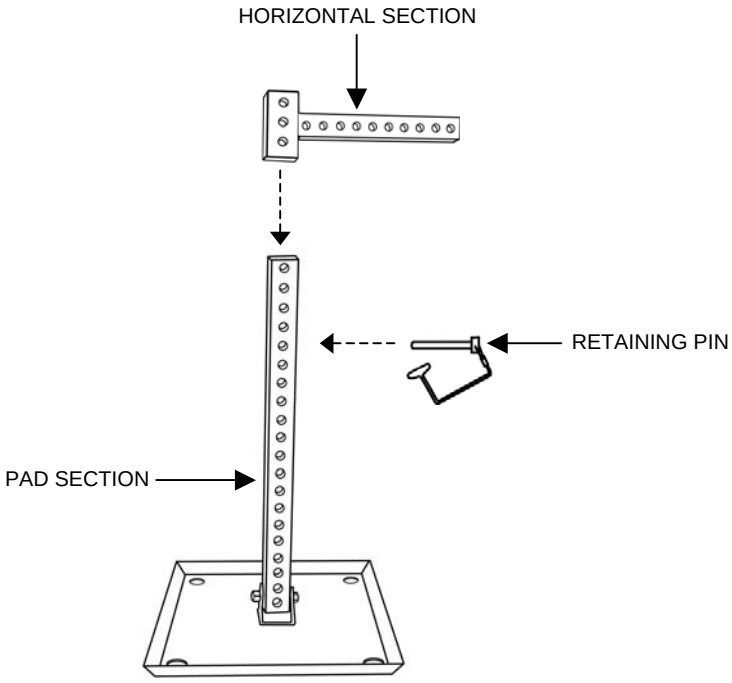

Figure 7. Deck Support Assembly.

6. With another person lifting up on the deck, slide the support assemblies into the brackets on the deck and secure them with the retaining pins.
7. Lower the deck until the support assembly pads are on the ground. Adjust the height of individual assemblies as necessary until the deck is level and all four pads are on the ground.

WARNING

Packed-out items can shift during transport and may fall out when the top panel is opened. To prevent personal injury, be careful when opening the panel.

8. Unlatch and lift up the top panel. With another person holding the panel open and horizontal, insert the retaining pins into the panel supports to lock it in position.
9. Remove the tie-down straps securing the packed-out items on the skid and flat rack.

NOTE
Do not remove the two straps that secure the NBC tank.

10. Remove the cargo cover from the generator area.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

Operator Station Off-load

A typical packout of the operator station area is shown in Figure 8. Unpack the area as follows:

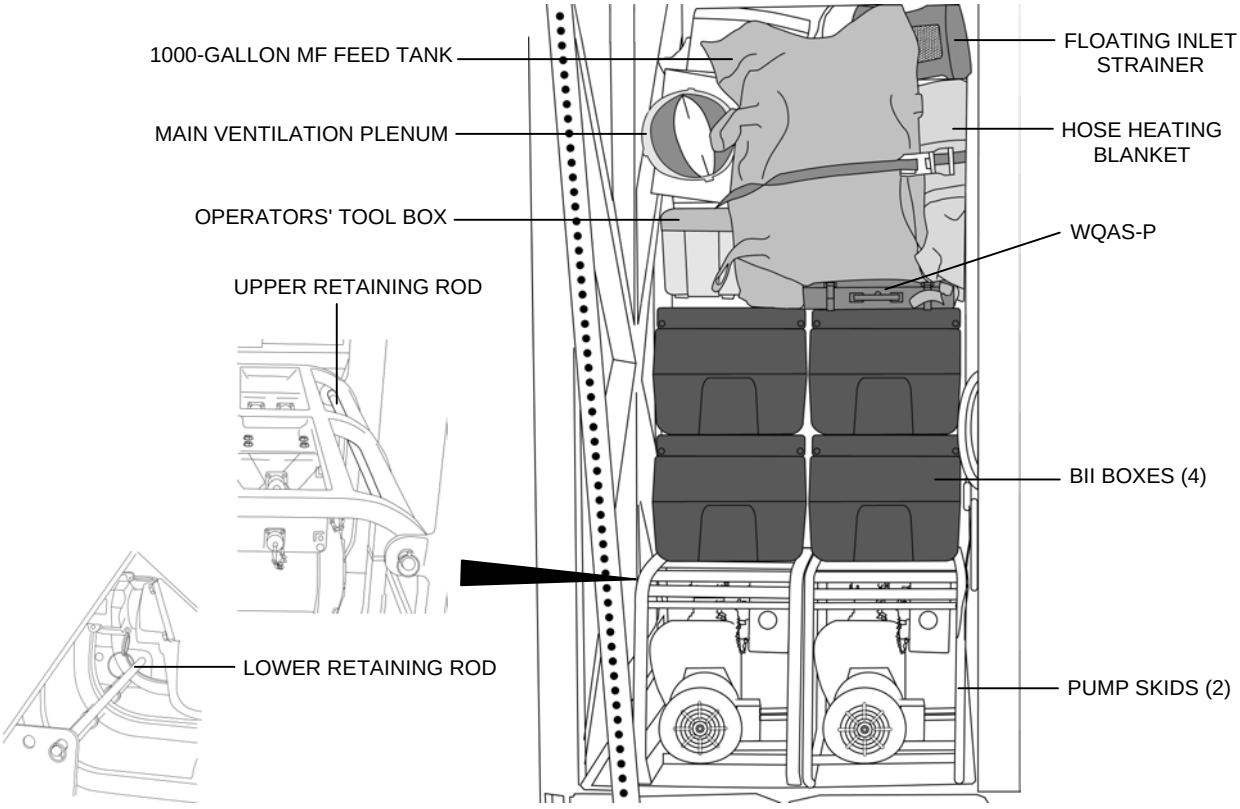

Figure 8. Typical Operator Station Area Packout.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

1. Remove the items packed out on top of the four BII boxes.

WARNING

Two person lift. Two people are required to safely move the BII boxes and pump skids. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Chemical dust. If any chemical buckets or chemical packets are broken and chemical dust is present, wear a dust mask, a protective face shield, and chemical gloves when handling. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

Liquid chemicals. If any liquid chemical containers are broken, wear a protective face shield, chemical gloves, and a chemical apron when handling. Keep water ready when handling. Avoid contact with the liquid. Failure to observe this warning may result in chemical burns, or severe irritation of the nose, throat, eyes, and skin.

NOTE

The caustic cleaner liquid (sodium hydroxide) in the four bottles in BII Box #5 solidifies at temperatures of 53 degrees F and lower. The caustic must be stored in a location warmer than 53 degrees F.

2. Remove the four BII boxes.
3. Remove the hose heating blankets and pump skid covers.
4. Remove the priming pitcher from inside the pump skid.
5. Remove the pump skid retaining rods. Store them in the framework at the end of the flat rack.
6. Remove the pump skids.
7. Remove the remaining items from the operator station area.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

Equipment Area Off-load

A typical packout of the equipment area is shown in Figure 9. Unpack the area as follows:

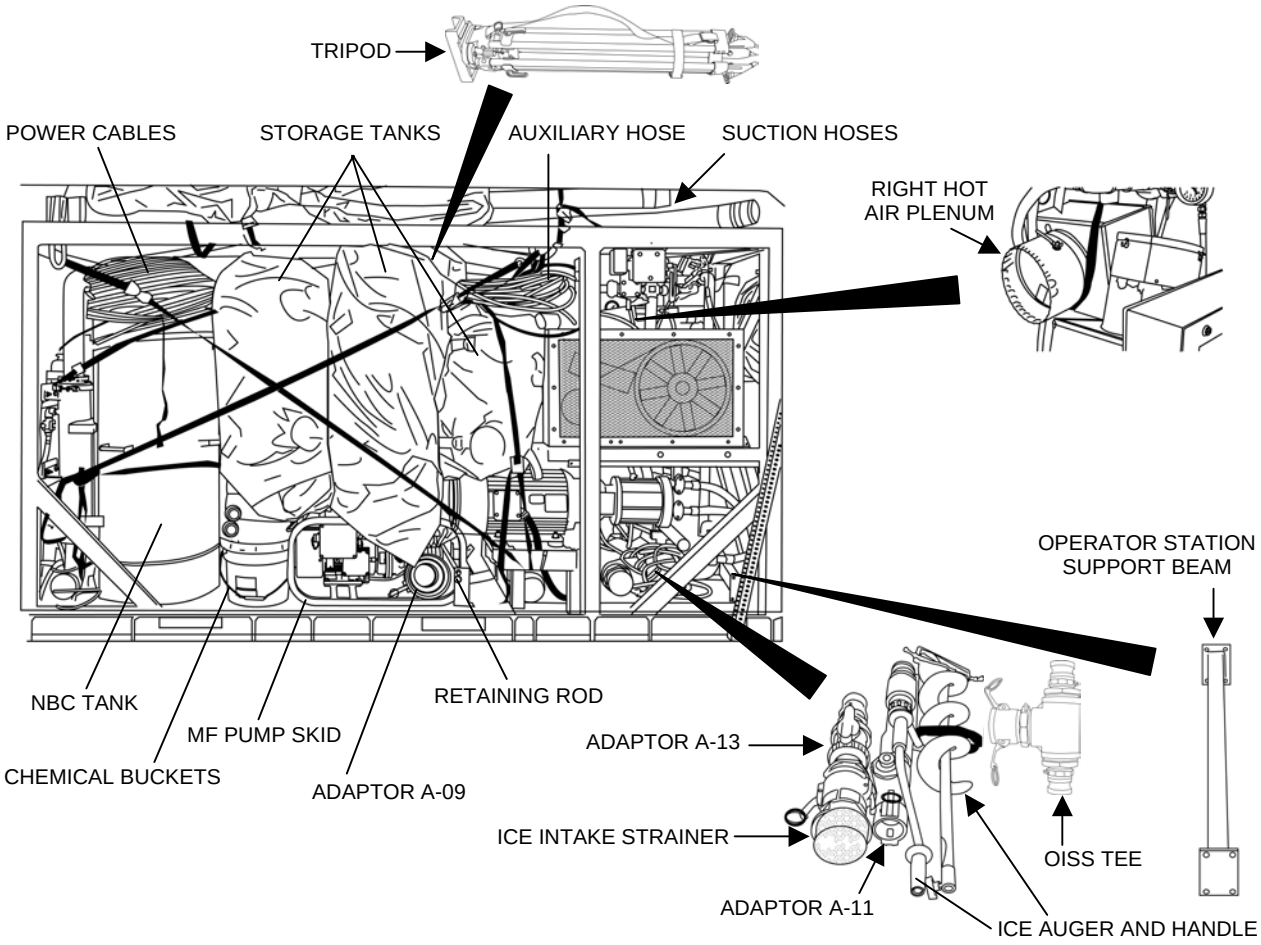

Figure 9. Typical Equipment Area Packout.

1. If they are to be used, remove the following items from underneath the high pressure pumps (Figure 9):
    - Ice intake strainer attached to adaptor A-13
    - Adaptor A-11
    - Ice auger and handle
    - OISS tee assembly
2. Remove the items packed on and around the MF pump skid.
3. Remove adaptor A-09 from inside the MF pump skid.
4. Remove the MF pump skid retaining rod and store it in the framework at the operator station end of the flat rack.

WARNING

Three person lift. Three people are required to safely move the MF pump skid. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

5. Remove the MF pump skid.

WARNING

Two person lift. Two people are required to safely move the cyclone separator assembly. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

6. Remove the cyclone separator assembly.
7. Remove the discharge hoses, fuel can, and anchor from behind the NBC tank.
8. Remove any items remaining in the equipment area.

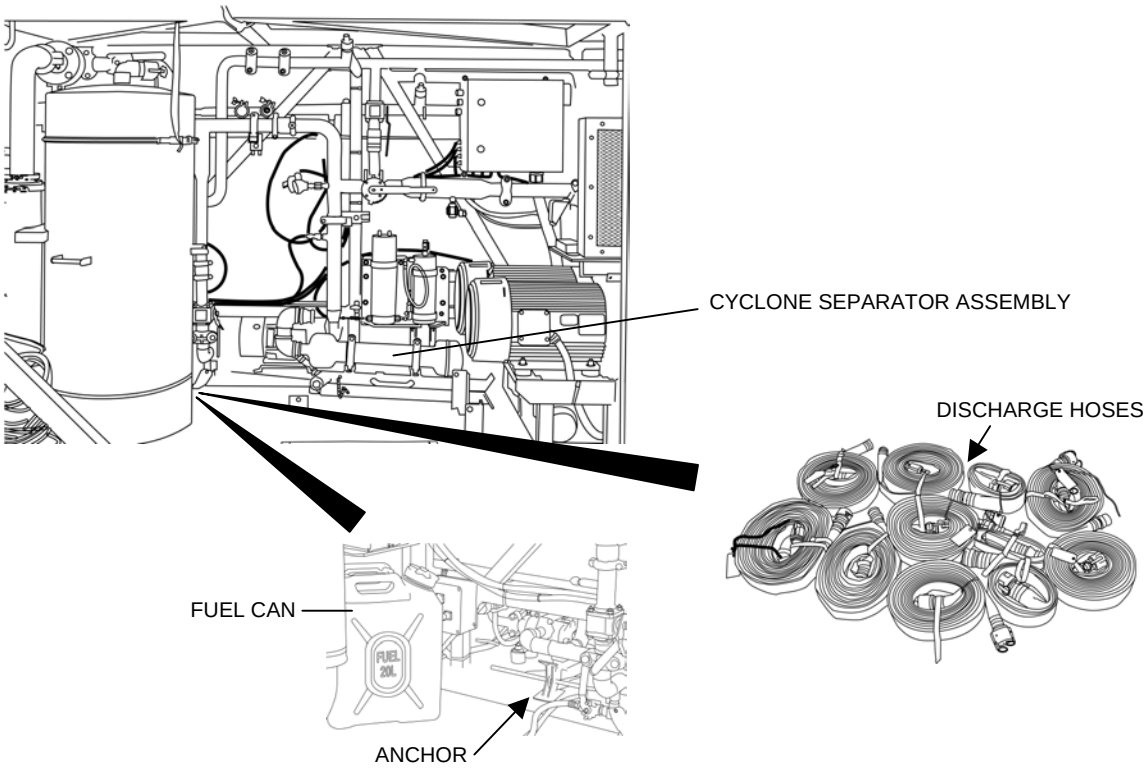

Figure 10. MF Pump Skid Removal.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

Generator Area Off-Load

A typical packout of the generator area is shown in Figure 11 and Figure 12. If desired, items that are not going to be used, such as insulating blankets, may be placed on top of the TWPS flat rack. Unpack the generator area as follows:

1. From the front of the flat rack, remove the fuel tank assembly and hose heating blankets packed on top of the generator and the diesel-fired heater.

WARNING

Two person lift. Two people are required to safely move the diesel-fired heater. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Three person lift. Three people are required to safely move the diesel pump skids. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

2. Remove the diesel-fired heater and the pump skids.

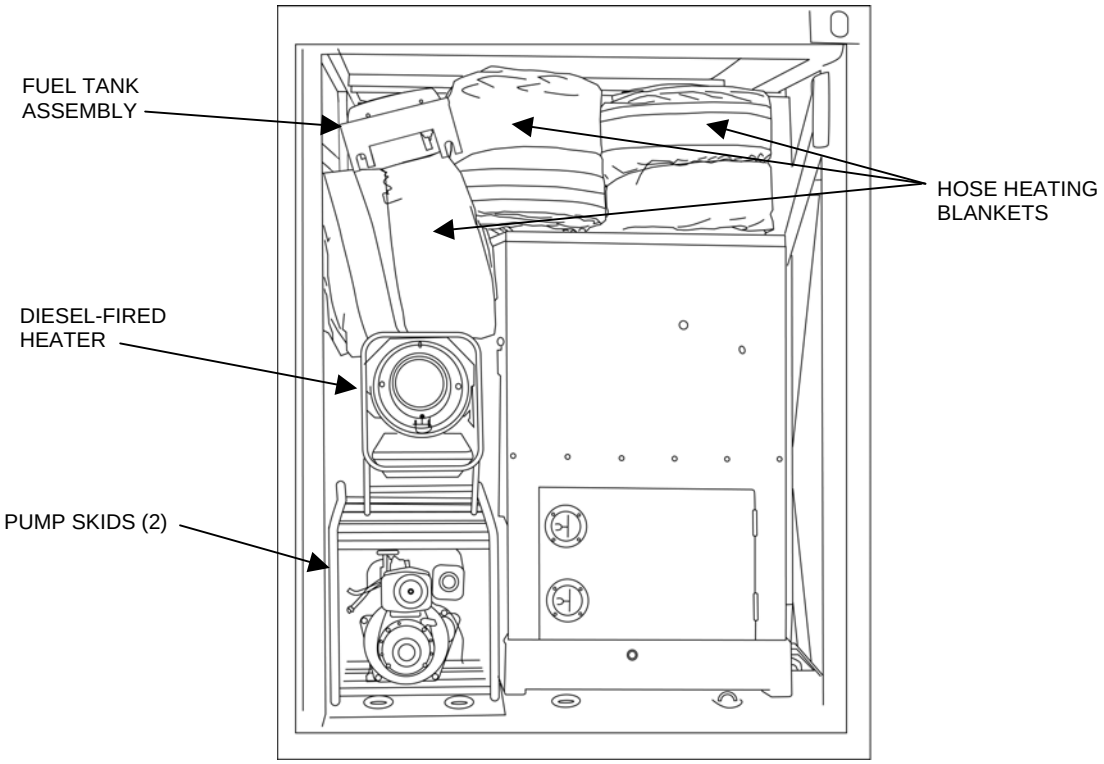

Figure 11. Typical Generator Area Packout - Front.

WARNING

Fall hazard. Make sure that flat rack rear panel #5 is fully latched in place before using the folding steps to climb onto the roof. Failure to observe this warning could result in personal injury from a fall.

3. From the rear and roof of the flat rack, remove the remaining items packed in the generator area.

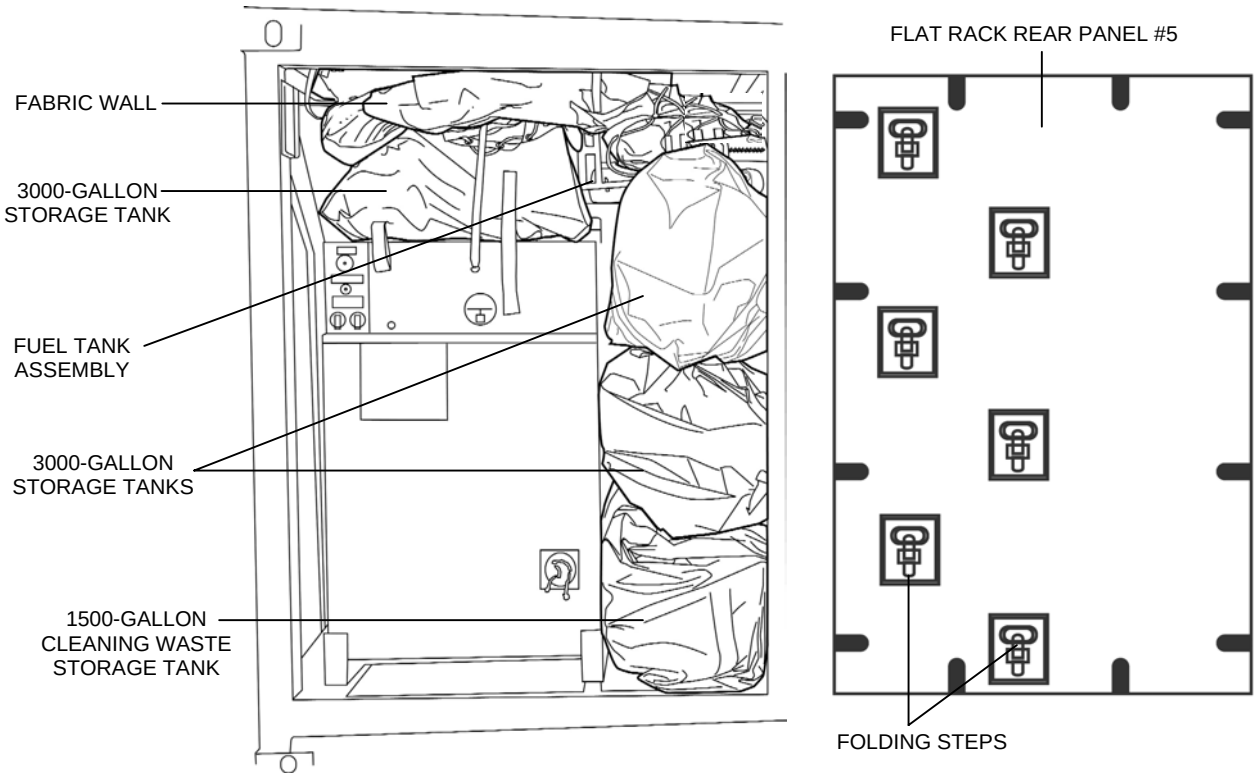

Figure 12. Typical Generator Area Packout - Rear.

WARNING

Two person lift. Two people are required to safely move the flat rack panels. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0005 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – ARMY UNIT

Flat Rack Panel, Duct, Suction Hose, and OISS Off-Load

Unpack the remaining items (see Figure 13).

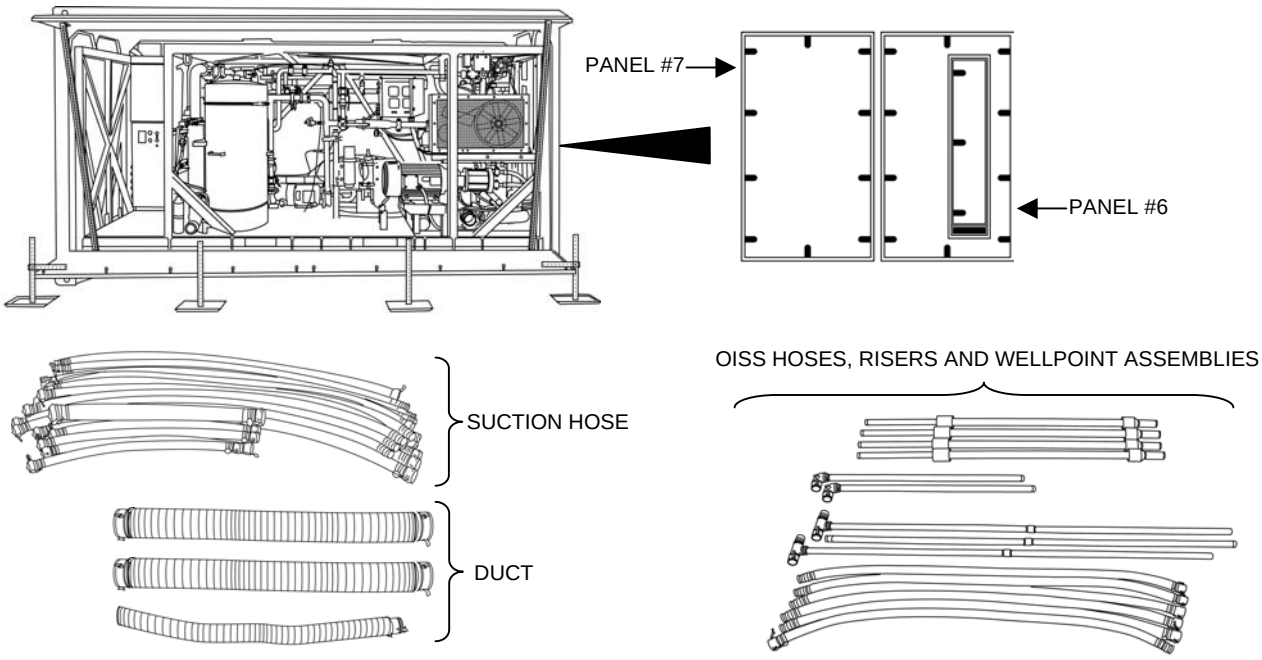

Figure 13. Flat Rack Panel, Duct, Suction Hose, and OISS Off-Load

1. Unlatch and remove flat rack end panels #6 and #7, located next to the generator.
2. Remove the three ventilation ducts stored on top of the RO feed tank.
3. Unlatch and remove flat rack rear panel #5.
4. Unstrap and remove the suction hoses packed on top of the skid frame.

NOTE

The OISS hoses are color coded yellow. They, along with the OISS risers and wellpoint assemblies, are separately strapped down on top of the skid frame, behind the rest of the hoses. The OISS components can be left in place unless the OISS will be used.

5. Group the suction hoses together and distribute them to their deployed locations in accordance with the following color coding:
    a. Green – Raw Water
    b. Blue – Product Water
    c. Red – Waste and Chemical Cleaning.
6. Reinstall all the flat rack panels if weather conditions such as rain, snow, or blowing sand require it. Otherwise, leave the panels off until the TWPS has been started and is operating.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

0006 00

INITIAL SETUP:

Personnel Required:
Three
Equipment Condition:
Skid packed out, with the cargo cover removed.

GENERAL

This work package provides instructions for off-loading equipment and components for operation at a deployed site. Before performing any off-loading procedures, the site and its terrain must be evaluated and the component locations and layout established as described in WP 0004.

Depending on the selected operating configuration, some packed-out items may not be used. For example, all of the hose assemblies may not be needed. However, most unused items must be off-loaded so they are not in the way during operation. Only the following items should be left on the skid:

- Nuclear, Biological, and Chemical (NBC) tank
- Chemical Injection System Adaptor A-11 (strapped to a pipe near the air compressor)
- Reverse Osmosis (RO) element pusher (strapped to a pipe to the left of the MF filters)
- Bisulfite and citric acid chemical buckets (stored in the equipment area)
- Operator's tool kit

Before starting off-load, select an area for storing the unused items so they are readily available if needed, and are all together to reduce the chance of items being lost. The area should be nearby but out of the way so it doesn't interfere with operation or personnel and vehicle traffic. If possible, the unused items should be stored in a tent or covered with a tarp so they are protected.

Extended Capability Modules

Depending on tactical and environmental conditions, and the layout of the deployment site, various extended capability modules may be used. These include:

- Cold Weather Module
- Supplemental Cleaning Waste Storage Module
- Ocean Intake Structure System Module
- NBC Water Treatment Module
- NBC Survivability Module
- Extended Product Water Distribution Kit

The components of these modules are packed out and transported in their own containers.

Hose Identification

To make hoses easier to identify, all suction and discharge hoses are coded with colored bands at each end as follows:

- Raw Water – green
- Product Water – blue
- Cleaning and Waste - red

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

EQUIPMENT OFF-LOAD

This section provides instructions for off-loading equipment. As items are off-loaded, place them in the general locations where they will be used, as determined by the site selection and component location procedures in WP 0004. Equipment can be off-loaded from the operator station and equipment area at the same time if enough personnel are available.

NOTE

The figures in this work package show typical packout arrangements. Some items may not always be packed out exactly as shown.

MC-TWPS Placement

Place the MC-TWPS unit on the ground as follows:

CAUTION

Do not lift the MC-TWPS from the back where the Micro-Filtration (MF) assembly is located. Lift the MC-TWPS from the front. Failure to observe this caution may result in significant damage to the MF assembly.

1. Using an appropriate lifting device, lift the MC-TWPS unit off the transportation unit (e.g. truck or trailer) and set it on the ground in the desired location.
2. Remove the protractor (level) provided with the unit from its holder on the frame at the operator end of the TWPS unit (see Figure 1).
3. Place the protractor (level) on any horizontal surface of the TWPS and check the following levels:
    a. No more than 2 degrees cross-wise (front to back) (see Figure 1).
    b. No more than 1 ½ degrees length-wise (side to side) (see Figure 1).
4. If the levels exceed the recommended values, the site must be graded or the TWPS unit moved to a site that meets the level requirements.

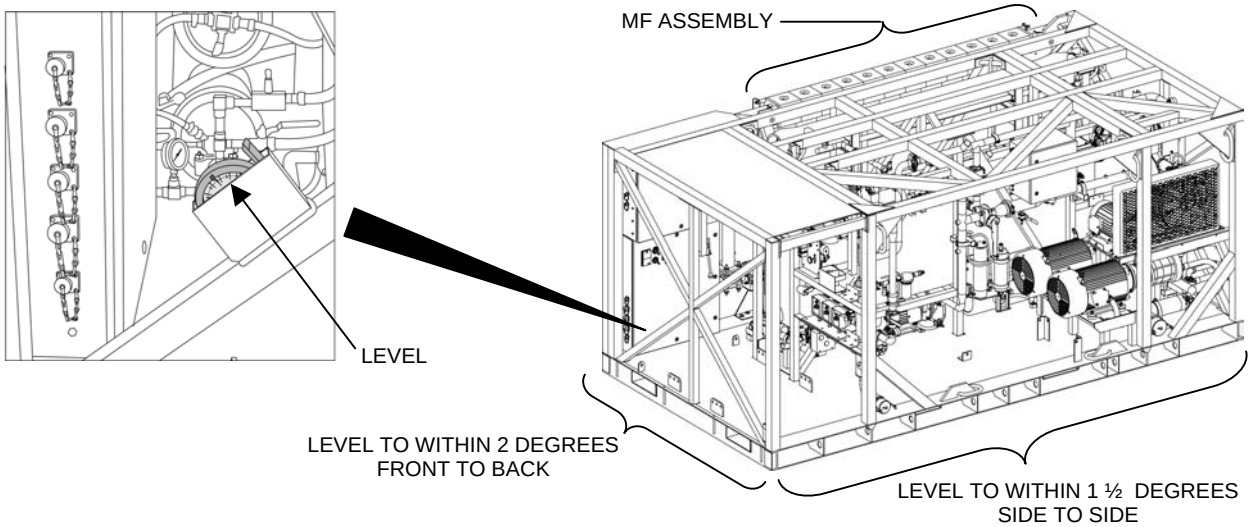

Figure 1. Leveling the MC-TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

Operator Station Off-Load

A typical packout of the operator station area is shown in Figure 2 and Figure 3.

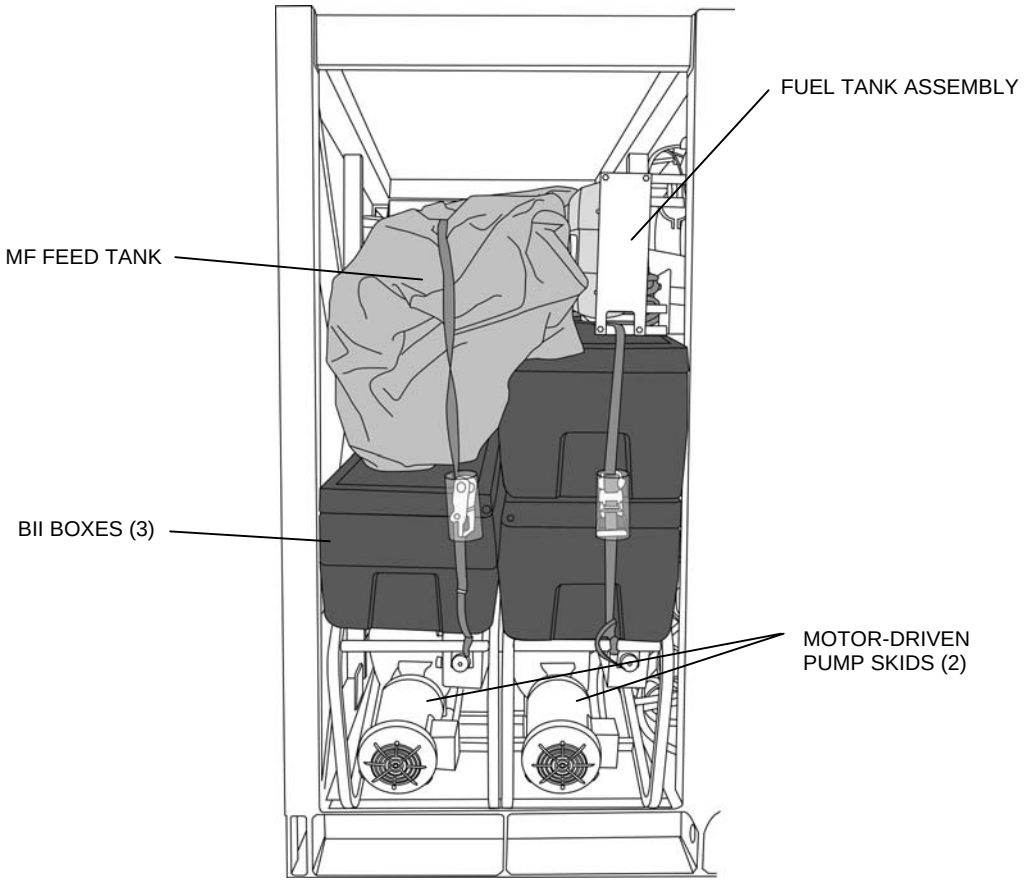

Figure 2. Typical Operator Station Packout – Front View.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

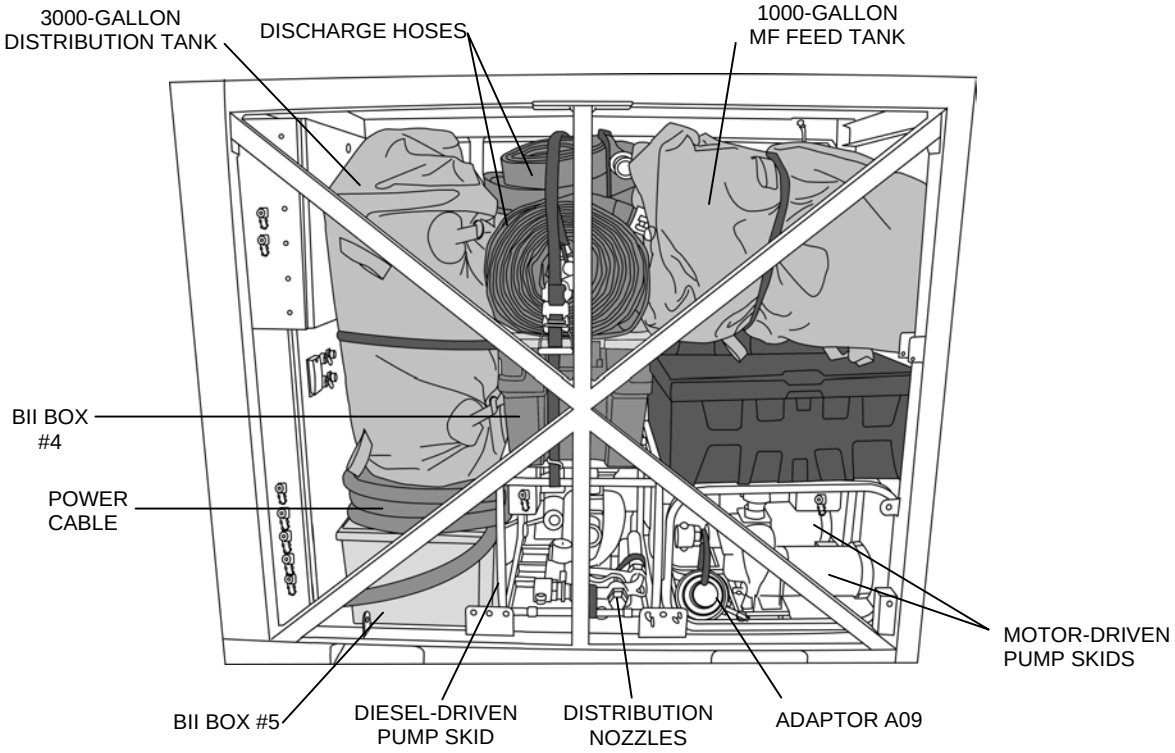

Figure 3. Typical Operator Station Packout – Side View.

Off-load the operator station as follows:

1. Remove the tie-down straps.
2. Remove the 1000-gallon MF feed tank and the fuel tank assembly.

WARNING

Two person lift. Two people are required to safely move the BII boxes and motor-driven pump skids. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

3. Remove the priming pitcher, Adaptor A09, and distribution nozzles from inside the pump skids.
4. Remove the three BII boxes from on top of the pump skids.
5. Remove the motor-driven pump skid retaining rods and the pump skids.
6. Remove the discharge hoses, power cables, and BII Box #4 from on top of the diesel pump skid.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

WARNING

Three person lift. Three people are required to safely move the diesel pump skid. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Two person lift. Two people are required to safely move the distribution tank, power cable, and BII box #5. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

7. Remove the diesel pump skid retaining rods and the pump skid.
8. Remove the 3000-gallon distribution tank.
9. With another person assisting, uncoil the power cable and route it out the end of the skid.

NOTE

The caustic cleaner liquid (sodium hydroxide) in the four bottles in BII Box #5 solidifies at temperatures of 53 degrees F and lower. The caustic must be stored in a location warmer than 53 degrees F.

10. Remove BII Box #5.

WARNING

Chemical dust. If any chemical buckets or chemical packets are broken and chemical dust is present, wear a dust mask, a protective face shield, and chemical gloves when handling. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

Liquid chemicals. If any liquid chemical containers are broken, wear a protective face shield, chemical gloves, and a chemical apron when handling. Keep water ready when handling. Avoid contact with the liquid. Failure to observe this warning may result in chemical burns, or severe irritation of the nose, throat, eyes, and skin.

11. Remove the chemical buckets and lids.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

Operator Station Roof Raising

Raise the operator station roof as follows:

1. If the general purpose cover is installed over the TWPS unit, unfasten the straps (three at one end) and snaps (six in front and six in back) around the expandable end of the cover above the operator station roof (see Figure 4).

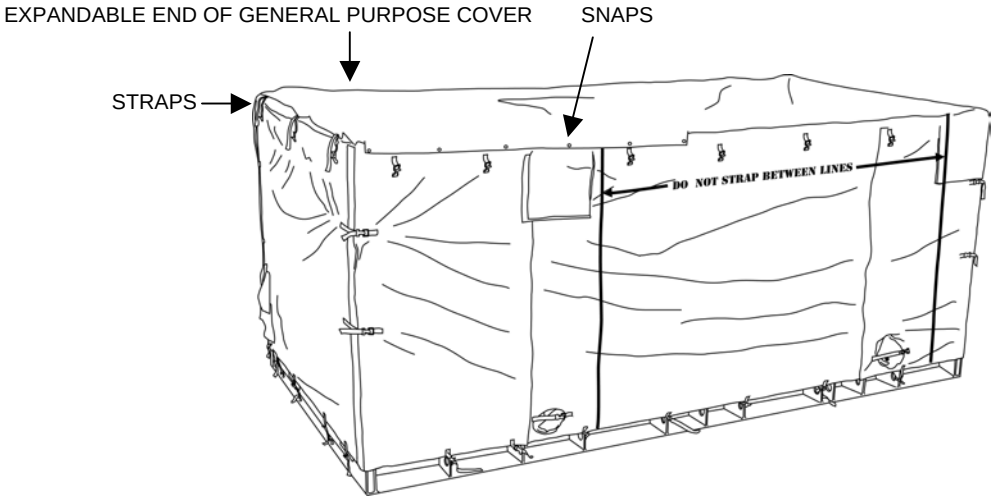

Figure 4. General Purpose Cover Straps and Snaps Over the Operator Station.

2. If the winter cover is installed over the TWPS unit, unfasten the straps around the expandable end of the cover above the operator station roof (see Figure 5).

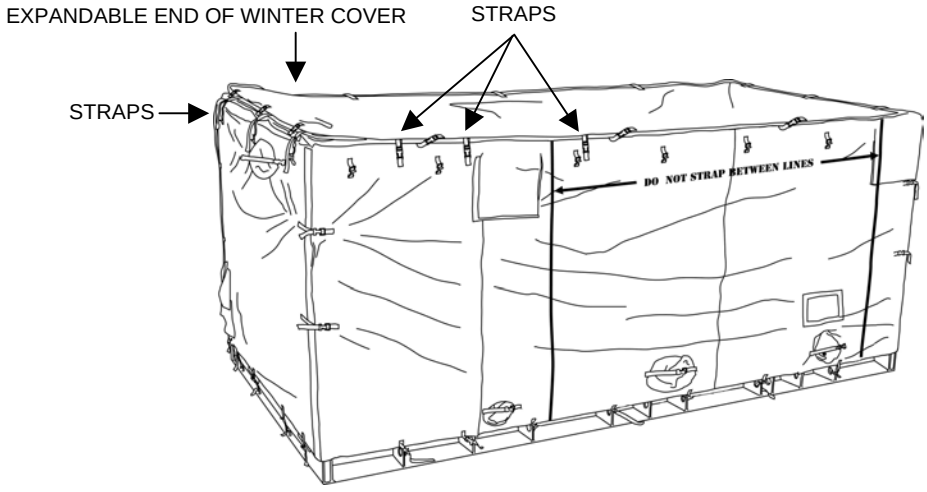

Figure 5. Winter Cover Straps Over the Operator Station.

3. Unfasten the operator station overhead support beam padding hook and loop seam and remove the padding from the support beam.
4. Store the padding in a BII Box after other components are unpacked from the boxes.
5. Remove the eight bolts and lock washers from the operator station overhead support beam and remove the beam (see Figure 6).
6. Reinstall the bolts and washers in the TWPS frame.
7. Store the beam under the high-pressure pumps.
8. Remove the retaining pins from the operator station roof and TWPS frame.
9. Raise the roof.
10. Install the pins through the bottom holes in the legs of the roof and through the holes in the TPWS frame to secure the roof in the raised position (see Figure 6).

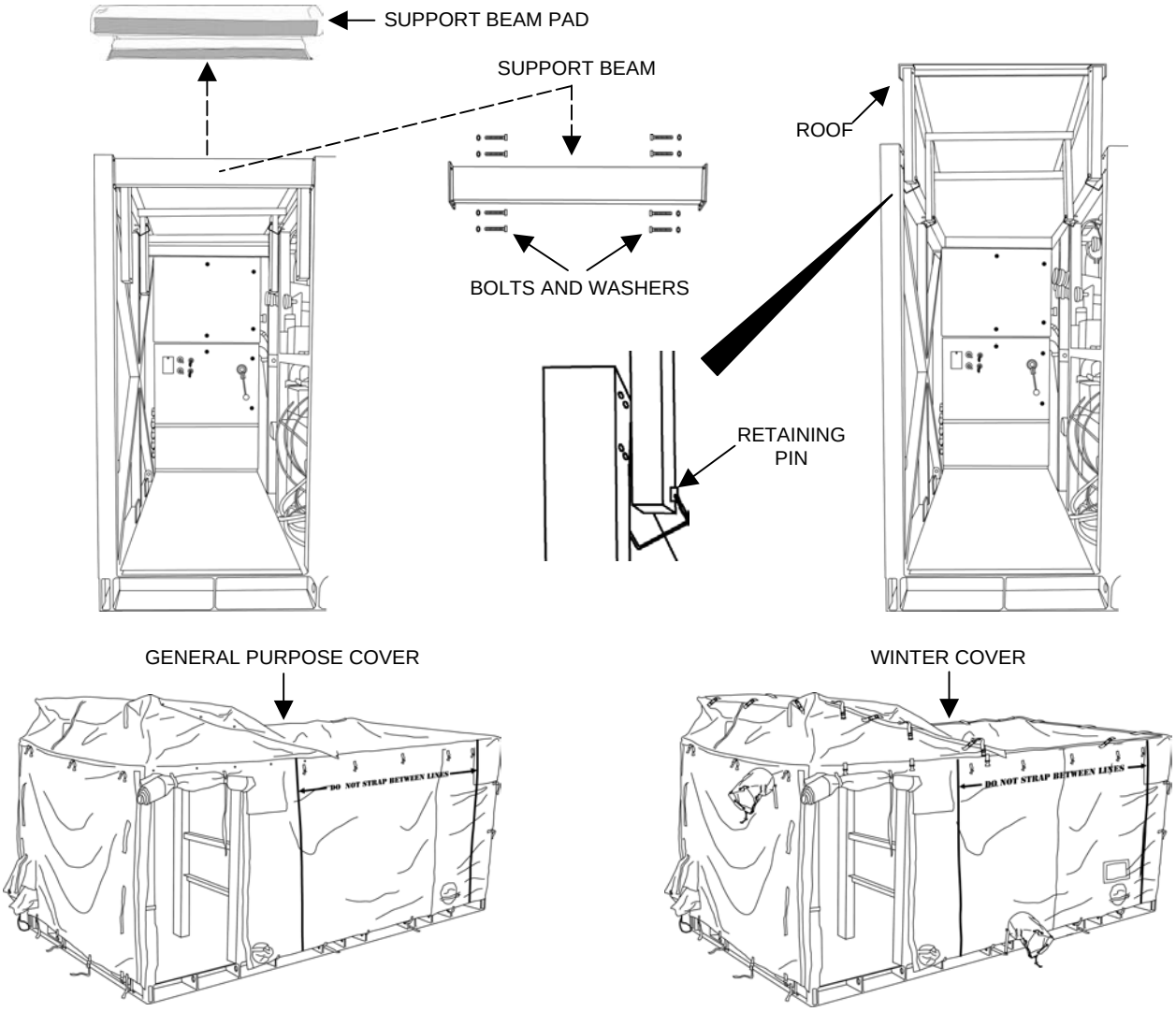

Figure 6. Operator Station Overhead Support Beam Removal and Roof Raising.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

Equipment Area Off-Load

A typical packout of the equipment area is shown in Figure 7.

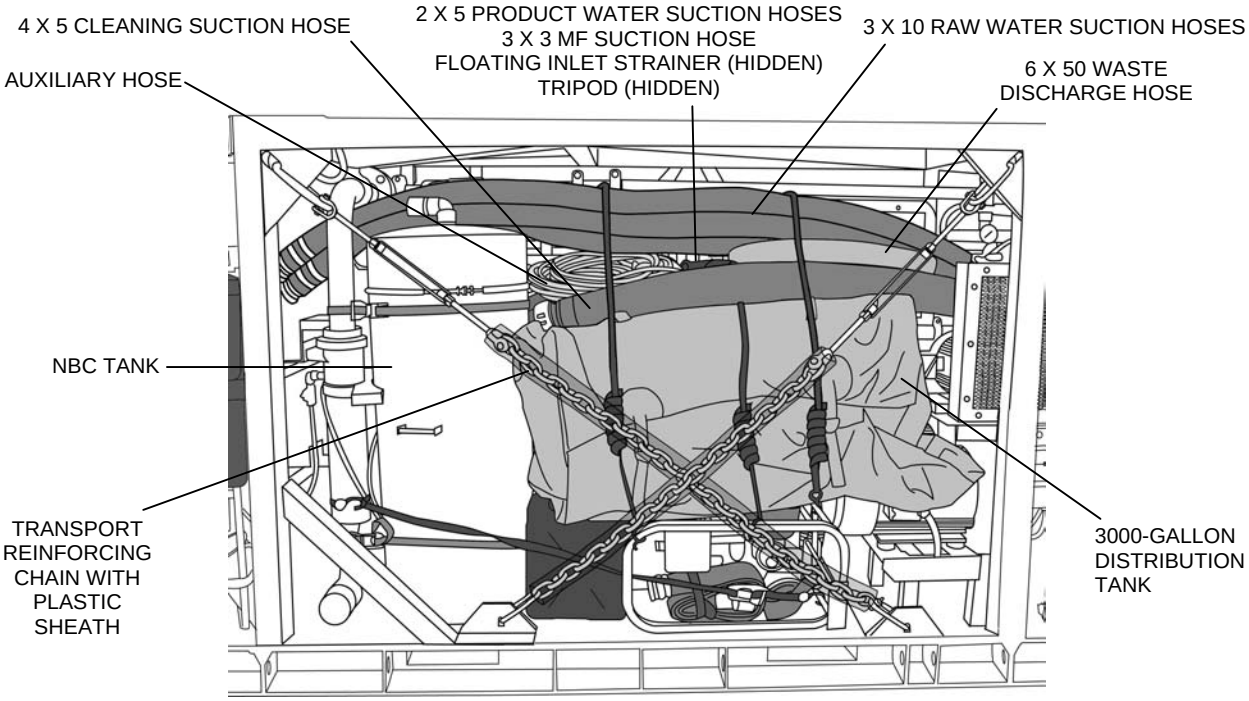

Figure 7. Typical Equipment Area Packout.

Off-load the equipment area as follows:

1. Remove the two transport reinforcing chains.
2. Remove the tie-down straps.

NOTE

Do not remove the two tie-down straps that secure the NBC tank. The tank will not be off-loaded.

3. Remove the following items from on top of and behind the distribution tank:
   - Three 3-in. x 10-ft. green-banded raw water suction hoses
   - 4-in. x 5-ft. red-banded cleaning suction hose
   - 5/8-in. x 50-ft. auxiliary hose assembly P06
   - Two 2-in. x 5-ft. product water suction hoses (not visible in Figure 7)
   - 3-in. x 3-ft. MF suction hose (not visible in Figure 7)
   - Floating inlet strainer
   - 6-in. x 50-ft., red-banded waste discharge hose
   - Tripod

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

WARNING

Two person lift. Two people are required to safely move the distribution tank. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

4. Remove the 3000-gallon distribution tank.
5. Remove the following items (see Figure 8):
    - Discharge hoses (3) packed inside the MF pump skid
    - Fuel can
    - Operator's tool kit
    - Bisulfite and citric acid chemical buckets (2)
    - MF pump skid retaining rod

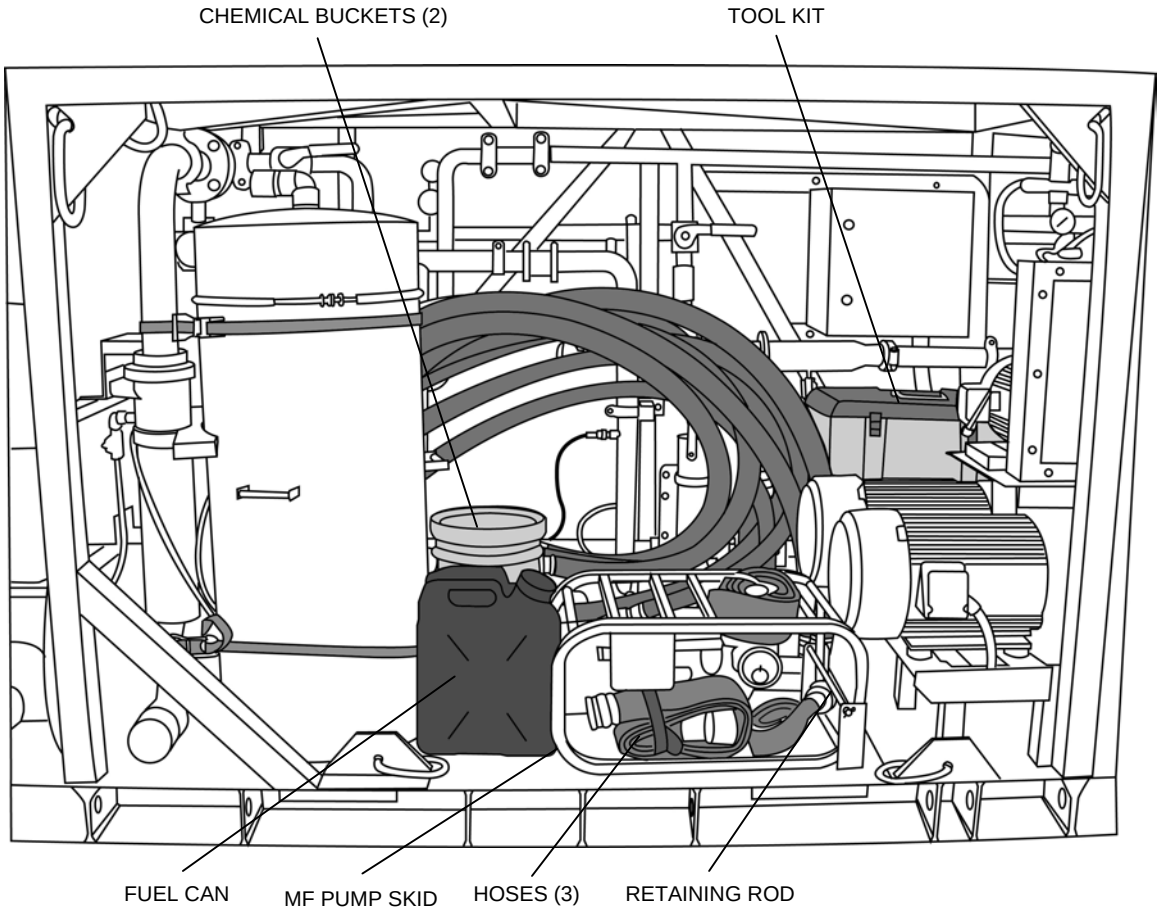

Figure 8. Equipment Area Off-Load 1.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

WARNING

Three person lift. Three people are required to safely move the MF pump skid. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

6. Remove the MF pump skid.
7. Remove the suction hoses packed on top of the cyclone separator and behind the NBC tank (see Figure 9).

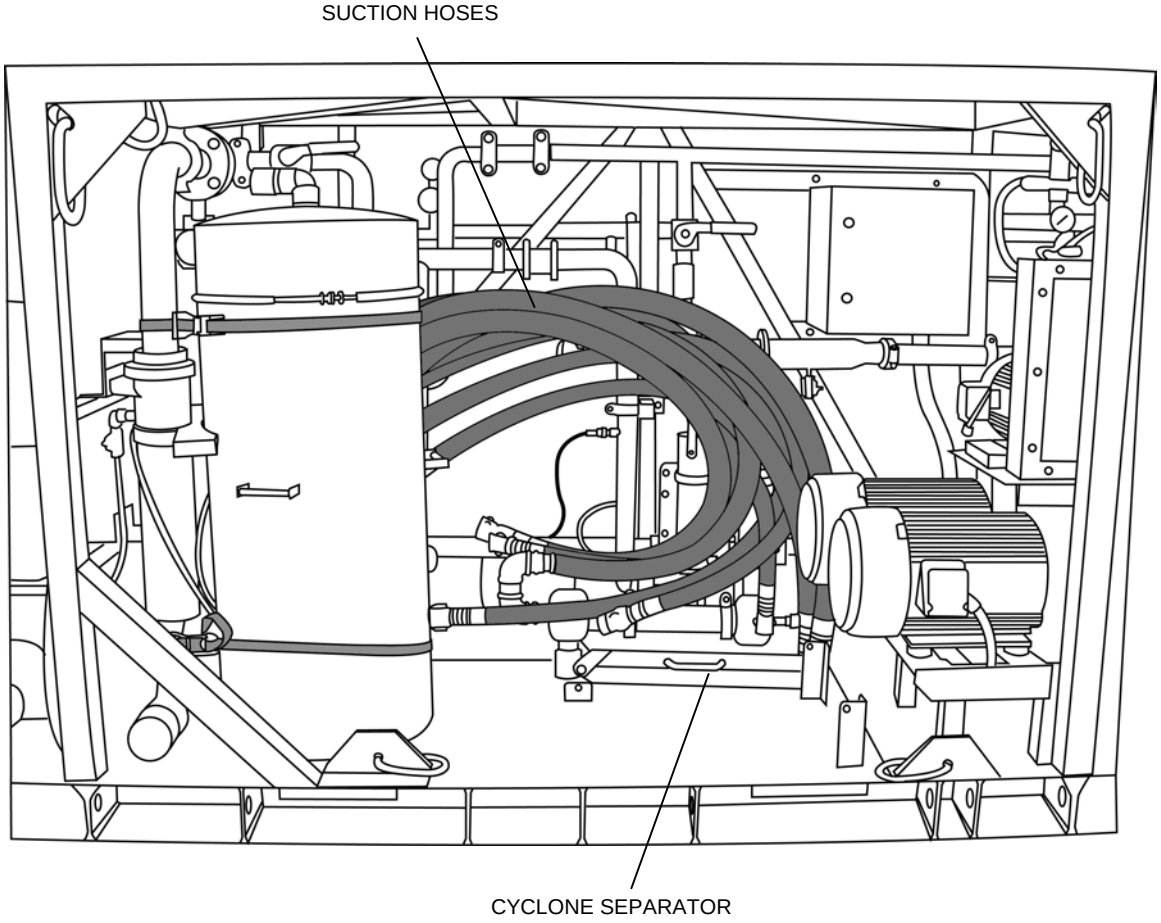

Figure 9. Equipment Area Off-Load 2.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0006 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
EQUIPMENT OFF-LOADING – MARINE CORPS UNIT

WARNING

Two person lift. Two people are required to safely move the cyclone separator assembly. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

8. Remove the cyclone separator assembly.
9. Remove the ten, green-banded raw water suction hoses from on top of the RO feed tank.

WARNING

Do not walk on the roof support sheets. They are not designed to support the weight of a person. Failure to observe this warning may result in injury or damage to equipment.

10. Check the position of the roof support sheets (see Figure 10). If they have shifted, space them equally over the top of the TWPS, but still under the general purpose cover or the winter cover, whichever is in use.

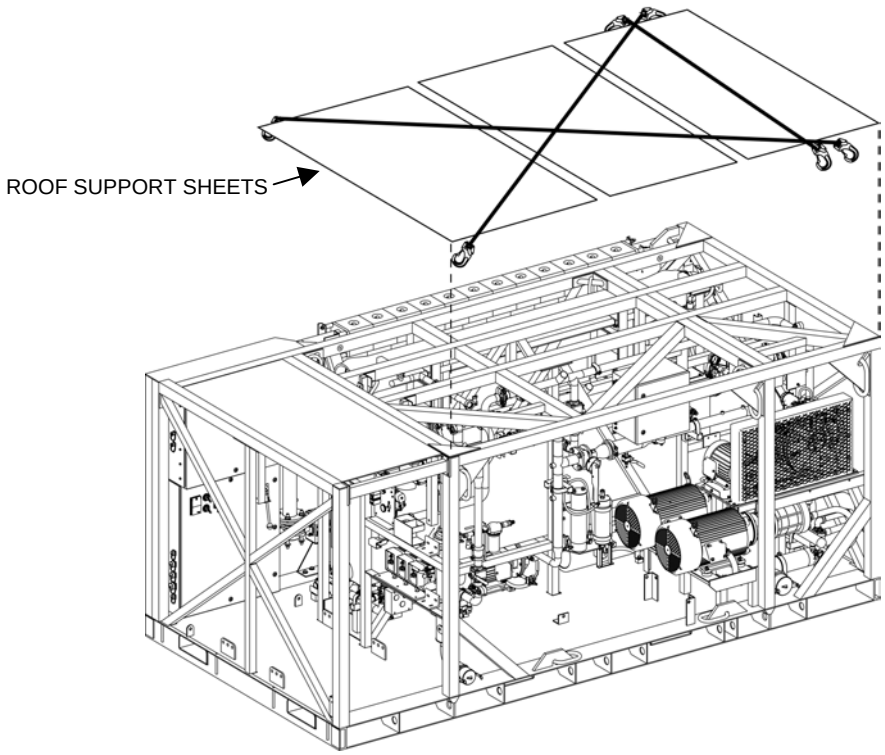

Figure 10. Roof Support Sheet Positioning.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS SET-UP – OPERATION UNDER USUAL CONDITIONS

0007 00

INITIAL SETUP

Reference:
Refer to this TM, WP 0038 – PMCS for "Before" PMCS checks
Refer to TM 5-6115-545-12 - Tactical Quiet Generator Operating Procedures for generator start up
Refer to Army TM 10-5430-237-12&P for collapsible water tank set up and operation
Or Refer to Marine Corps TM 01034E-12&P/1 for collapsible water tank set up and operation
Personnel Required:
Three Operator/Crew
Equipment Condition:
TWPS skid removed from transport vehicle and set on level ground.
Loose items unpacked (off-loaded) from the TWPS skid and placed in their general operational position.

GENERAL

This work package contains the procedures to fully set up the TWPS for initial operation under normal operational conditions. Before performing set up procedures the site and terrain must be evaluated and the component locations and layout established as described in WP 0004.

Refer to WP 0009, Cold Weather Set-Up – Operation Under Unusual Conditions, if the existing outdoor temperature is below 32 degrees F or expected to be below 32 degrees F within the next 24 hours.

Refer to WP 0010, Other Set-Ups – Operation Under Unusual Conditions, if the TWPS is deployed on a mission with any of the following unusual conditions:

- Chlorinated raw water source
- NBC decontamination mission
- Existing temperatures are above 90º F or expected to go above 90º F within the next 24 hours
- Sandy or dusty environment

The procedures covered in this work package include:

- Planning and Organization
- Locate Fire Extinguisher
- Establish Electrical Power
- Air Compressor Start-Up
- P-1 Pump to P-2 Pump to Cyclone Separator Configuration Deployment
- P-2 or P-1 Pump Only Configuration Deployment
- Sodium Bisulfite System Set-Up
- Floating Inlet Strainer and Anchor Deployment
- Micro-Filtration Equipment Set-Up
- Waste Outlet Connections
- Making Power Cable Connections to the TWPS
- Establishing Raw Water Flow
- Standard Distribution System Set-Up
- Pre-Operational Checks
- Fabric Wall Set-Up (A-TWPS)
- Extended Distribution System Set-Up (A-TWPS)
- Lowering the Bail Bar (A-TWPS)

TACTICAL WATER PURIFICATION SYSTEM (TWPS) PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS SET-UP – OPERATION UNDER USUAL CONDITIONS

0007 00

PLANNING AND ORGANIZATION

Table 1 is a recommended team approach for establishing the various water and electrical connections and performing the initial checks and inspections to get the TWPS ready for operation. The procedures are in the general order of activity. While setting up the ground-operated equipment, keep in mind the overall work site dimensions as described in the Site Selection and Component Location WP 0004.

Table 1. Set-up Procedure for Usual Conditions

PROCEDURE	OPERATOR		
	1	2	3
Locate fire extinguisher	x		
Establish electrical power	x		
Start-up the air compressor	x		
Move raw water pump skids into position		x	x
Move raw water hoses/power cables into position		x	x
Connect raw water hoses		x	x
Connect cyclone separator/raw water hoses		x	x
Deploy the raw water strainer/anchor/OISS		x	x
Move micro-filtration pump skid & water tank into position		x	x
Connect micro-filtration water hoses		x	x
Connect waste outlet drain hose			x
Connect raw water and MF feed pump skid power cables	x		
Establish raw water flow	x	x	
Move distribution pump skid and water tanks into position		x	x
Connect distribution water hoses		x	x
Connect distribution power cable	x		
Perform pre-operational checks	x		
Start the TWPS	x		
Set up the fabric wall (A-TWPS)	x	x	x
Set up the extended distribution system (A-TWPS)	x	x	x

LOCATE FIRE EXTINGUISHER

Remove the fire extinguisher from the mounting bracket located below the MF Feed Strainer S-2. Set the fire extinguisher on the ground in the general location where the ground rod will be placed.

ESTABLISH ELECTRICAL POWER

For the most efficient use of time, one person can be establishing power to the TWPS while the other two people are setting up the equipment. To ensure each other's safety, all three people should coordinate their activities so that no one is put in danger when electrical connections and operations are made.

Refer to WP 0012, Establishing Electrical Power, for the specific procedures for establishing electrical power to the TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0007 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SET-UP – OPERATION UNDER USUAL CONDITIONS

AIR COMPRESSOR START-UP

As soon as electrical power is established at the TWPS and the PDP is energized, it is recommended that the air compressor be started up. A minimum air pressure is required for the automatic backwash operation before the TWPS can be operated. Starting the compressor as early as possible during set up allows the compressor to pressurize the air supply tank (in about 30 minutes) while other set up steps are performed.

The instructions for starting up the air compressor are described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained.

SET UP THE RAW WATER SYSTEM

Two possible raw water system configuration set-ups are described here. They are:
- P-1 Pump to P-2 Pump to Cyclone Separator Configuration Deployment
- P-2 or P-1 Pump Only Configuration Deployment

NOTE

As the discharge hoses are laid out and connected, any excess length must be taken up in long smooth curves to avoid kinking of the hose when pressurized.

P-1 PUMP TO P-2 PUMP TO CYCLONE SEPARATOR CONFIGURATION DEPLOYMENT

CAUTION

Potential water damage to equipment. Make note of potential tidal or river flood conditions and keep the raw water pumps located beyond the reach of the water. Failure to observe this caution may result in water damage to the pump and diesel engine or motor.

1. Position the raw water pumps and cyclone separator as follows (see Figure 1):

WARNING

Three person lift. Three people are required to safely lift Diesel-Driven Pump Skid P-1. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Two person lift. Two people are required to safely lift the cyclone separator and Motor-Driven Pump Skid P-2. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   a. Move Diesel-Driven Pump Skid P-1 and Motor-Driven Pump Skid P-2 into place.
   b. Place the pump skids on solid footing and as nearly level as possible.

c. Move the cyclone separator into place. Make sure that the location selected for the separator will hold the weight of the cyclone when filled with water without the cyclone tipping over.
d. Place an absorbent pad under Diesel-Driven Pump Skid P-1 for environmental protection in the event of a fuel spill.

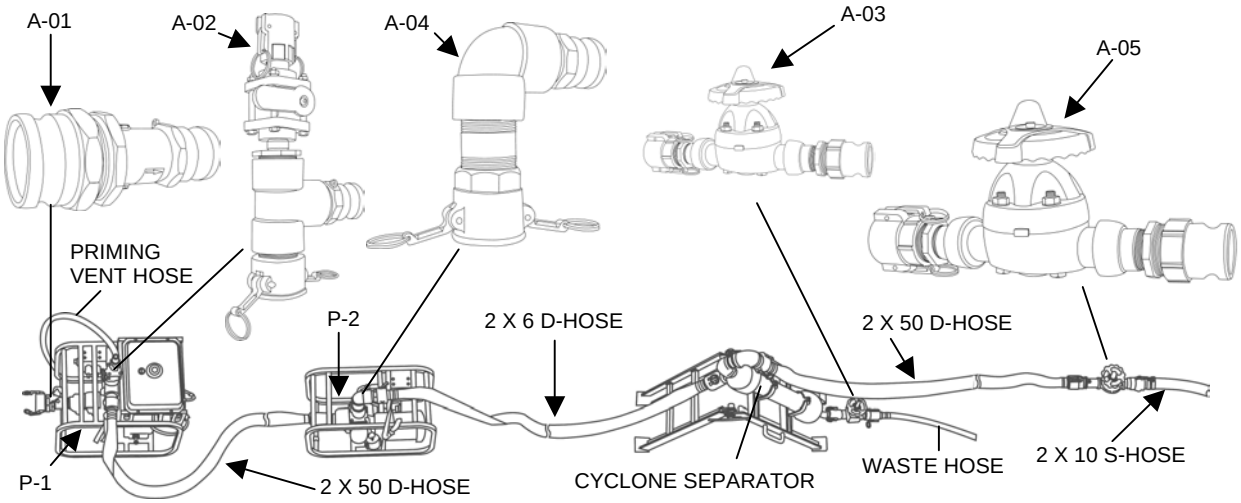

Figure 1. P-1 Pump to P-2 Pump to Cyclone Separator Configuration Deployment.

e. Install the fuel tank on Diesel-Driven Raw Water Pump Skid P-1 as follows (see Figure 2):
   1) Set the fuel tank assembly on the pump skid.
   2) Connect the red-banded fuel tank fuel supply hose to the red-banded engine fuel supply hose with the quick-connect fittings.
   3) Connect the yellow-banded fuel tank return hose to the yellow-banded engine fuel return hose with the quick-connect fittings.

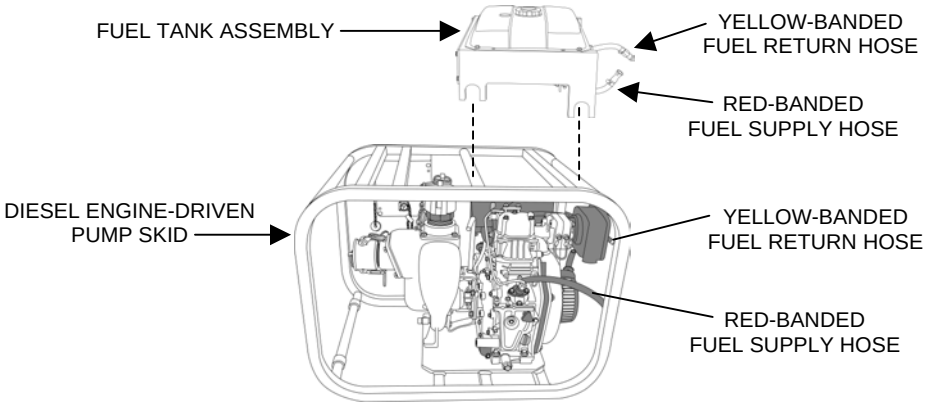

Figure 2. Diesel-Driven Pump Fuel Tank Installation.

2. Connect the raw water adaptors and hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following hoses and adaptor assemblies:
   1) One 2 in. x 6 ft., green-banded raw water discharge hose.
   2) Two to four 2 in. x 50 ft., green-banded raw water discharge hoses.
   3) One 2 in. x 10 ft., green-banded raw water suction hose.
   4) Adaptor assemblies A-01, A-02, A-03, A-04, and A-05.
   5) One 1 in. x 5 ft., clear plastic priming vent hose.
   6) One 1 in. x 5 ft., clear plastic cyclone separator waste hose.
b. Inspect the gaskets in the female ends of the hoses. Replace any damaged or missing gaskets.
c. Check the inlet, outlet, and waste openings of the cyclone separator for any foreign matter that may have entered during transit and clear it out of the openings.

NOTE

When installing Adaptor A-01 the bolt on the check valve must be oriented in a vertical position. Failure to observe this note may limit the effectiveness of the check valve and result in an inability to maintain prime.

The support strap on Adaptor A-01 must be oriented near the top of the adaptor and firmly secured to the pump frame to make sure air does not leak into the adaptor. Failure to observe this note may result in a reduced pumping capacity or an inability to maintain prime.

d. Attach Adaptor A-01 to the suction inlet of the diesel-driven pump. Loop the strap over the pump frame crossbar and tighten to a slight tension.
e. Attach Adaptor A-02 to the discharge outlet of the diesel-driven pump.
f. Connect the priming vent hose to Adaptor A-02.
g. Attach Adaptor A-03 to the wastewater outlet of the cyclone separator and then attach the cyclone separate waste hose.
h. Attach Adaptor A-04 to the discharge outlet of the motor-driven pump.
i. Connect, as needed, one or two 2 in. x 50 ft., green-banded discharge hoses to Adaptor A-02 at the discharge outlet of Diesel-Driven Pump P-1 and to the suction inlet of the Motor-Driven Pump P-2.
j. Connect, the 2 in. x 6 ft., green-banded discharge hose to Adaptor A-04 at the discharge outlet of Motor-Driven Pump P-2 and to the inlet of the cyclone separator.
k. Connect, as needed to reach the MF Feed Tank, one or two 2 in. x 50 ft., green-banded discharge hoses to the cyclone separator outlet.
l. Connect Adaptor A-05 to the end of the discharge hose that is coming from the cyclone separator.
m. Connect the 2 in. x 10 ft., green-banded suction hose to Adaptor A-05.

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WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. Do NOT connect the Motor-Driven Pump P-2 electrical power cable at this time. Failure to observe this warning may result in serious injury or death from electrocution.

P-2 PUMP OR P1 PUMP ONLY CONFIGURATION DEPLOYMENT

CAUTION

Potential water damage to equipment. Make note of potential tidal or river flood conditions and keep the raw water pump located beyond the reach of the water. Failure to observe this caution may result in water damage to the pump and motor.

1. Position the raw water pump as follows (see Figure 3 and Figure 4):

WARNING

Three person lift. Three people are required to safely lift Diesel-Driven Raw Water Pump Skid P-1. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Two person lift. Two people are required to safely lift Motor-Driven Raw Water Pump Skid P-2. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

a. Move Motor-Driven Pump Skid P-2 or Diesel-Driven Pump Skid P-1 into place.
b. Place the pump skid on solid footing and as nearly level as possible.

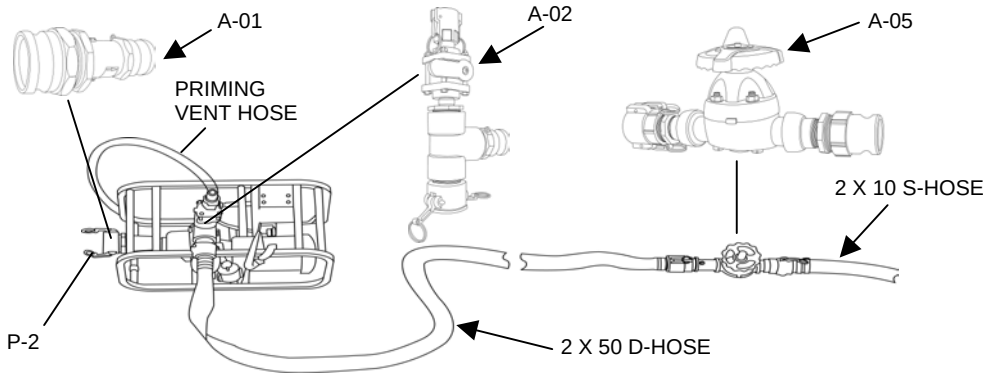

Figure 3. P-2 Pump Only Configuration Deployment.

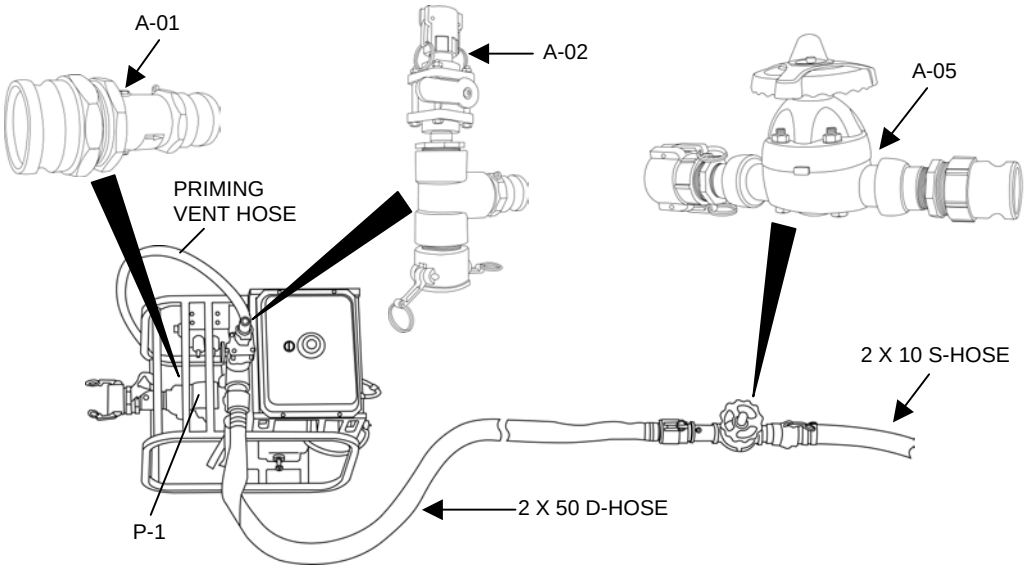

Figure 4. P-1 Pump Only Configuration Deployment.

c. If Diesel-Driven Pump P-1 is used, place an absorbent pad under it for environmental protection in the event of a fuel spill and install the fuel tank as follows (see Figure 2):
   1) Set the fuel tank assembly on the pump skid
   2) Connect the red-banded fuel tank fuel supply hose to the red-banded engine fuel supply hose with the quick-connect fittings.
   3) Connect the yellow-banded fuel tank return hose to the yellow-banded engine fuel return hose with the quick-connect fittings.

2. Connect the raw water adaptors and hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following hoses and adaptor assemblies:
   1) One to two 2 in. x 50 ft., green-banded raw water discharge hoses.
   2) One 2 in. x 10 ft., green-banded raw water suction hose.
   3) Adaptor assemblies A-01, A-02, and A-05.
   4) One 1 in. x 5 ft., clear plastic priming vent hose.

b. Inspect gaskets in the female ends of the hoses. Replace damaged or missing gaskets.

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NOTE

When installing Adaptor A-01 the bolt on the check valve must be oriented in a vertical position. Failure to observe this note may limit the effectiveness of the check valve and result in an inability to maintain prime.

The support strap on Adaptor A-01 must be oriented near the top of the adaptor and firmly secured to the pump frame to make sure air does not leak into the adaptor. Failure to observe this note may result in a reduced pumping capacity or an inability to maintain prime.

c. Attach Adaptor A-01 to the suction inlet of the raw water pump. Loop the strap over the pump frame crossbar and tighten to a slight tension.
d. Attach Adaptor A-02 to the discharge outlet of the raw water pump.
e. Connect the priming vent hose to Adaptor A-02.
f. Connect, as needed to reach the MF Feed Tank, one or two 2 in. x 50 ft., green-banded discharge hoses to Adaptor A-02 at the discharge outlet of the raw water pump.
g. Connect Adaptor A-05 to the end of the discharge hose that is coming from Adaptor A-02.
h. Connect the 2 in. x 10 ft., green-banded suction hose to Adaptor A-05.

WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. If Motor-Driven Pump P-2 is used, do NOT connect its electrical power cable at this time. Failure to observe this warning may result in serious injury or death from electrocution.

SODIUM BISULFITE SYSTEM SET-UP

CAUTION

Potential for damage to the MF elements and RO membranes. Chlorine will destroy the MF elements and RO membranes. If the raw water source is chlorinated, sodium bisulfite must be mixed into the raw water before it is pumped into the MF feed tank. Sodium bisulfite neutralizes the chlorine. Failure to observe this caution will result in the destruction of the MF elements and RO membranes.

The sodium bisulfite system MUST be set up before chlorinated raw water is pumped into the MF Feed Tank. The instructions for setting up the sodium bisulfite system are described in WP 0010, Other Set-Ups – Operation Under Unusual Conditions.

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SET-UP – OPERATION UNDER USUAL CONDITIONS

FLOATING INLET STRAINER AND ANCHOR DEPLOYMENT

If the raw water source is from a sandy beach location and if surf conditions or tide extremes make it difficult or impossible to use the floating inlet strainer, the OISS should be deployed instead of the floating inlet strainer. For OISS setup see WP 0008.

Deploy the floating inlet strainer and anchor as follows:

1. Carry the following items to the 1st raw water pump skid:
    a. Floating inlet strainer.
    b. The number of raw water suction hoses required to deploy the inlet strainer to the desired location in the raw water source (up to thirteen 3 in. x 10 ft., green-banded suction hoses).
    c. Anchor.
    d. Anchor tie-down rope.

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

NOTE

The floating strainer and anchor may be used in conjunction with the Ocean Intake Structure System (OISS). If the OISS is to be used, refer to WP 0008, OISS Set-Up Instructions, for the procedures for installing the OISS.

When deploying the floating inlet strainer, keep the following in mind:
- Two persons are required to deploy the inlet strainer.
- Place the inlet strainer in deep water at the center of narrow rivers.
- Place the inlet strainer as far from shore as possible in wide rivers.
- Place the inlet strainer as far out as possible at ocean beaches.
- Flat tidal beaches may require moving the pump according to tide conditions.

2. Assemble the anchor, rope, inlet strainer, and hoses on-shore as follows (see Figure 5):
    a. Attach the shackle and pulley to the anchor eye and double the rope back so that the rope length from the anchor to the free end is at least 150 feet.
    b. Inspect the gaskets in the female ends of the hoses. Replace any damaged or missing gaskets.
    c. Always rinse off the hose ends with water to remove dirt and sand.
    d. Connect the number of 10 ft., green-banded suction hoses to each other that will be required to deploy the inlet strainer to the desired location in the raw water source.
    e. Connect one end of the hose assembly to the inlet strainer. Install the 3 in. plug in the other end of the raw water hose assembly. This traps air inside the hose that will allow the hose to float until the inlet strainer is positioned at the desired location in the raw water source.
    f. Shackle the end of the rope to the inlet strainer eye and tie the free end to the suction hose.
    g. Carefully coil the rope to prevent it from tangling when the anchor is deployed.

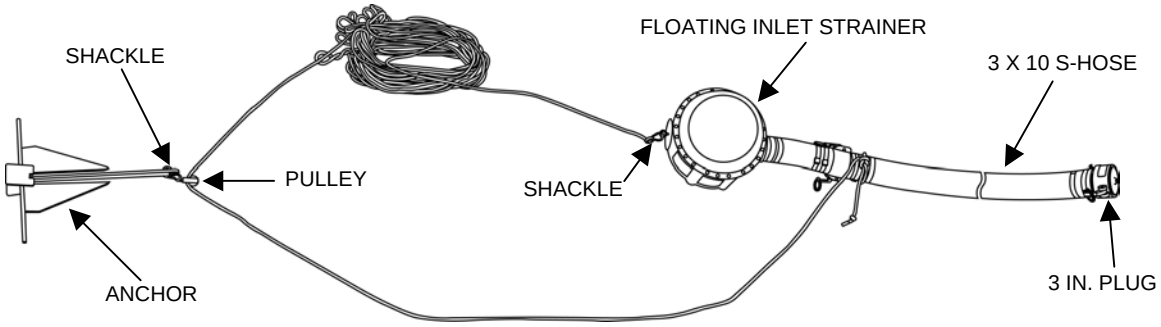

Figure 5. Anchor, Rope, Inlet Strainer, and Hoses Assembled On-Shore.

3. Deploy the anchor as follows:

WARNING

Potential for physical injury. Crew members other than those deploying the anchor must stand clear when the anchor is being deployed. Failure to observe this warning may result in serious injury if a person is hit with the anchor.

a. Gain good footing near the water's edge.
b. Make sure the rope is free to play out.
c. Throw the anchor underhand into the water source.
d. At beach sites, walk or carry the anchor to the desired location about 30 feet past the desired location of the inlet strainer.
e. Pull slowly on the rope and feel for the anchor to grab. If it does not grab, repeat the anchor deployment throwing it into an adjacent location.

NOTE

The anchor may be deployed by boat if available and if water conditions allow. Appropriate water safety precautions, such as the use of life jackets or vests, must be observed.

4. Complete the raw water hose connections as follows (see Figure 6):
   a. Untie the free end of the rope from the suction hose.
   b. One crew-member pulls the free end of the rope as another feeds out the inlet strainer and suction hose into the water.
   c. When the inlet strainer is in the desired position, uncap the hose end and the hose will sink.
   d. Tie the free end of the anchor rope to the raw water pump frame to secure the anchor.
   e. Connect the uncapped end of the raw water suction hose to Adaptor A-01 at the raw water pump inlet.

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NOTE

If it is necessary to elevate the pump off the ground, such as at locations with significant tidal variations, it will also be necessary to stake up the inlet hose at the raw water pump inlet to limit the strain on the A-01 adaptor and to ensure a tight seal (no air leaks) at the adaptor. Failure to observe this note may result in a reduced pumping capacity or an inability to maintain prime.

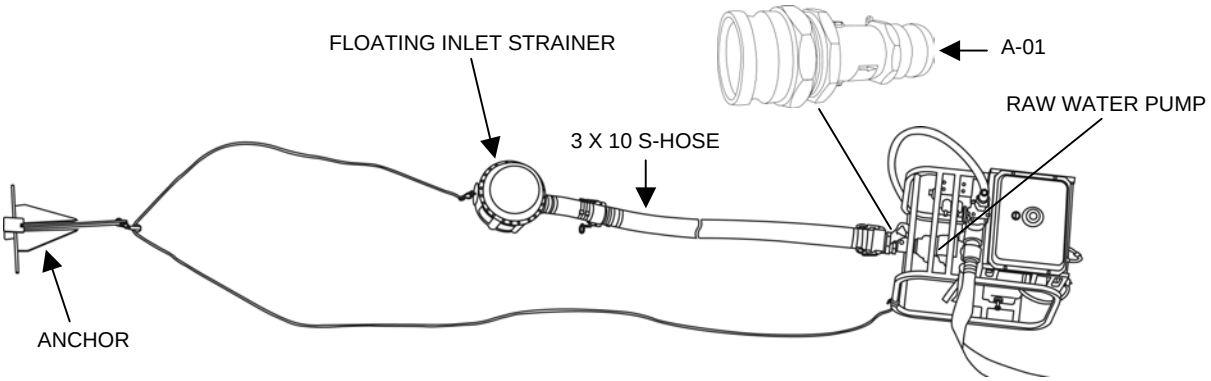

Figure 6. Raw Water Inlet System Deployment.

MICRO-FILTRATION (MF) EQUIPMENT SET-UP

Deploy the MF system equipment as follows: (See Figure 7)

WARNING

Two person lift. Two people are required to lift the MF feed tank. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Three person lift. Three people are required to lift the MF feed pump. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

1. Position the MF feed tank, tripod, and MF feed pump as follows:
   a. Place the MF feed tank in its rough location (about 20 ft. from the TWPS).
   b. Unfold the ground cloth from around the tank and unfold the tank on the ground cloth.
   c. Spread the tank out to its final shape and eliminate any ridges in the bottom.
   d. Insert the MF feed tank Bag Strainer S-1 inside the MF feed tank. Overlap the top of the strainer over the open lip of the feed tank.
   e. Tighten the strainer draw rope to take up the slack and place it under a little tension.
   f. Pull the tank inlet and outlet connections out away from the tank bottom so that they will be clear when the tank is filled.
   g. Set up the tripod at the side of the tank where the 2x10 raw water hose will be inserted.
   h. Move Motor-Driven MF Feed Pump Skid P-3 roughly in place as shown in Figure 7.
   i. Place the pump skid on solid footing and as nearly level as possible.

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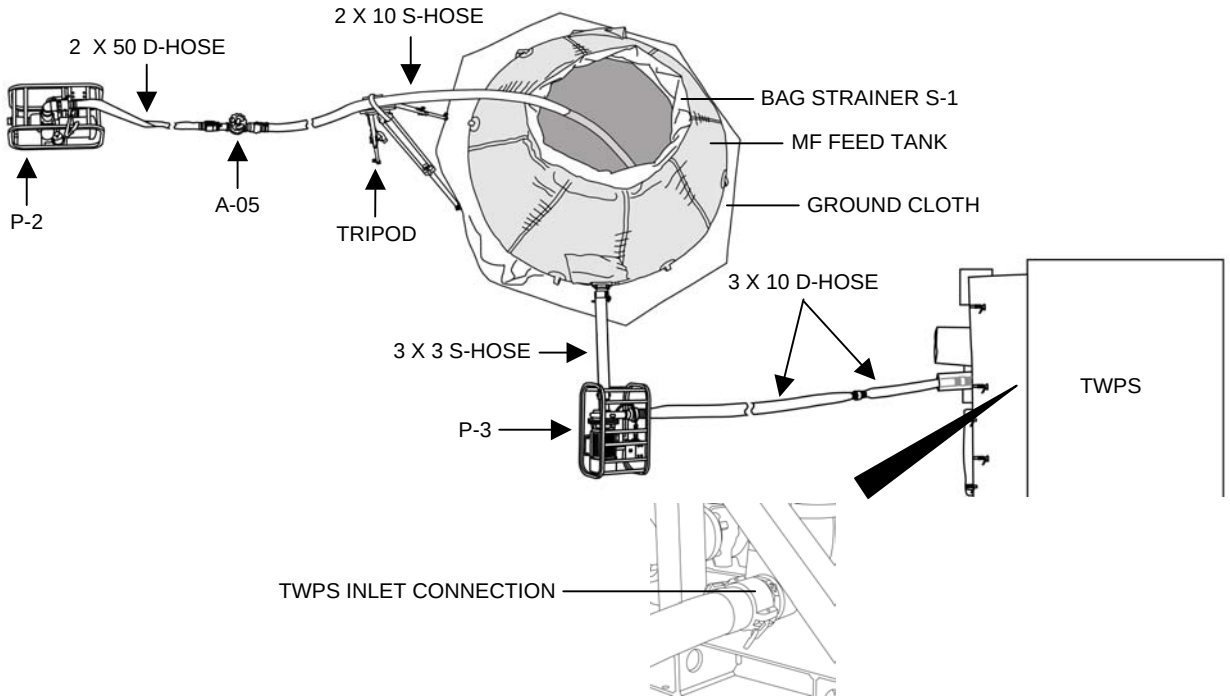

Figure 7. MF Equipment Deployment.

2. Connect the hoses as follows (see Figure 7):

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following hoses:
   1) One 3 in. x 3 ft., green-banded raw water suction hose.
   2) One or two 3 in. x 10 ft., green-banded raw water discharge hoses.
b. Inspect the gaskets in the female ends of the hoses. Replace any damaged or missing gaskets. (Wash both ends with water before connecting).
c. Connect one or two 3 in. x 10 ft., green-banded discharge hose to the raw water inlet connection at the TWPS and to the discharge outlet of the MF feed pump (see Figure 7).
d. Move the pump as needed to give a long smooth curve in the 3 in. discharge hose.
e. Connect the 3 in. x 3 ft., green-banded suction hose to the outlet of the MF feed tank and to the suction inlet of MF Feed Pump P-3. Move the tank as needed to allow the connection.
f. Place the open end of the 2 in. x 10 ft., green-banded raw water suction into the MF feed tank as far as it will go. Place the middle of the hose on top of the tripod and secure the hose to the tripod with a hook and loop strap.

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WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. Do NOT connect the MF Feed Pump P-3 electrical power cable at this time. Failure to observe this warning may result in serious injury or death from electrocution.

WASTE OUTLET CONNECTIONS

Install the waste outlet connections as follows (see Figure 8):

1. Collect the following adaptor and hoses.
    a. One 4 in. x 5 ft., red-banded suction hose.
    b. Waste out Adaptor A-09.
    c. One 6 in. x 50 ft., red-banded discharge hose.
2. Connect the hoses and adaptor as follows:

WARNING

Under certain conditions, air may be pushed out of the waste hose causing the end to whip. Do not make any waste hose connections while the TWPS is operating. Stand clear of the waste hose end by at least 20 ft. while the TWPS is operating. Failure to observe this warning may result in serious injury.

    a. Connect the 4 in. x 5 ft., red-banded suction hose to the waste outlet at the TWPS. (Wash the ends with water before connecting)
    b. Connect Adaptor A-09 to the end of the 4 in. x 5 ft. suction hose.
    c. Connect the 6 in. x 50 ft., red-banded discharge hose to the other end of Adaptor A-09.
    d. Place the other end of the waste hose so that it discharges as far downstream from the raw water inlet as possible. Remove any sharp kinks or bends in the hose.

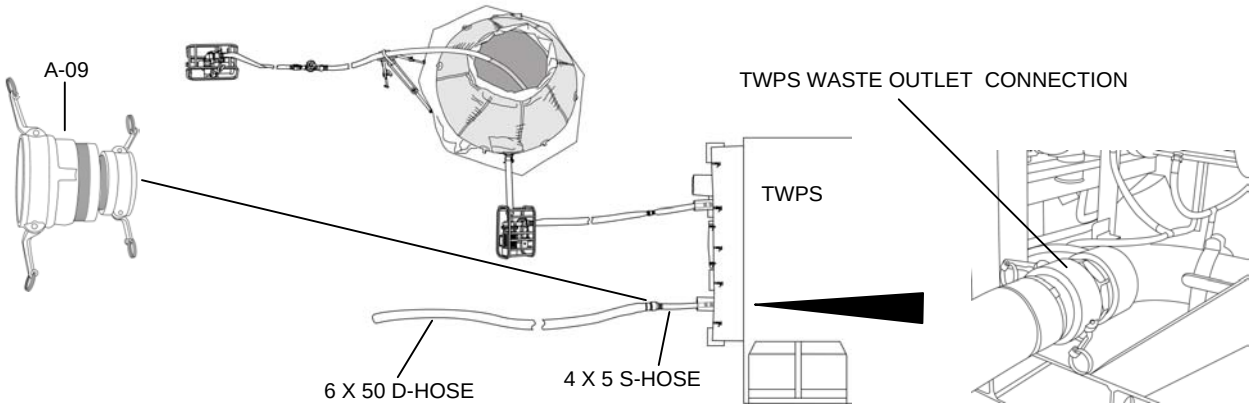

Figure 8. Waste Outlet and Drain Connections.

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MAKING POWER CABLE CONNECTIONS TO THE TWPS

WARNING

Potential electrical hazard to other personnel. The crew member who is establishing electrical power to the TWPS should make the cable connections from the pumps to the Power Distribution Panel (PDP). Before making the power cable connections, notify all crew members. Do NOT continue with these procedures until all crew members are notified. Failure to observe this warning may result in injury or death due to electrocution.

1. Connect the Motor-Driven Pump Skid P-2 and MF Pump Skid P-3 electrical power cables to the PDP as follows (see Figure 9):

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. FIRST connect the pump skid power cables to their respective pump skid junction box. NEXT, make sure the Main Breaker on the PDP is switched to OFF. LAST, connect the pump skid power cables to the PDP power outlet. Failure to observe this warning may result in serious injury or death from electrocution.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

a. The crew member who is establishing electrical power to the TWPS should make the cable connections from the pumps to the PDP. Do NOT continue with these procedures until all crew members are notified.
b. Uncoil the electrical power cables for the P-2, and P-3 skid junction boxes.
c. FIRST, connect the power cables to the power input terminal on the P-2 and P-3 skid junction boxes.
d. NEXT, switch the Main Breaker on the PDP to OFF. (Typically at this stage, the Main Breaker will be ON and the air compressor will be running).
e. LAST, connect the power cables to their power source connector terminal at the PDP.

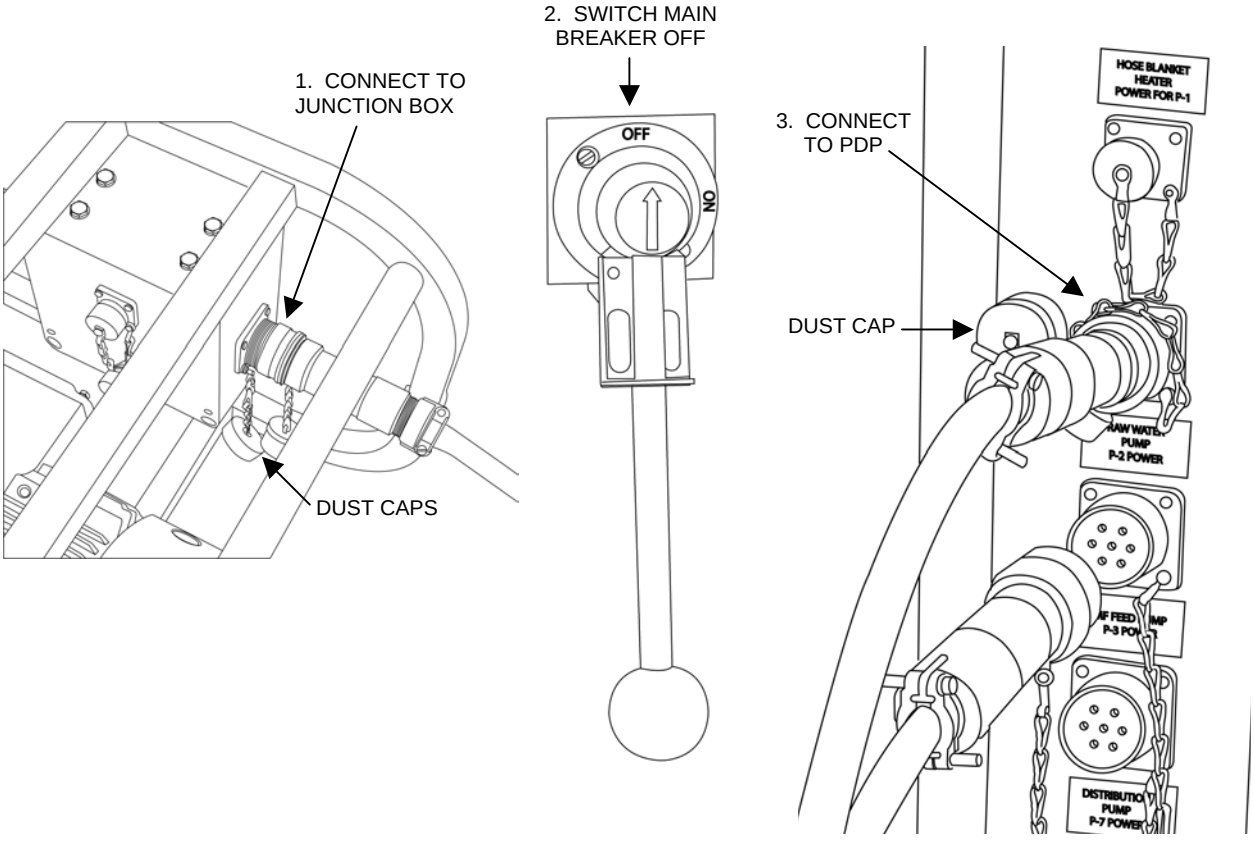

Figure 9. Pump Skid Power Cable Connections.

2. After making sure that all connections have been completed, switch the Main Breaker on the PDP back to the ON position.

ESTABLISHING RAW WATER FLOW

It will take 10 minutes or more to prime the raw water pump and another 10 minutes to fill the MF feed tank 3/4 full as needed to start the TWPS. Plan to establish raw water flow at least 20 minutes before you expect to begin operation of the TWPS.

The instructions for establishing raw water flow are described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained.

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STANDARD DISTRIBUTION SYSTEM SET-UP

NOTE

All of the distribution hoses and adaptors are provided with caps or plugs for the couplings to keep the inside of the hoses and adaptors clean. The caps and plugs are not chained. They are to be removed as each hose and Adaptor is installed and placed into Storage Box #3.

Deploy the standard product water distribution system equipment as follows (see Figure 10):

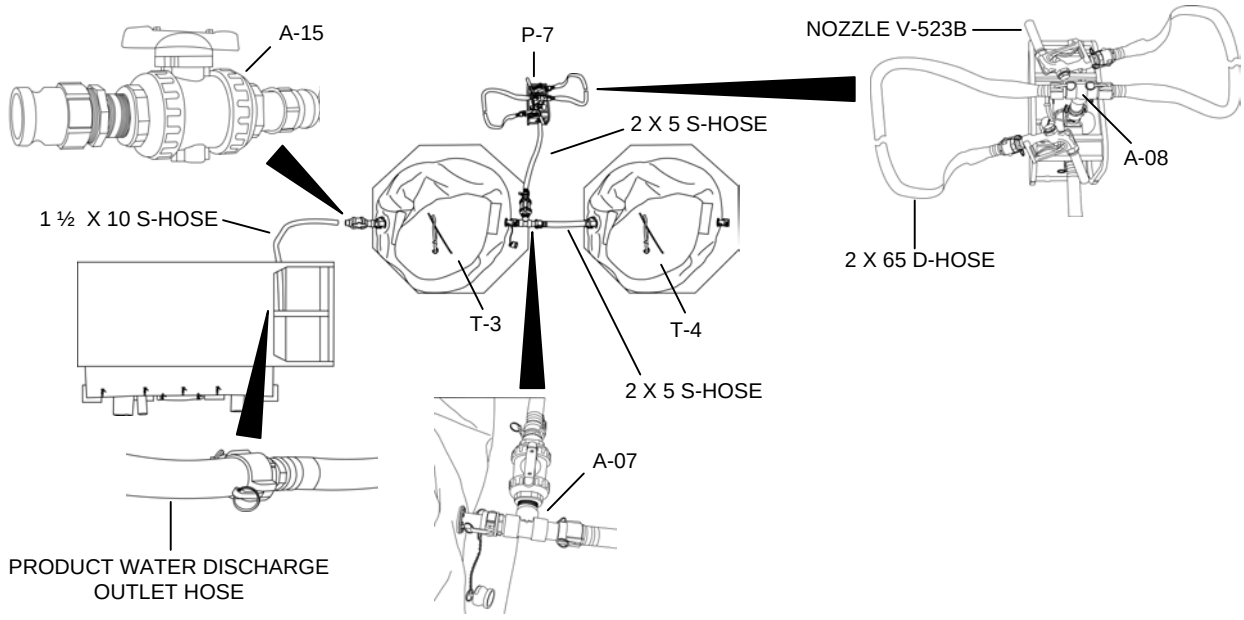

Figure 10. Standard Distribution System Equipment Deployment.

WARNING

Two person lift. Two people are required to safely lift the product water distribution water tanks and Motor-Driven Product Water Distribution Pump P-7. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

1. Position Product Water Distribution Tanks T-3 and T-4 and Product Water Distribution Pump P-7 as follows:
    a. Place the distribution tanks in their rough locations, making sure that the 1st tank is within 40 ft. of the TWPS product water outlet.
    b. Unfold the ground cloth from around each tank and unfold each tank on its ground cloth.
    c. Spread the tanks out to their final shape and eliminate any ridges in the bottoms.
    d. Position the tanks about 6 ft. apart with the connections facing each other.
    e. Pull the tank inlet and outlet connections out away from the tank bottoms so that they will be clear when the tanks are filled.

f. Move Motor-Driven Product Water Distribution Pump Skid P-7 roughly into place.
g. Place the pump skid on solid footing and as nearly level as possible.

2. Connect the hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following adaptors, hoses, and dispensing nozzles:
   1) Four 1½ in. x 10 ft, blue-banded product water suction hoses.
   2) Adaptor A-15.
   3) Adaptor A-07.
   4) One 2 in. x 5 ft., blue-banded product water suction hose with male couplings at each end.
   5) One 2 in. x 5 ft., blue-banded product water suction hose with female couplings at each end.
   6) Pump outlet tee Adaptor A-08.
   7) Two 2 in. x 65 ft., blue-banded product water distribution discharge hoses.
   8) Two Dispensing Nozzles V-523A and V-523B.
b. Inspect the gaskets in the female ends of the hoses and adaptors. Replace any damaged or missing gaskets.
c. Connect the four 1 ½ in. x 10 ft., blue-banded product water suction hoses to each other.
d. Remove the plug from the TWPS product water discharge outlet hose and connect the assembled blue-banded product water suction hoses to the discharge hose. Put the plug in Storage Box #3.
e. Connect Adaptor A-15 to an outside inlet (not an inlet between tanks) of the product water distribution tank that is closest to the TWPS product water outlet.

WARNING

Health hazard. Do not connect the product water hose from the TWPS to Adaptor A-15 at the product water distribution tank at this time. Initial product water discharge from the product water outlet of the TWPS will not be of adequate purity. Product water is not discharged into the product water tanks until after clean product water flow is established. Failure to observe this warning could cause contamination of the product water.

f. Connect the male end of the straight section of Adaptor A-07 directly to the female outlet of one of the distribution tanks.
g. Connect the male-male 2 in. x 5 ft., blue-banded product water suction hose to the other end of the straight section of Adaptor A-07.
h. Connect the other end of the 2 in. x 5 ft. suction hose to the outlet of the other distribution tank.

i. Connect the female-female 2 in x 5 ft., blue-banded suction hose to the remaining Adaptor A-07 connection and to the suction inlet of Product Water Distribution Pump P-7. Move the pump as needed to connect to the hose.
j. Connect the pump outlet tee Adaptor A-08 to the discharge outlet of the product water distribution pump.
k. Connect one 2 in. x 65 ft., blue-banded product water distribution hose to each end of the straight section of Adaptor A-08. (A 5/8-in. x 50 ft. auxiliary hose and Valve V-522 may be connected in place of a distribution hose and nozzle for certain cleaning operations.)
l. Connect a dispensing nozzle to the end of both of the product water distribution hoses.
m. Lay the dispensing nozzles on top of the pump frame. Do not leave them on the ground.

3. Connect the Motor-Driven Product Water Distribution Pump P-7 electrical power cable as follows:

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. Make sure Product Water Distribution Pump P-7 is shut off (push the distribution pump STOP button on the OCP) and then that the panel cover is closed and secured. Connect the power cable to the P-7 pump skid before connecting it to the PDP power outlet. Failure to observe this warning may result in serious injury or death from electrocution.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

a. Make sure that Distribution Pump P-7 is shut off (push the distribution pump STOP button on the PDP).
b. Close and secure the OCP cover.
c. Uncoil the electrical power cable for Motor-Driven Distribution Pump P-7.
d. Connect the power cable to the P-7 skid junction box.
e. Connect the power cable to the P-7 power source connector at the PDP.
f. Open the OCP cover and continue with start-up and normal operation.

PRE-OPERATIONAL CHECKS

Before starting the TWPS to begin producing potable water, perform the following checks:

1. Check all hose couplings and verify that the camlock connectors are locked in place.
2. Check that the ground rod has been installed and that the ground connections are tight at both ends.
3. Check that all raw water, MF feed pump, and product water distribution pump power cables are properly connected.

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CAUTION

The high pressure pump mounting flange drain tube must be positioned lower than the flange and must be free of obstructions so that the tube drains freely. Failure to observe this caution may result in water accumulating in the flange, which can lead to pump shaft and bearing corrosion and failure.

4. Check that the HP pump mounting flange drain tube is directed off the TWPS and is free of any obstructions.
    a. The drain tube on the MC-TWPS extends to the edge of the TWPS frame (see Figure 11).
    b. The drain tube on the A-TWPS is slightly longer so that the end can be directed down between the right edge of the deck and the fabric wall.

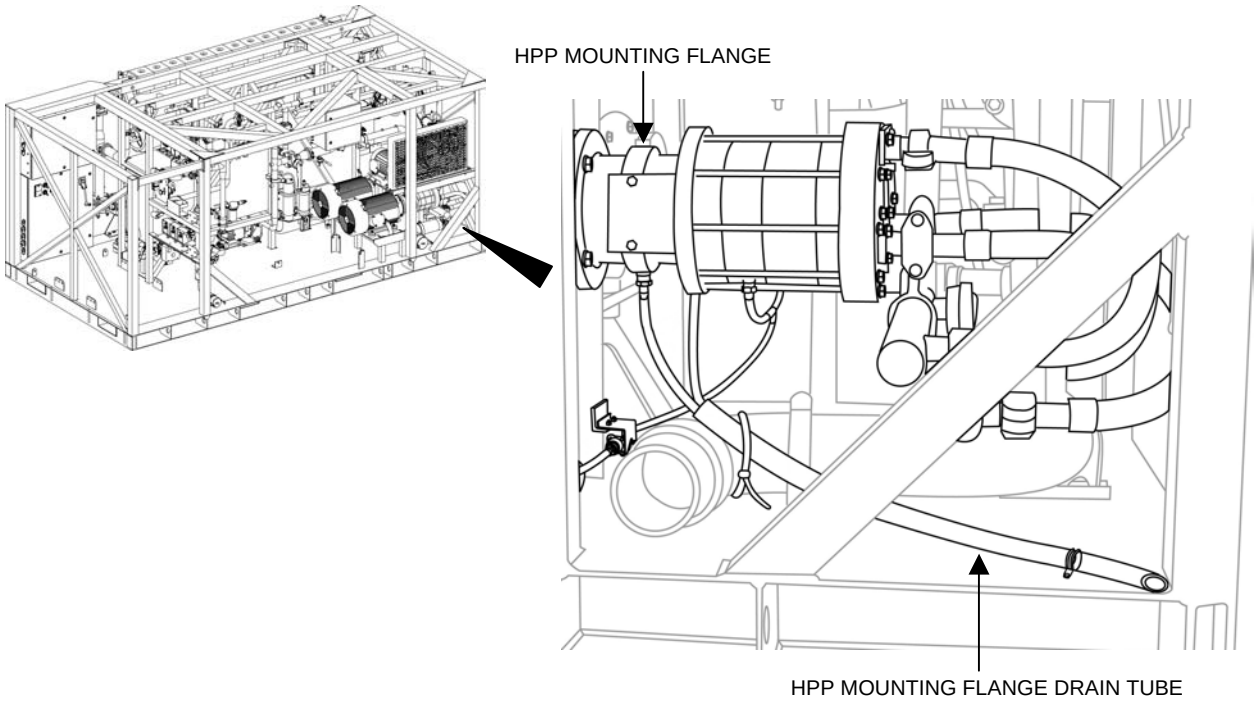

Figure 11. High Pressure Pump Mounting Flange Drain Tube.

NOTE

For the most efficient use of time, it is recommended that you proceed to WP 0013 for pre-operational diagnostic self-tests and then the appropriate start-up procedures WP before performing the Fabric Wall Set-Up and Extended Distribution System Set-Up procedures below. You will be instructed to return to these two procedures after performing the electrical pre-operational procedures and the appropriate start-up procedures.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0007 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SET-UP – OPERATION UNDER USUAL CONDITIONS

FABRIC WALL SET-UP (A-TWPS)

After the TWPS is running and producing product water and delivering it to the product water distribution tanks, set up the fabric wall as follows (see Figure 12):

1. Unfold the fabric wall and lay it on the ground oriented as follows:
    a. The outside of the wall on the ground and the inside of the wall facing up.
    b. The bottom of the zippered, roll-up door closest to the TWPS.
    c. The 3 in. hose feed-through opposite the raw water inlet of the TWPS.
    d. The 4 in. hose feed-through opposite the waste water outlet of the TWPS.
    e. The straps laid out for easy access.

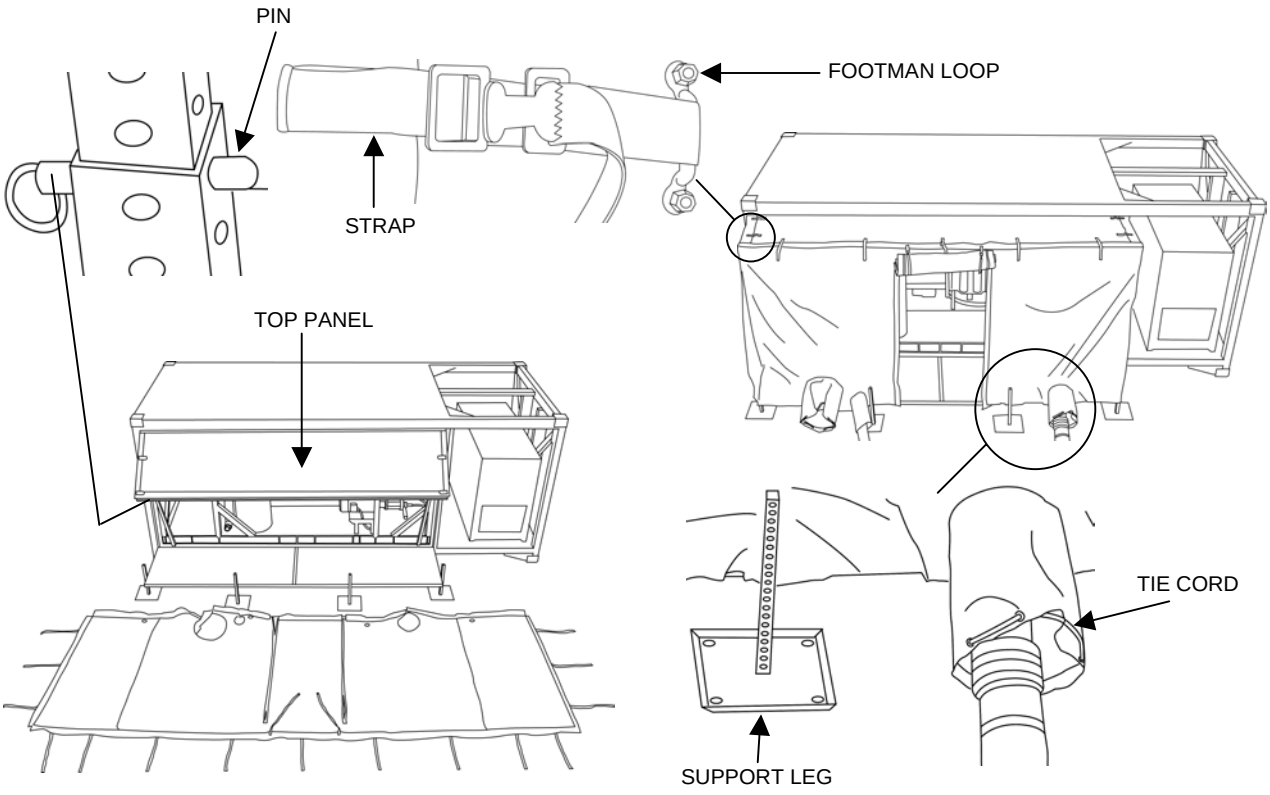

Figure 12. Fabric Wall Set-Up (A-TWPS).

WARNING

Potential for head injury. Hold the top panel while removing the pins from the top panel supports. Failure to do so could result serious head injuries.

2. Two people carefully remove the pins from the top panel supports and lower the top panel to about a 45° angle with about 18 in. of the supports extended. Insert the pins to hold this position.

3. Attach the top, front, and side edges of the wall to the top panel as follows:
    a. Lift the fabric wall by the top, front edge.
    b. Secure the hook and loop strip on the top edge of the wall to the hook and loop strip on the top panel.
    c. Loop each of the straps through its corresponding footman loop on the top panel and secure each strap in its buckle.
4. Two people raise the top panel with the attached fabric wall into position.
5. The third person inserts the pins in the top panel supports to secure the top panel.
6. Attach the side edge of both end walls as follows:
    a. Match and smooth the hook and loop strip on the side edge of the wall side flap to the hook and loop strip on the TWPS frame.
    b. Loop each side wall strap through its corresponding footman loop on the end panel and secure the strap in its buckle.
7. Attach the bottom edge of both wall side flaps to the bottom panel as follows:
    a. Fit the opening in the wall side flap for the support leg over the support leg.
    b. Match and smooth the hook and loop strip on the bottom edge of the wall side flap to the hook and loop strip on the bottom panel.
    c. Loop both of the straps on the bottom of one wall side flap through its corresponding footman loop on the bottom panel and secure each strap in its buckle.
8. Attach the bottom, front edge of the wall to the deck as follows:
    a. Fit the openings in the wall front for the support legs over the support legs.
    b. Fit the sleeves in the wall front for the raw water hose and the waste-water hose over the hoses. Close the sleeves snug around the hoses using the hook and loop strip at the bottom of the sleeve and with the tie cord.
    c. Match and smooth the hook and loop strip on the bottom edge of the wall to the hook and loop strip on the bottom panel.
    d. Loop each of the straps on the bottom, front edge of the wall through its corresponding footman loop on the bottom panel and secure each strap in its buckle.

EXTENDED DISTRIBUTION SYSTEM SET-UP (A-TWPS)

Deploy the extended product water distribution system equipment as follows (see Figure 13):

WARNING

Two person lift. Two people are required to safely lift the product water distribution water tanks. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Three person lift. Three people are required to lift Diesel-Driven Distribution Pump P-8. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

1. Position Product Water Distribution Tanks T-5, T-6, and T-7 and Product Water Distribution Pump P-8 as follows:
    a. Place the distribution tanks in their rough locations. One of the three tanks must be within 40 ft. of the TWPS product water outlet and within reach of the distribution hoses that are set out for connection to the tanks in the standard distribution system.
    b. Unfold the ground cloth from around each tank and unfold each tank on its ground cloth.

c. Spread the tanks out to their final shape and eliminate any ridges in the bottoms. Position the tanks about 6 ft. apart with the connections facing each other.
d. Pull the tank inlet and outlet connections out away from the tank bottoms so that they will be clear when the tanks are filled.
e. Move Diesel-Driven Product Water Distribution Pump Skid P-8 roughly into place.
    1) Place the pump skid on solid footing and as nearly level as possible.
    2) Place an absorbent pad under the diesel-driven pump skid for environmental protection in the event of a fuel spill.

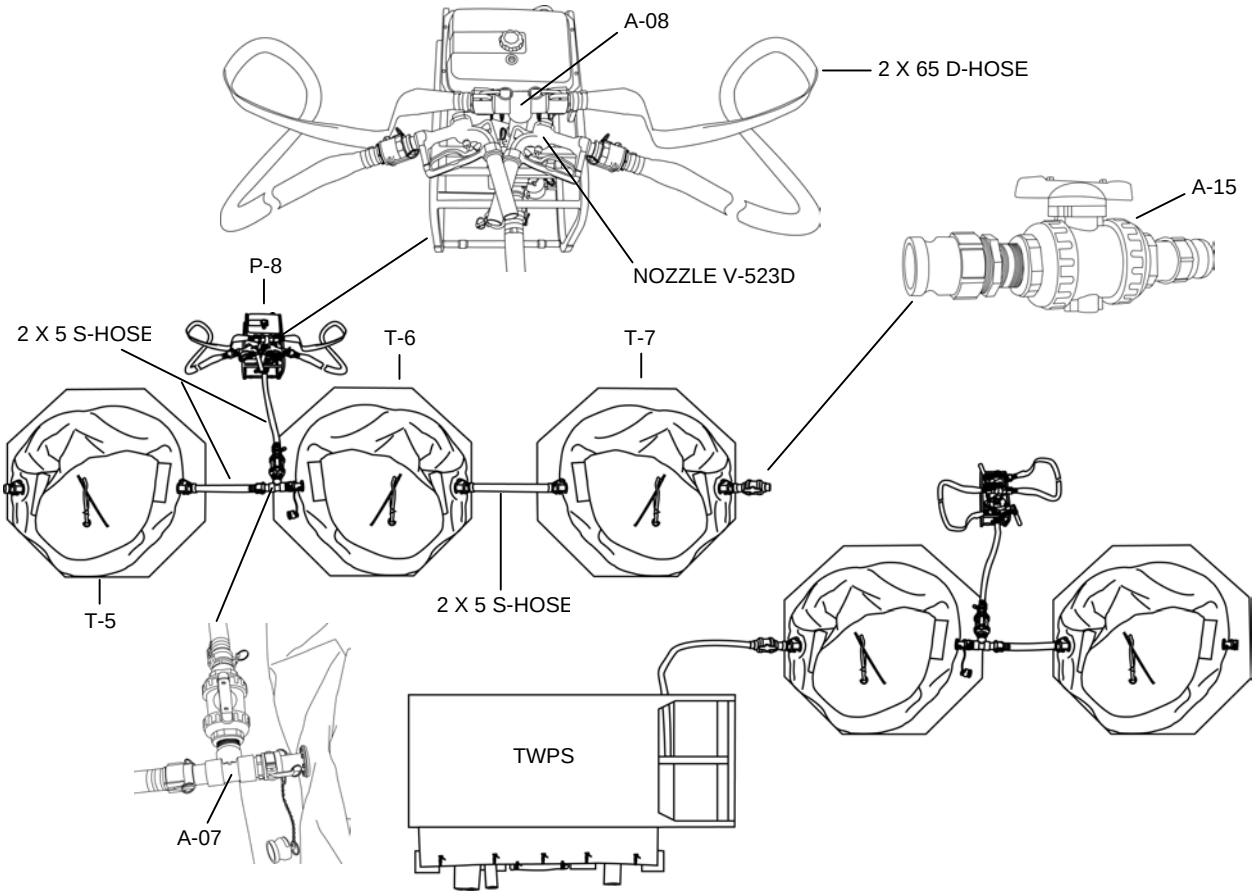

Figure 13. Extended Product Water Distribution System Equipment Deployment

2. Connect the hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0007 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SET-UP – OPERATION UNDER USUAL CONDITIONS

a. Collect the following adaptors, hoses, and dispensing nozzles:
   1) Adaptor A-15.
   2) Tee Adaptor A-07.
   3) Two 2 in. x 5 ft., blue-banded product water suction hoses with male couplings at each end.
   4) One 2 in. x 5 ft., blue-banded product water suction hose with female couplings at each end.
   5) Pump outlet tee Adaptor A-08.
   6) Two 2 in. x 65 ft., blue-banded product water distribution discharge hoses.
   7) Two Dispensing Nozzles V-523C and V-523D.
b. Inspect the gaskets in the female ends of the hoses and adaptors. Replace any damaged or missing gaskets.
c. Connect Adaptor A-15 to the inlet of one of the extended product water distribution tanks.
d. Connect the male end of the straight section of Adaptor A-07 directly to the female outlet of one of the extended distribution system tanks.
e. Connect one of the male-male 2 in. x 5 ft., blue-banded product water suction hoses to the other end of the straight section of Adaptor A-07.
f. Connect the other end of the 5 ft. suction hose to the outlet of a second extended distribution system tank.
g. Connect the female-female 5 ft., blue-banded suction hose to the remaining Adaptor A-07 connection and to the suction inlet of Product Water Distribution Pump P-8.
h. Connect the second male-male 5 ft., blue-banded suction hose from the middle tank to the third tank.
i. Connect the pump outlet tee Adaptor A-08 to the discharge outlet of Product Water Distribution Pump P-8.
j. Connect the one 2 in. x 65 ft., blue-banded product water distribution discharge hose to each end of the straight section of pump outlet tee Adaptor A-08.
k. Connect one dispensing nozzle to the end of each of the product water distribution discharge hoses.
l. Lay the dispensing nozzles on top of the pump frame. Do not leave them on the ground.

CAUTION

If the TWPS is operating, disconnect the product hose from Adaptor A-15 at the standard distribution system tank before closing Adaptor A-15. Make sure that the A-15 Adaptor valve on the extended distribution system tank is open before connecting the product hose to it. Failure to observe this caution will cause the relief valve RV-501 to vent.

m. When Distribution Tanks T-3 and T-4 of the standard water distribution system are filled, the suction hose can be disconnected from Adaptor A-15 of the standard system and connected to Adaptor A-15 in the extended distribution system.
   1) Open the A-15 Adaptor valve on the extended distribution system tank.
   2) Disconnect the product hose from Adaptor A-15 at the standard distribution system tank, then close the valve on that adaptor.
   3) Connect the product hose to Adaptor A-15 on the extended distribution system tank.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0007 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
SET-UP – OPERATION UNDER USUAL CONDITIONS

LOWERING AND RAISING THE BAIL BAR (A-TWPS)

The A-TWPS Flat Rack Bail is lowered as required for access to the TQG (Tactical Quiet Generator), such as may be needed to perform TQG PMCS.

Tool:
Wrench, Bail Bar, aluminum (BII)
Equipment Condition:
Tactical Quiet Generator shut down

1. Lower the flat rack bail bar as follows:

WARNING

Crushing hazard. Always attach the winch cable hook to the bail bar ring before removing any bolts from the bail bar. Failure to observe this warning could result in the bail bar falling down unrestrained, killing anyone underneath it.

a. Attach the winch cable hook onto the ring near the top of the bail bar (see Figure 14).

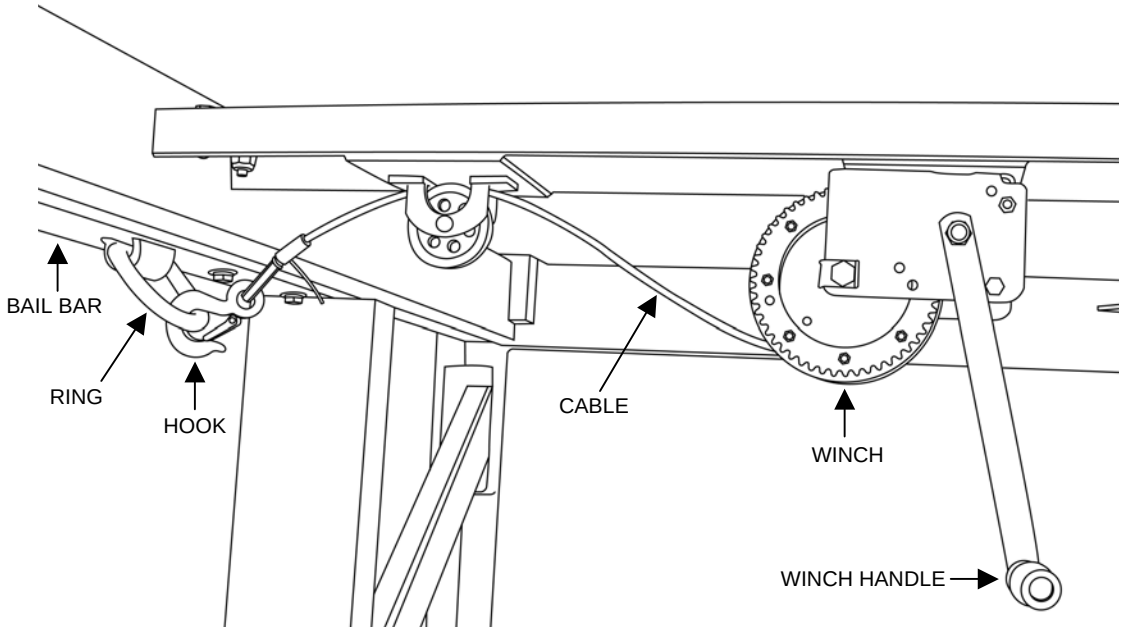

Figure 14. Winch Cable Hook Attached to Bail Bar Ring.

b. Remove the hardware that secures the bail bar to the flat rack as follows (see Figure 15):
   1) Remove the eleven bolts, lockwashers, and flat washers that secure the bail bar to the top horizontal beam of the flat rack.
   2) Remove the four bolts, eight flat washers, four lock washers, and four nuts that secure the bail bar to the diagonal beam of the flat rack.
   3) Insert the flat end of the pinch bar between the large back nut and the flat rack frame at the bottom of the flat rack.
   4) Unscrew the bolt out of the nut using the bail bar socket wrench. Retain the bolt, lock washer and nut.
   5) Remove the back bolt, lock washer and nut at the other side of the bail bar in the same manner.

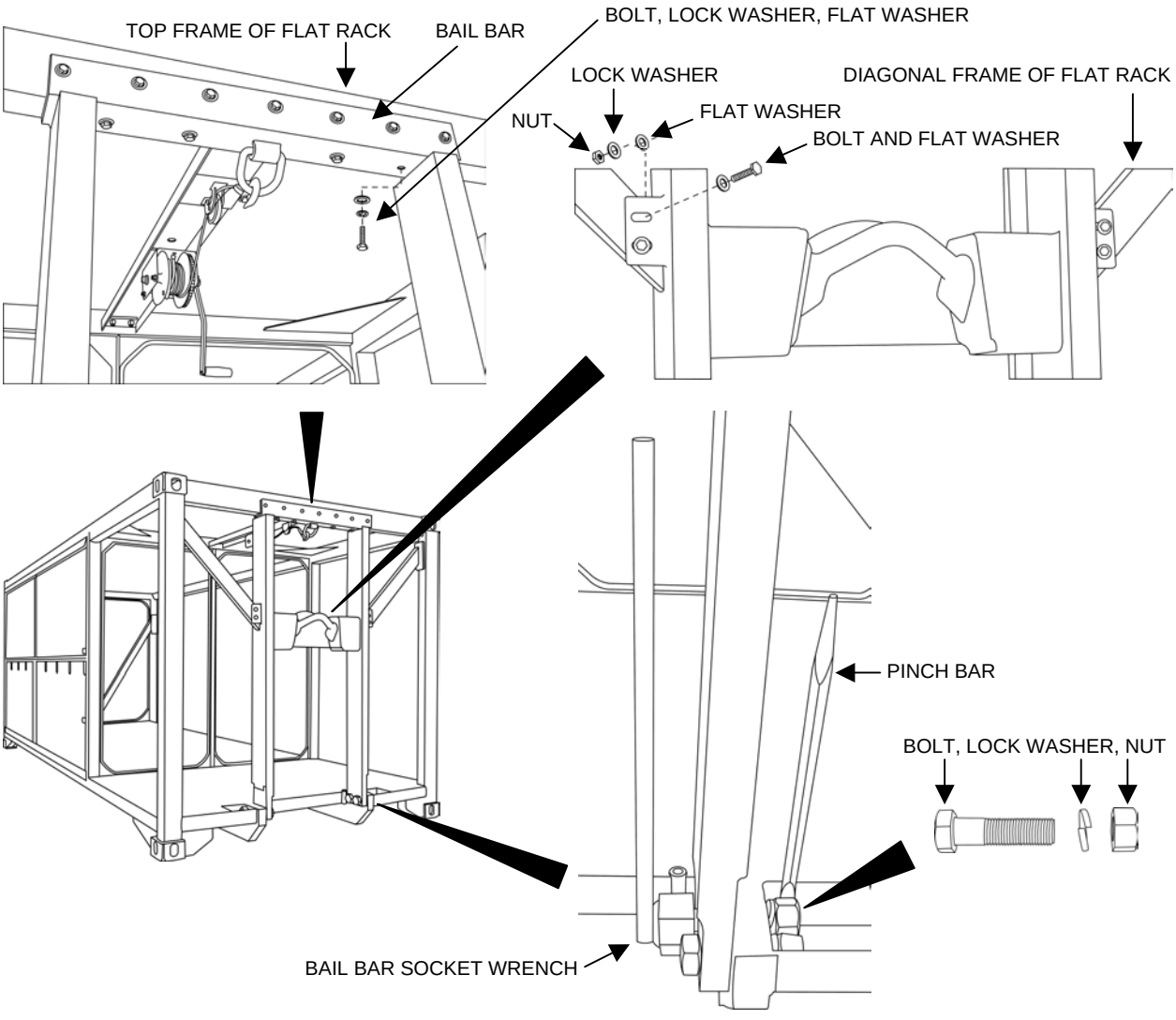

Figure 15. Removing the Bolts from the Bail Bar.

c. Turn the winch crank handle to lower the bail bar to the desired position (see Figure 16).
d. Disconnect the cable and move it out of the way so it is not a hazard.

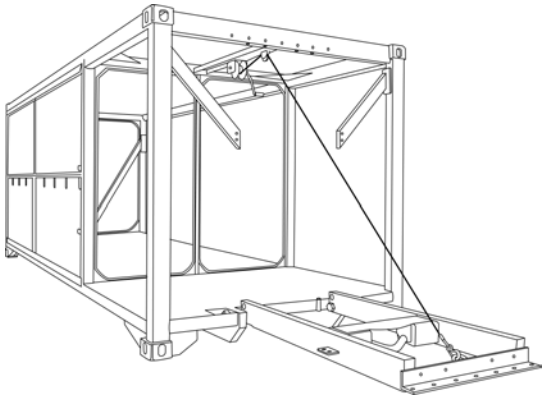

Figure 16. Flat Rack Bail Bar Lowered.

2. Raise and secure the bail bar as follows:
   a. Connect the cable to the bail bar.
   b. Turn the winch crank handle to raise the bail bar.

NOTE

Installing the two large bolts, lockwashers, and nuts at the bottom of the bail bar first helps align the holes for the other bolts and makes the other bolts easier to install.

c. Install the two large bolts, lock washers, and nuts that secure the bottom of the bail bar to the flat rack (see Figure 15).

WARNING

A minimum of 6 bolts in the front of top horizontal beam of the flat rack and a minimum of 3 bolts in the underside of the top horizontal beam are required in order to safely lift the flat rack by the bail bar. Failure to observe this warning may result in equipment damage and severe injury or death.

NOTE

The middle and upper bail bar bolts must be installed in their proper locations to ensure that the bail bar is properly secured. There are three different length bolts that are used. The longest of the three is used with washers and nuts to secure the bail bar to the diagonal beam of the flat rack. The other two shorter bolts thread into rivet nuts, which are threaded inserts that are welded in the top horizontal beam of the flat rack.

d. Separate the three different size bolts that are used to secure the middle of the bail bar to the diagonal beam of the flat rack and the top of the bail bar to the top horizontal flat rack beam (see Figure 17).
e. Loosely secure the top part of the bail bar to the front of the top horizontal flat rack beam using the seven short bolts with their lock washers and flat washers. Do NOT tighten yet.
f. Loosely secure the top part of the bail bar to the underside of the top horizontal flat rack beam using the four longer bolts with their lock washers and flat washers. Do NOT tighten yet.
g. Secure the middle of the bail bar to the diagonal flat rack beams using the four longest bolts with eight flat washers, four lock washers, and four nuts.
h. Tighten all 15 bolts. Torque to 250 in-lbs.

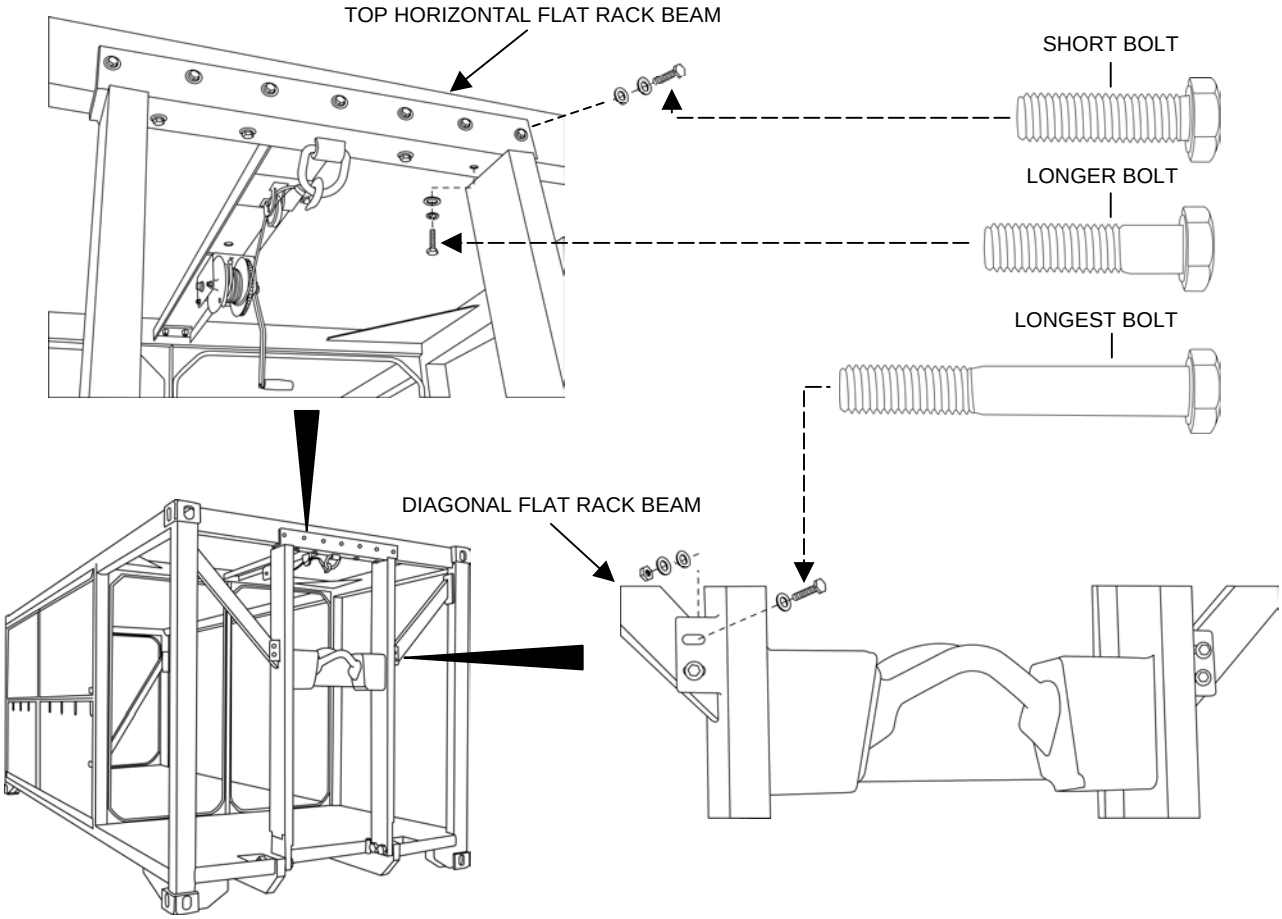

Figure 17. Correct Bail Bar Bolt Installation Locations.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0008 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OCEAN INTAKE STRUCTURE SYSTEM (OISS) SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

INITIAL SETUP:

Materials:
Teflon Tape
Reference:
Refer to this TM, WP 0007 – Set-Up - Operation Under Usual Conditions
Personnel Required
Three Operator/Crew
Equipment Condition
TWPS skid removed from transport vehicle and set on level ground.
Loose items unpacked (off-loaded) from the TWPS skid and placed in their general operational position.

GENERAL

The OISS is used for water intake from sandy beach locations when surf conditions or tide extremes make it difficult or impossible to use the floating inlet strainer. This work package contains the procedures to set up the OISS (Ocean Intake Structure System). The procedures covered in this work package include:

- Planning
- Establishing a Water Source to Jet the Wellpoints
- Jetting the First Wellpoint
- Jetting the Second Wellpoint
- Jetting the Third Wellpoint
- Jetting the Fourth Wellpoint
- Checking for Hydrogen Sulfide

PLANNING

Assess the tidal and surf conditions to determine the best location for the OISS using the following guidelines:

- When there is a large horizontal tidal variation and/or water surface conditions are rough, install the OISS above the high tide position with two 5 ft. risers attached to each of the four wellpoints.
- When water surface conditions are calm or if hydrogen sulfide or iron is known to be present in the groundwater, install the OISS at a low tide position with 2 ft. risers attached to each of the four wellpoints.

The best time to install the OISS is at low tide when the wellpoints can be installed at an optimum configuration.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0008 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OCEAN INTAKE STRUCTURE SYSTEM (OISS) SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

LAYOUT OISS

1. Connect one or two 5 ft. risers or a 2 ft. riser as required by the site to each elbow or tee and its wellpoint. Use Teflon tape when connecting the threaded sections.
2. Lay out (but do not connect) the wellpoints and (yellow-banded) hoses as shown in Figure 1 in the general area where they will be assembled. If the terrain is rocky or otherwise unsuitable for driving wellpoints into the sand, the OISS can be submerged in the raw water source in a horizontal position. Note that there are two riser/wellpoint assemblies with elbow fittings and two with tee fittings.

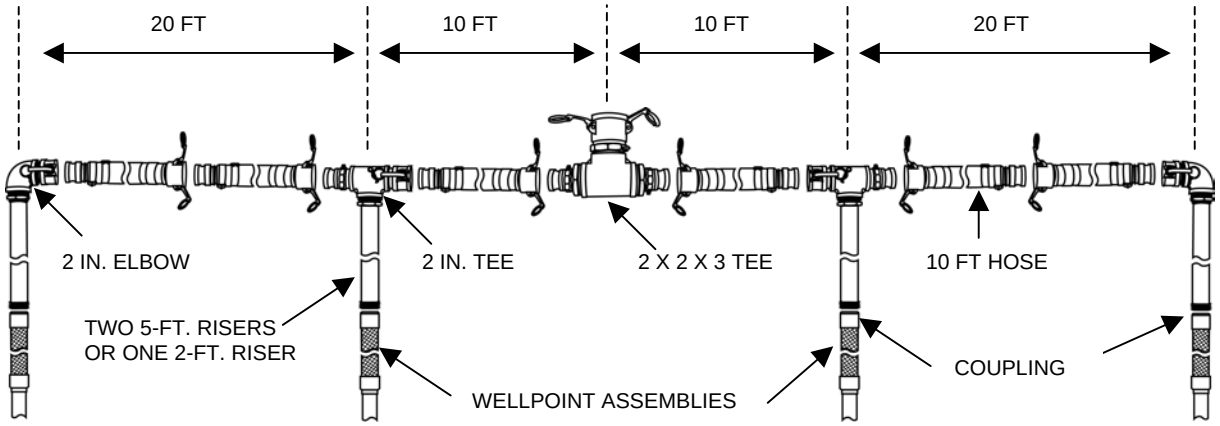

Figure 1. Typical OISS Configuration.

3. Check the condition of the wellpoints. Notify Unit Maintenance if damaged beyond use.
4. Check the gaskets inside the female ends of the elbows, tees, and hoses. Replace missing or damaged gaskets with new gaskets.
5. Rinse the camloks (locking ends of elbows, tees, and hoses) in a bucket of water to remove sand and ensure a leak-free connection.

ESTABLISHING A WATER SOURCE TO JET THE WELLPOINTS

"Jetting the Wellpoints" is a procedure for forcing water through the risers, out the wellpoints and into the sand. The jet of water fluidizes the sand and allows the wellpoint to easily sink down into the sand. A water source is required to jet the wellpoints. Either of the following two setups can be used to establish a water source for jetting the wellpoints:

1. If conditions permit, the floating inlet strainer and anchor can be installed as described in WP 0007, Set-Up – Operation Under Usual Conditions, under the heading **FLOATING INLET STRAINER AND ANCHOR DEPLOYMENT**. After the OISS is installed, the floating inlet strainer can be left in place and used to provide a source of water to operate the TWPS when operational conditions permit (see Figure 2).
2. If desired, or if necessary due to rough water conditions, two wellpoints can be connected together and submerged horizontally in the surf (see Figure 2).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0008 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OCEAN INTAKE STRUCTURE SYSTEM (OISS) SET-UP – OPERATION
UNDER UNUSUAL CONDITIONS

a. Connect a 2 in. diameter x 10 ft. long, yellow banded OISS suction hose to the 2 in. elbow fitting of one riser/wellpoint assembly.
b. Connect the other end of the hose to the 2 in. tee fitting of a second riser/well point assembly.
c. Connect a second 2 in. x 10-ft., yellow-banded OISS suction hose to the other end of the 2 in. tee fitting.
d. Connect the 2x2x3 in. tee to the other end of the second hose.
e. Cap the remaining 2 in. end of the 2x2x3 in. tee.
f. Connect 3 in. x 10 ft., green-banded suction hoses as needed to the floating inlet strainer or the 2x2x3 in. tee of two wellpoints.
g. Connect the other end of the 3 in. x 10 ft., green-banded suction hose(s) to the suction inlet of the raw water pump. The procedures here refer to the use and operation of Diesel-Driven Raw Water Pump P-1. Either Diesel-Driven Pump P-1 or Motor-Driven Pump P-2 can be used.
h. Submerge the wellpoint assembly horizontally in the surf.

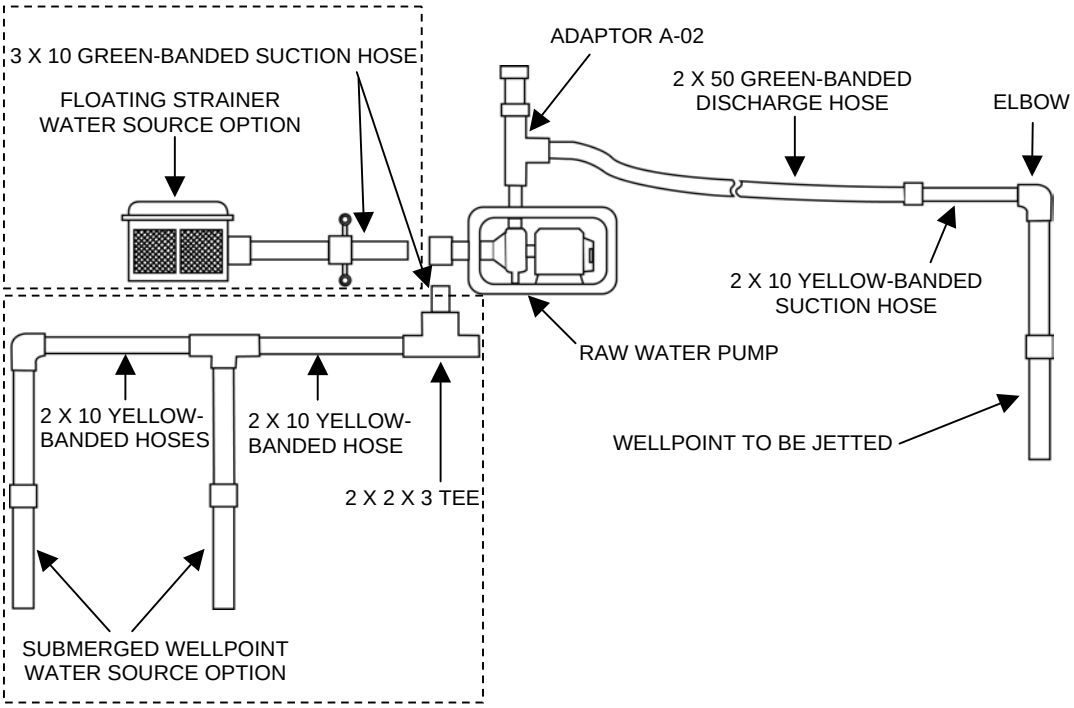

Figure 2. Set-Up for Jetting a Wellpoint.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0008 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OCEAN INTAKE STRUCTURE SYSTEM (OISS) SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

JETTING THE FIRST WELLPOINT

Each of the four wellpoints are jetted into the sand in essentially the same manner with a few changes in connections. Refer to Figure 2 for an illustration of how various raw water system components are assembled in order to jet a wellpoint.

1. Connect a 2 in. x 50 ft., green-banded raw water discharge hose from the discharge of the diesel-driven pump to a 2 in. x 10 ft., yellow-banded OISS suction hose that is connected to the elbow of the first wellpoint to be jetted.

WARNING

Water pressure will fluidize the sand and could create a large unstable area surrounding the wellpoint. As a result, the person inserting the wellpoint could sink below the surface of the water or under the sand. The person holding the wellpoint must wear flotation gear and be tied to a safety line. Additional personnel must be present to retrieve the individual if the individual falls or sinks into the sand as it is fluidized. Failure to observe this warning may result in death from drowning or suffocation.

2. Start the diesel-driven pump as described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained, under the heading **ESTABLISHING RAW WATER FLOW**, to pump water through the hoses, the riser and out the bottom of the wellpoint.
3. For low tide installations, one person holds the safety line and a second person remains near the person installing the wellpoint. The second person holds the suction hose and assists the person installing the wellpoint in the event the person falls or sinks into the sand as it is fluidized.
4. Move the wellpoint into position in a vertical orientation and insert the bottom of the wellpoint into the sand. Do not force the wellpoint. Allow it to drive itself into the sand, raising and lowering the wellpoint to wash fine material from the well location.
5. Continue jetting the wellpoint until the elbow or tee is just above the sand level.
6. Continue pumping water into the well point for five minutes to flush fine materials from the well. During this five minute period, raise and lower the wellpoint about one ft. every ten seconds.
7. After flushing for five minutes, slow the diesel engine to idle speed.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0008 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OCEAN INTAKE STRUCTURE SYSTEM (OISS) SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

JETTING THE SECOND WELLPOINT

1. Disconnect the 2 in x 50 ft., green-banded discharge hose from the 2 in. x 10 ft., yellow-banded OISS suction hose.
2. Connect the discharge hose to another 2 in x 10 ft., yellow-banded OISS suction hose that is connected to the 2 in. tee of a second wellpoint/riser assembly. Cap the unused port of the tee.
3. Increase the diesel engine speed to establish flow for jetting the wellpoint.
4. Connect a second 2 in. x10 ft., yellow-banded OISS suction hose to the first hose on the jetted wellpoint to determine where to jet the second wellpoint.
5. Jet the second wellpoint into the sand using the same procedures that were followed to jet the first wellpoint. Observe the warning.
6. After flushing the second well point for five minutes, slow the diesel engine to idle speed.
7. Remove the discharge hose from the 2 in. x 10 ft., yellow-banded OISS suction hose.
8. Connect the two 10 ft., yellow-banded suction hoses from the first wellpoint to the 2nd wellpoint.

JETTING THE THIRD WELLPOINT

1. If the floating inlet strainer is used as the water source for jetting the wellpoints, repeat the procedures that were followed for the first two wellpoints to jet the third and fourth wellpoints into the sand. Use the yellow-banded OISS suction hoses as a guide to determine the location of the wellpoints. Insert the 2x2x3 tee adapter between the second and third wellpoints.
2. If two submerged wellpoints are used as the water source, use the two jetted wellpoints as the source of water for jetting the third and fourth wellpoints as follows:
    a. Remove the submerged wellpoint assembly from the water.
    b. Connect one 10 ft., yellow-banded OISS suction hose to the 2 in. tee of the second wellpoint.
    c. Connect the 2x2x3 in. tee adapter to the other end of the hose.
    d. Cap the other 2 in. end of the tee assembly.
    e. Connect the 2 in. discharge hose from the raw water pump to another 10 ft., yellow-banded OISS suction hose that is connected to the 2 in. tee of the third wellpoint/riser assembly. Remove the hose from the other end of the tee and cap the tee.
    f. Increase the diesel engine speed to establish flow for jetting the wellpoint.
    g. Using the 10 ft. suction hose on the third wellpoint as a guide, determine the location of the third wellpoint from the 2x2x3 tee adapter.
    h. Jet the third wellpoint into the sand using the same procedures that were followed to jet the first and second wellpoints. Observe the warning.
    i. After flushing the third well point for five minutes, slow the diesel engine to idle speed.
    j. Remove the discharge hose from the 10 ft. suction hose.
    k. Connect the suction hose to the 2x2x3 tee adapter.
    l. Connect a 10 ft. suction hose from the tee of the jetted third wellpoint and cap the other end of the hose.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0008 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OCEAN INTAKE STRUCTURE SYSTEM (OISS) SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

JETTING THE FOURTH WELLPOINT

1. Connect a 2 in. x 10 ft., yellow-banded OISS suction hose to the fourth wellpoint.
2. Using the 10 ft. hose on the third wellpoint and the 10 ft. hose on the fourth wellpoint, determine where to jet the fourth wellpoint.
3. Jet the fourth wellpoint into the sand using the same procedures that were followed to jet the other three wellpoints. Observe the warning.
4. After flushing the fourth wellpoint for five minutes, shut down the diesel pump.
5. Remove the discharge hose from the 10 ft. suction hose.
6. Connect the two 10 ft. suction hoses between the third and fourth wellpoints.
7. If the OISS is going to be submerged at high tide, secure all camloks with plastic wire ties.

CHECKING FOR HYDROGEN SULFIDE

When first filling the MF Feed tank, smell the water. If a smell of rotten eggs is observed, hydrogen sulfide is present. Extended operation with hydrogen sulfide present will result in pump seal failures, pump impellor corrosion and eventual corrosion of the TWPS piping. Iron is often present with hydrogen sulfide. Iron will rapidly foul both the MF membranes and the RO membranes and should be avoided if possible. The hydrogen sulfide will also pass over to the product water and result in poor tasting water.

If hydrogen sulfide is present, respond as follows:

1. If the smell is weak, continue with operation, but check to make sure it does not become stronger. If the mission is planned to exceed 100 hours, reset the OISS at low tide using the 2 ft. risers. This will draw seawater directly and avoid the hydrogen sulfide.
2. If the smell is strong, do not operate the TWPS. Reset the OISS at low tide using the 2 ft. risers to avoid the hydrogen sulfide. If mission water demands require immediate operation, reset the OISS as soon as the water demand allows.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0009 00
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
COLD WEATHER SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

INITIAL SETUP

References:
Refer to this TM, WP 0038 – PMCS for "Before" PMCS checks
Refer to TM 5-6115-545-12 - Tactical Quiet Generator Operating Procedures for generator start up
Refer to Army TM 10-5430-237-12&P for collapsible water tank set up and operation
Or Refer to Marine Corps TM 01034E-12&P/1 for collapsible water tank set up and operation
Personnel Required:
Three Operator/Crew
Equipment Condition:
TWPS skid removed from transport vehicle and set on level ground.
Loose items unpacked (off-loaded) from the TWPS skid and placed in their general operational position.

GENERAL

This work package contains the procedures to fully set up the TWPS for initial operation under cold weather conditions. "Cold weather conditions" is loosely defined as when icing could be encountered in the next 24 hours. A more precise definition of "cold weather conditions" takes into account both water and air temperatures. Table 1 provides a general guideline that can be followed to determine when it may be appropriate to set up the TWPS for cold weather conditions and deploy the cold weather kit.

Table 1. Conditions Appropriate for Cold Weather Set-Up.

Water Temperature (degrees F)	Air Temperature (degrees F)			
	Less than 15°F	15-20°F	20-25°F	Over 25°F
Less than 35°F	Yes	Yes	Yes	Yes
35-40°F	Yes	Yes	No	No
Over 40°F	Yes	No	No	No

If conditions do not necessitate cold weather set-up, the TWPS should be set up as described in WP 0007, Set-Up – Operation Under Usual Conditions.

NOTE

If not done prior to cold weather deployment, notify Unit Maintenance to replace the oil in the raw water diesel engine P-1 with 10W motor oil.

Cold weather kit components are shown in Figure 1 through Figure 3 and in Table 2 through Table 4.

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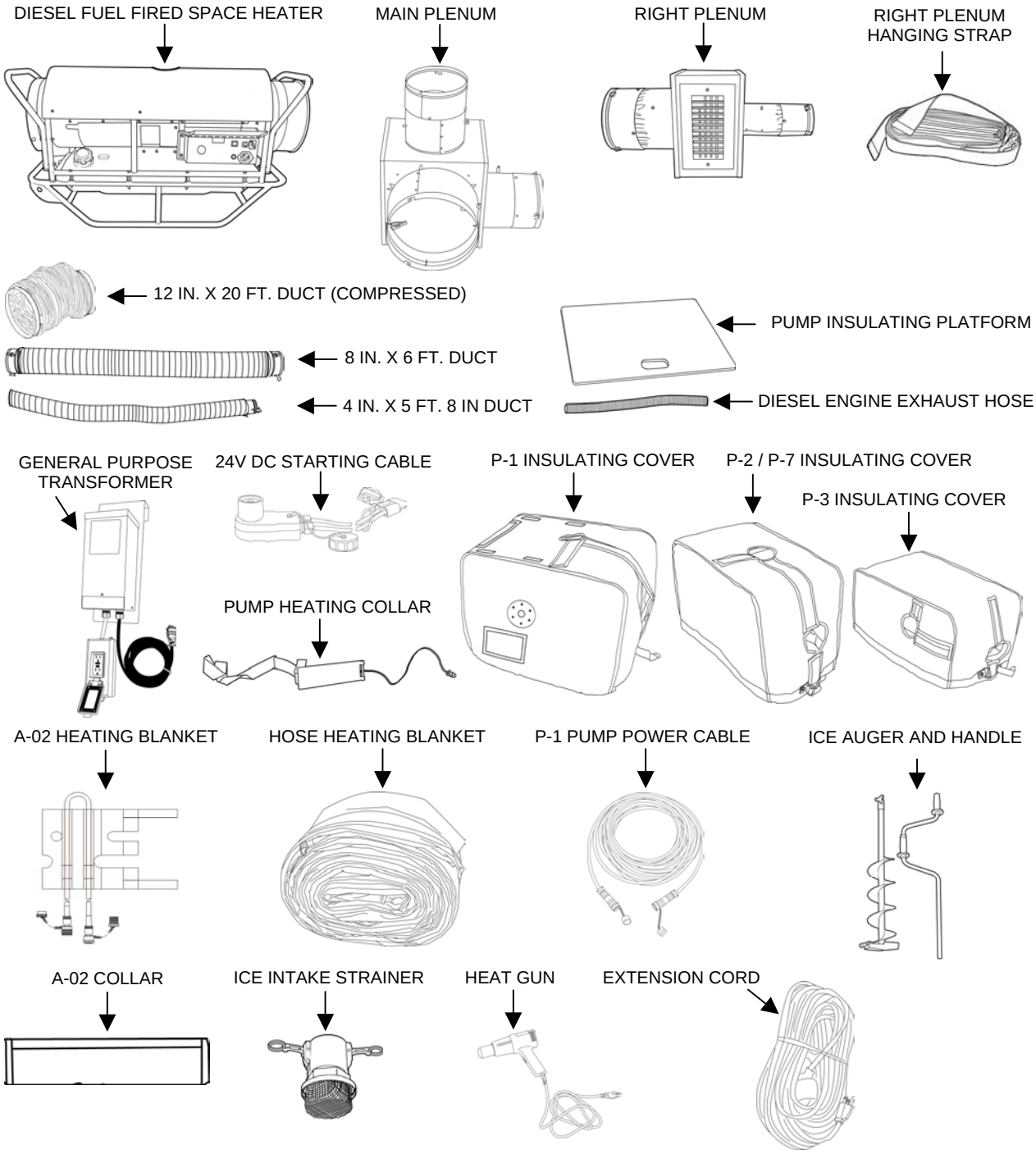

Figure 1. Drawings of Components of the Cold Weather Kit Common to A-TWPS and MC-TWPS.

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Table 2. Listing of Components of the Cold Weather Kit Common to A-TWPS and MC-TWPS.

ITEM	QTY
Diesel Fuel Fired Space Heater	1
General Purpose Transformer	1
Plenum, Main Hot Air	1
Plenum, Right Side	1
Plenum, Hanging Straps, Right Side (already installed and left on the TWPS frame)	2
Duct, 12 in. X 20 ft.	2
Duct, 8 in. x 6 ft.	2
Duct, 4 in. x 5 ft. 8 in.	1
Pump Insulating Platform	4
Diesel Engine Corrugated Exhaust Hose	1
Diesel Engine 24-Volt DC Starting Cable (stays with TWPS; stored in Box #1 when not in use)	1
Insulating Cover, Diesel Pump P-1 Skid	1
Insulating Cover, MF Pump P-3 Skid	1
Insulating Cover, Raw Water Pump P-2 Skid & Distribution Pump P-7 Skid	2
Heating Collar, P-2, P-3, P-7 Pumps	3
Heating Blanket, Adaptor A-02	1
Heating Blanket F01-1, Raw Water Suction Hose, 3 in. x 5 ft, short power cable	1
Heating Blanket F01-2, Raw Water Suction Hose, 3 in. x 11 ft., long power cable	1
Heating Blanket F03-1, Raw Water Discharge Hose, 2 in. x 50½ ft., long power cable	1
Heating Blanket F03-2, Raw Water Discharge Hose, 2 in. x 50½ ft., short power cable	3
Heating Blanket F12, Raw Water Suction Hose, 2 in. x 9 ft.	1
Heating Blanket F07, MF Feed Pump Discharge Hose, 3 in. x 21 ft.	1
Heating Blanket P02, Product Outlet Hose, 1 ½ in. x 41½ ft.	1
Heating Blanket P03-1, Distribution Tank Connecting Hose, 2 in. x 6 ft., long power cable	1
Heating Blanket P04, Distribution Pump Suction Hose, 2 in. x 7.1 ft., short cable	1
Heating Blanket P05, Distribution Hose, 2 in. x 66.5 ft.	2
Raw Water Pump P-1 Heating Blanket Power Cable	1
Ice Auger and Handle	1
Insulating Collar, A-02	1
Ice Intake Strainer	1
Heat Gun	1
Cord, 100-ft., Extension	1

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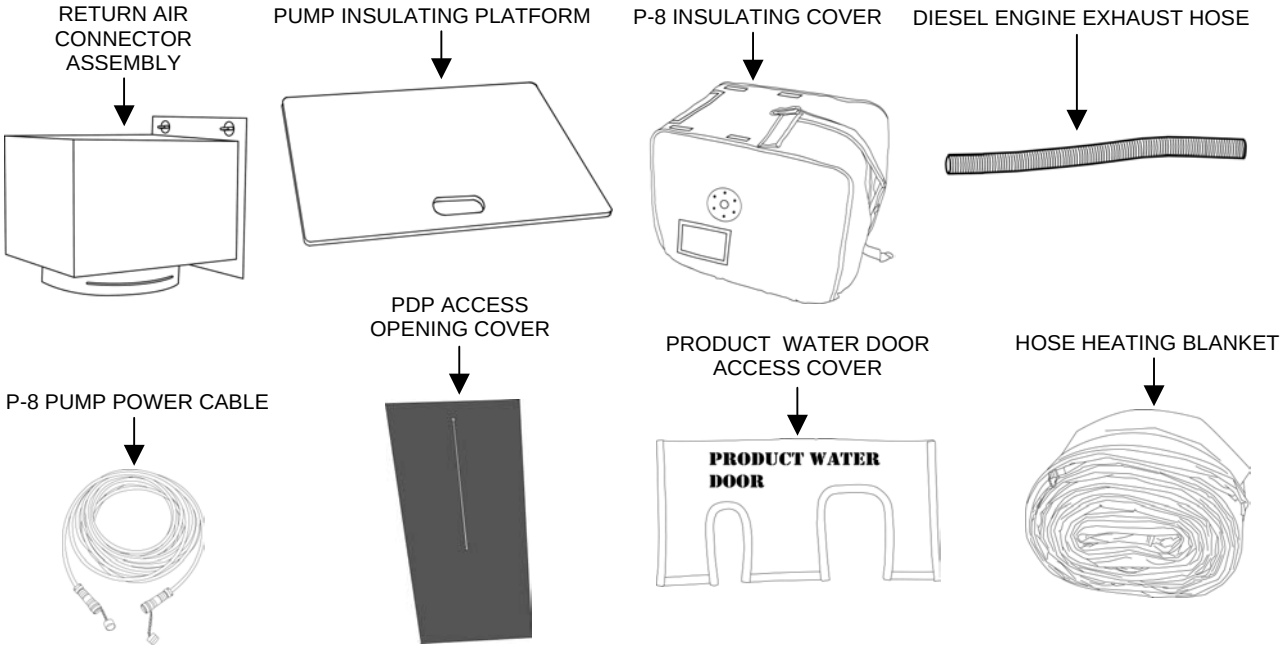

Figure 2. Drawings of Additional Cold Weather Components for A-TWPS.

Table 3. Listing of Additional Cold Weather Components for A-TWPS.

ITEM	QTY
Return Air Connector Assembly	1
Pump Insulating Platform	1
Insulating Cover, Distribution Pump P-8	1
Diesel Engine Corrugated Exhaust Hose	1
Distribution Pump P-8 Heating Blanket Power Cable	1
PDP Access Opening Cover	1
Product Water Door Access Cover	1
Heating Blanket P03-1, Distribution Tank Connecting Hose, 2 in. x 6 ft., long power cable	1
Heating Blanket P03-2, Distribution Tank Connecting Hose, 2 in. x 6 ft., longest power cable	1
Heating Blanket P04, Distribution Pump Suction Hose, 2 in. x 7.1 ft., short power cable	1
Heating Blanket P05, Distribution Hose, 2 in. x 66.5 ft.	2

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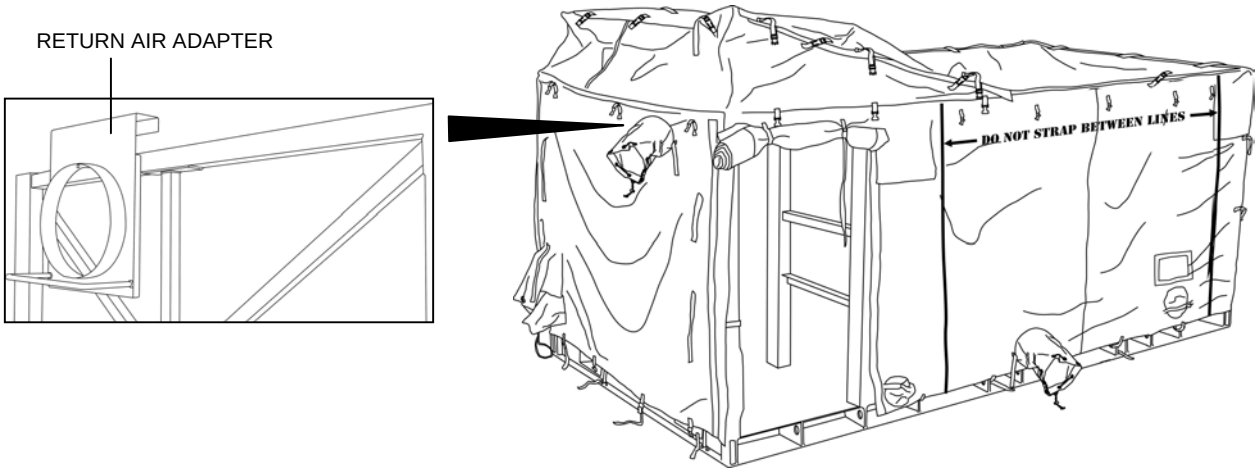

Figure 3. MC-TWPS Winter Cover.

Table 4. Listing of Additional Cold Weather Component for MC-TWPS.

ITEM	QTY
Return Air Adapter	1
Winter Cover	1

Cold weather set-up procedures are very similar to the TWPS set-up under usual conditions. Some new steps are added and some other steps are changed slightly to address the cold weather conditions.

The procedures covered in this work package include:

- Planning and Organization
- Locate Fire Extinguisher
- TWPS Skid Cover Installation
- Diesel Heater Deployment
- Place Items to Warm Up
- P-1 Pump to P-2 Pump Configuration Deployment
- P-2 Pump Only Configuration Deployment
- Sodium Bisulfite System Set-Up
- Micro-Filtration Equipment Set-Up
- Pump, Hose, and Adaptor Heaters and Pump Skid Cover Set-Up
- Waste Outlet Connections
- Making Power Cable Connections to the TWPS
- Heat-Up and Operating Temperature Requirements
- Air Compressor Start-Up
- Standard Distribution System Set-Up
- Raw Water Intake Deployment
- Establishing Raw Water Flow
- Pre-Operational Checks
- Extended Distribution System Set-Up (A-TWPS)

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PLANNING AND ORGANIZATION

Table 5 is a recommended team approach for establishing the various water and electrical connections and performing the initial checks and inspections to get the TWPS ready for operation. The procedures are in the general order of activity. While setting up the ground-operated equipment, keep in mind the overall work site dimensions as described in the Site Selection and Component Location WP 0004. Procedures with an asterisk (*) in front of them are different from set up procedures under usual conditions.

Table 5. Set-Up Procedure for Cold Weather Conditions

PROCEDURE	OPERATOR		
	1	2	3
*Install the winter cover (MC-TPWS) or fabric wall (A-TWPS)	x	x	x
*Install and start-up the diesel heater system	x		
Establish electrical power	x		
*Set Diesel-Driven P-1 Pump (if to be used) and antiscalant inside TWPS to heat up.		x	x
Move Raw Water Pump Skid P-2 into position (if to be used)		x	x
Move raw water hoses/power cables into position		x	x
Connect raw water hoses		x	x
Move micro-filtration pump skid & water tank into position		x	x
Connect micro-filtration water hoses		x	x
*Install pump, hose, & adaptor heaters and pump skid covers	x	x	x
Connect waste outlet drain hose			x
Connect Raw Water Pump P-2 and MF feed pump skid power cables	x		
Start-up the air compressor (after heat up of TWPS)	x		
Move distribution pump skid and water tanks into position		x	x
Connect distribution water hoses		x	x
*Install distribution pump & hose heaters and pump skid cover		x	x
Connect distribution pump skid power cable	x		
*Deploy the raw water intake		x	x
Start Diesel-Driven P-1 Pump (if used), move to position and complete installation of hose & adaptor heaters and cover		x	x
Connect P-1 heater power cable	x		
Perform initial checks	x		
Establish raw water flow	x	x	
Start the TWPS	x		
Set up the extended distribution system (A-TWPS)	x	x	x

LOCATE FIRE EXTINGUISHER

Remove the fire extinguisher from the mounting bracket located below the MF Feed Strainer S-2. Set the fire extinguisher on the ground in the general location where the ground rod will be placed.

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TWPS SKID COVER INSTALLATION

MC-TWPS Winter Cover Installation

Install the winter cover main cover section as follows (see Figure 4):

1. Make sure the TWPS operator station roof is in the down position and secured prior to installing the cover.

WARNING

Do not walk on the roof support sheets. They are not designed to support the weight of a person and may become slippery when wet. Failure to observe this warning may result in injury or damage to equipment.

2. Make sure the roof support sheets are spaced evenly over the top of the TWPS and secured with the three roof sheet straps.
3. Unfold the winter cover.
4. Set aside the top and back panels of the winter cover.
5. Loosen the hook and loop strip and unzip the main cover section at the four corners
6. Orient the cover so that the inlet and discharge flaps are at the front of the TWPS unit.
7. Make sure the straps (1) at the expandable end of the cover above the operator station roof are secured.
8. Pull the cover over the top of the TWPS unit.
9. Align the top seams of the cover with the top of the TWPS frame.
10. Secure the three straps (2) across the top of the TWPS unit so that they hold the front and back walls of the winter cover in place.
11. Loosen the hook and loop strip (3) and unzip the zippers (4) for each panel of the cover, secure the inner hook and loop straps (5) inside the corners of the cover and at the inner edge of each panel to the TWPS frame, then zip the zippers and re-secure the hook and loop strips adjusting the position of the cover as necessary for a proper fit at the corners.

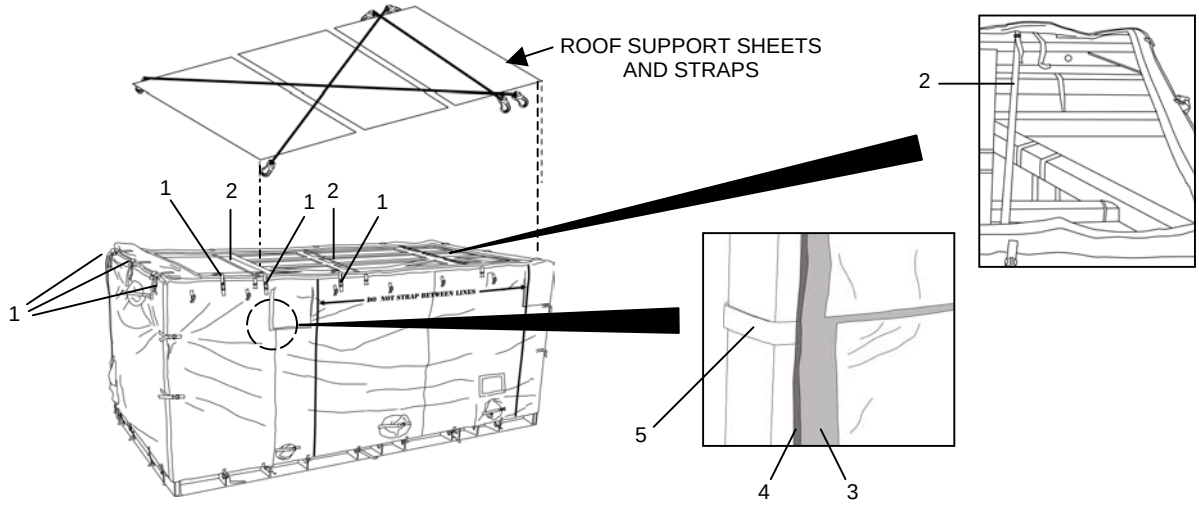

Figure 4. Winter Cover Main Cover Section Installation (MC-TWPS).

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Install the winter cover top panel as follows (see Figure 5):

1. Lay the winter cover top panel (1) on the top edges of the main cover section, matching the hook and loop strips on the top panel to the main cover section.
2. Secure each of the twelve straps on the top panel (2) to its matching strap on the top of the main cover section (3) and tighten.

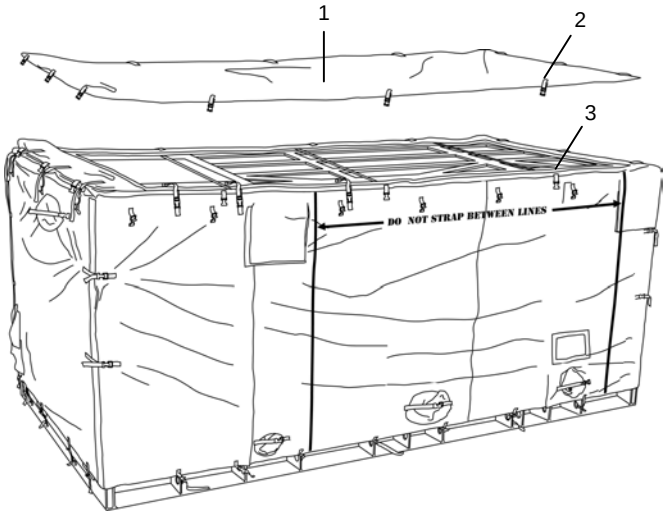

Figure 5. Winter Cover Top Panel Installation (MC-TWPS).

Install the winter cover back panel as follows (see Figure 6):

1. Orient the winter cover back panel (1) so that the edge of the panel that has three straps is positioned at the top and the stenciled warning “DO NOT FORK LIFT THIS SIDE” is facing out. Attach the back panel to the back of the main cover section by matching the hook and loop strips.
2. Secure each back panel top and side strap (2) to its matching strap on the back of the main cover section (3) and tighten.

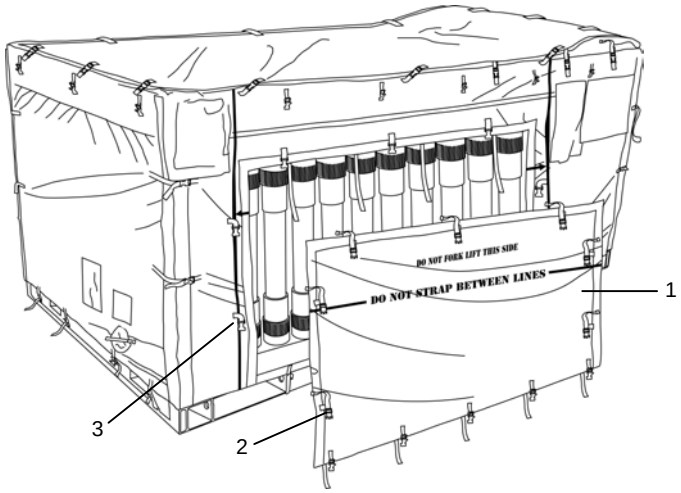

Figure 6. Winter Cover Back Panel Installation (MC-TWPS).

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Secure and tighten the following straps, zippers, and hook and loop strips (see Figure 7):

1. The outer straps at all four corners of the winter cover (1).
2. Route the 416 VAC generator cable out under the left bottom edge of the winter cover then secure and tighten the bottom straps at the ends of the cover to the loops on the TWPS I-beam (2).
3. The bottom straps at the front and back of the cover to the TWPS I-beam (3).
4. The two zippered and hook and loop seams in front of the equipment area of the TWPS (4).
5. The hook and loop strips on the four flaps over the rail transport tie-down rings (5).

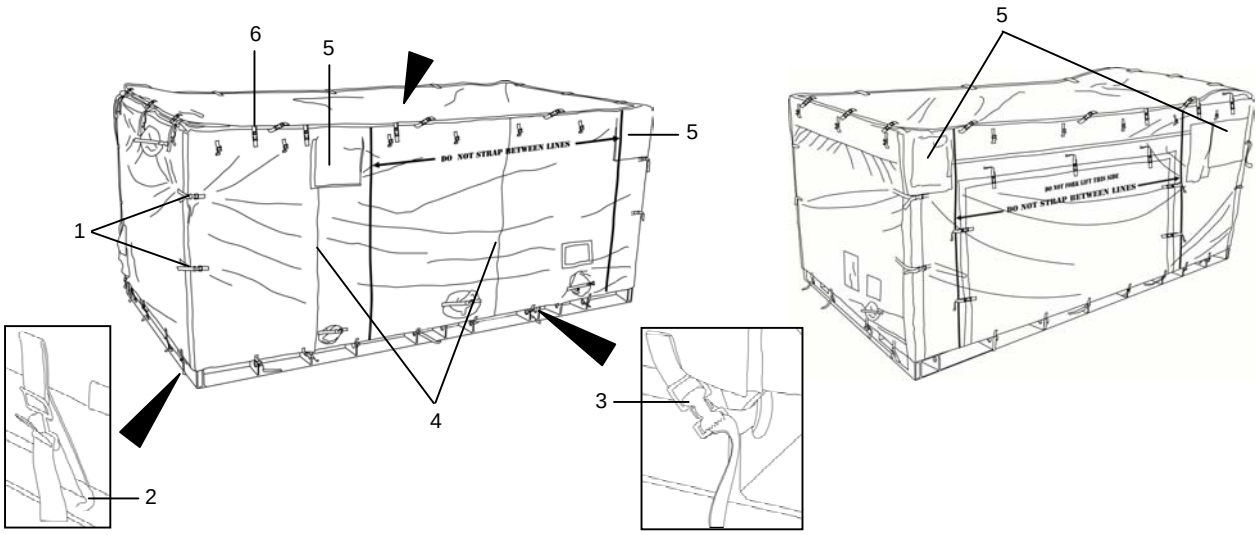

Figure 7. Winter Cover Installation Detail (MC-TWPS).

Raise the operator station roof as follows:

1. Unfasten the nine straps around the expandable end of the cover above the operator station roof (6) (see Figure 7).
2. Unfasten the hook and loop strip on the operator station overhead support beam pad and remove the padding from the support beam.
3. Store the pad in a BII Box after other components are unpacked from the boxes.
4. Remove the eight bolts and lock washers from the operator station overhead support beam and remove the beam (see Figure 8).
5. Reinstall the bolts and washers in the TWPS frame.
6. Store the beam under the high-pressure pumps.
7. Remove the retaining pins from the operator station roof and TWPS frame.
8. Raise the roof.
9. Install the pins through the bottom holes in the legs of the roof and through the holes in the TWPS frame to secure the roof in the raised position (see Figure 8).

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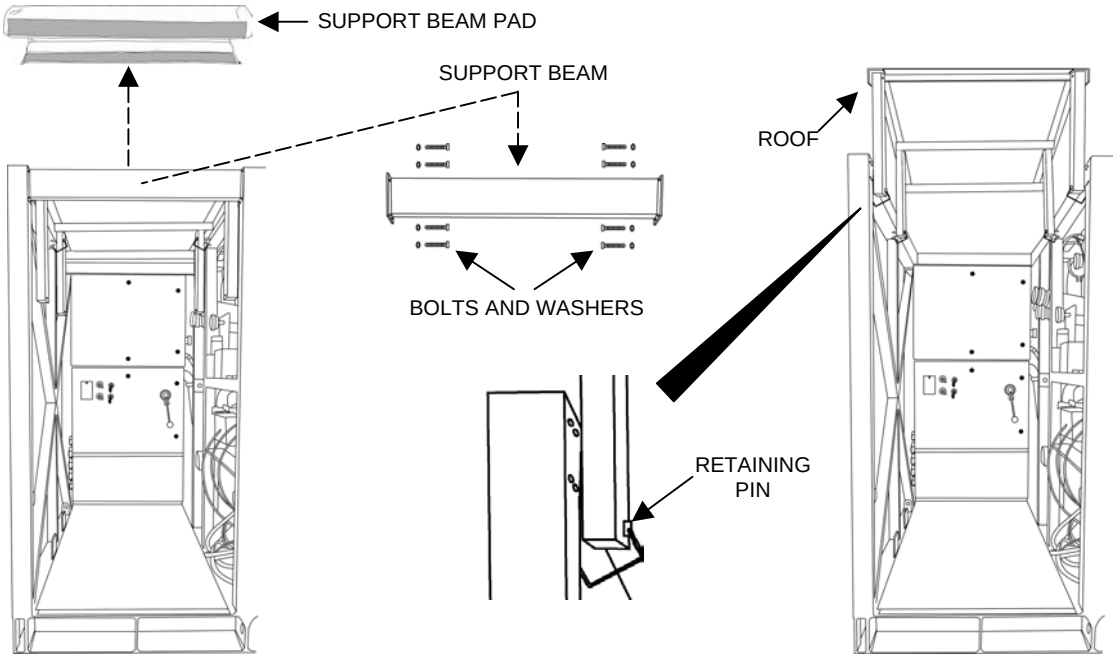

Figure 8. Operator Station Overhead Support Beam Removal and Roof Raising.

A-TWPS Fabric Wall Installation

Install the fabric wall as follows (see Figure 9):

1. Unfold the fabric wall and lay it on the ground oriented as follows:
    a. The outside of the wall on the ground and the inside of the wall facing up.
    b. The bottom of the zippered, roll-up door closest to the TWPS.
    c. The 3 in. hose feed-through opposite the raw water inlet of the TWPS.
    d. The 4 in. hose feed-through opposite the waste water outlet of the TWPS.
    e. The straps laid out for easy access.

WARNING

Potential for head injury. Hold the top panel while removing the pins from the top panel supports. Failure to do so could result in serious head injuries.

2. Two people carefully remove the pins from the top panel supports and lower the top panel to about a 45° angle. Insert the pins to hold this position.
3. Attach the top, front and side edges of the wall to the top panel as follows:
    a. Lift the fabric wall by the top, front edge.
    b. Loop each of the straps through its corresponding footman loop on the top panel and secure each strap in its buckle.
    c. Attach the hook and loop strip on the top edge of the wall to the strip on the top panel.
4. Two people raise the top panel with the attached fabric wall into position.
5. The third person inserts the pins in the top panel supports to secure the top panel.

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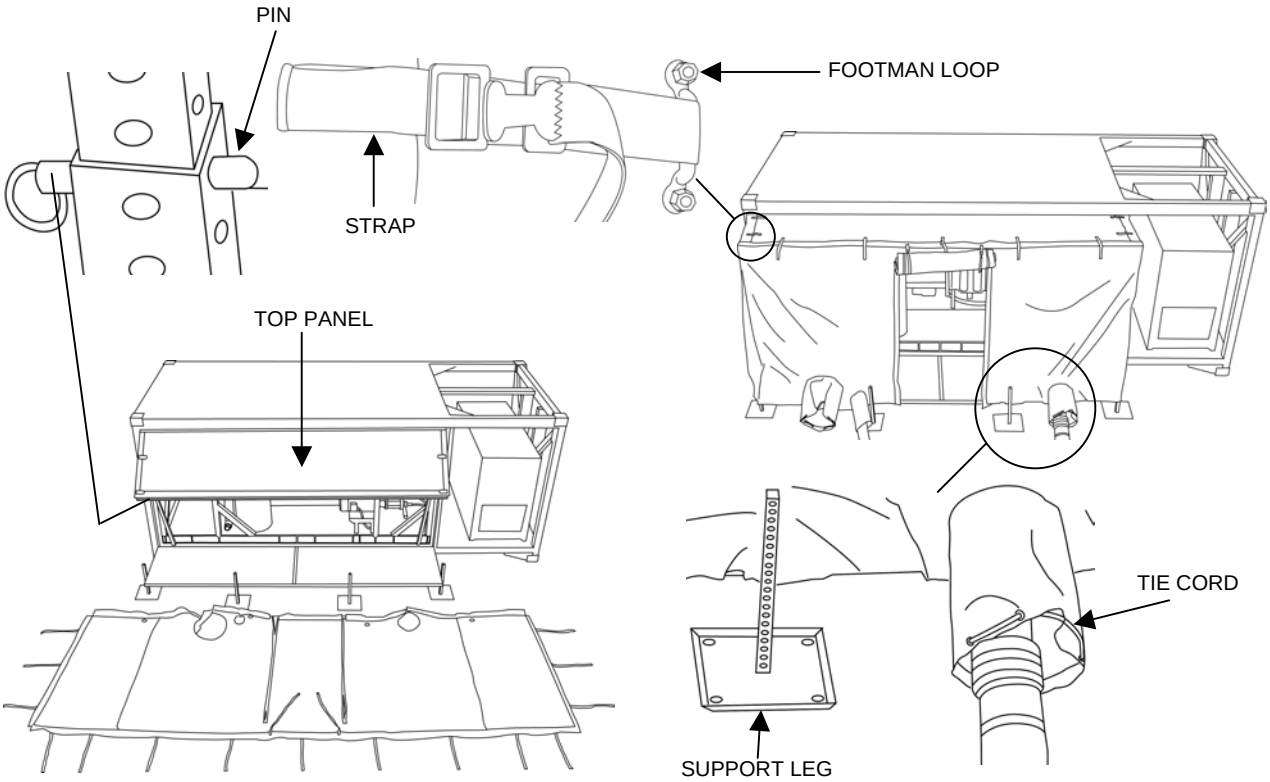

Figure 9. Fabric Wall Installation (A-TWPS).

6. Attach the side edge of both end walls as follows:
    a. Loop each side wall strap through its corresponding footman loop on the end panel and secure the strap in its buckle.
    b. Match and smooth the hook and loop strip on the side edge of the wall side flap to the hook and loop strip on the TWPS frame.
7. Attach the bottom edge of both wall side flaps to the bottom panel as follows:
    a. Fit the opening in the wall side flap for the support leg over the support leg.
    b. Loop both straps on the bottom of one wall side flap through its corresponding footman loop on the bottom panel and secure each strap in its buckle.
    c. Match and smooth the hook and loop strip on the bottom edge of the wall side flap to the hook and loop strip on the bottom panel.
8. Attach the bottom, front edge of the wall to the deck as follows:
    a. Fit the openings in the wall front for the support legs over the support legs.
    b. Fit the sleeves in the wall front for the raw water hose and the waste-water hose over the hoses. Close the sleeves snug around the hoses using the hook and loop strip at the bottom of the sleeve and with the tie cord.
    c. Loop each strap on the bottom, front edge of the wall through its corresponding footman loop on the bottom panel and secure each strap in its buckle.
    d. Match and smooth the hook and loop strip on the bottom edge of the wall to the hook and loop strip on the bottom panel.

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DIESEL HEATER DEPLOYMENT

1. Set up the diesel fuel fired heater as follows (see Figure 10):

WARNING

Fire hazard. Parts of the heater can get hot enough during operation to cause combustible materials to burn. Keep the heater at least 4 ft. away from the winter cover (or fabric wall) or any other combustible materials. Failure to observe this warning may result in severe injury or death and equipment damage or destruction.

Fire and explosion hazard. Use only DF2, DL2, or JP-8 in the heater. Never burn gasoline, naphtha, paint thinners, alcohol or other volatile fuels. Failure to observe this warning may result in fire, explosion, serious injury, or death.

Fire and explosion hazard. Do not fill the fuel tank or move the heater while it is on. Only fill the fuel tank or move the heater when the heater is shut off. Failure to observe this warning may result in fire, explosion, serious injury, or death.

Suffocation hazard. If this heater is ever used inside an enclosure, exhaust gases from the exhaust stack must be vented vertically to the outside in order to prevent carbon monoxide (CO) build-up inside. Failure to observe this warning may result in carbon monoxide poisoning, loss of consciousness, brain damage, and death.

a. Position the diesel heater outside the winter cover (MC-TWPS) or the fabric wall (A-TWPS) in front of the TWPS as shown in Figure 10. The controls face the TWPS. Keep the diesel heater at least 4 ft. away from the cover / wall or other combustible materials.
b. Remove the storage cap from the diesel heater inlet duct adapter.
c. Install the stack extension in the heater exhaust stack.
d. Attach the 12-in. air return duct to the heater inlet duct adapter (left end in Figure 10).
e. A-TWPS only. Remove the return air cover plate from the left front flat rack panel and install the return air connector assembly.
f. MC-TWPS only. Hang the return air adapter on the TWPS frame inside the winter cover return air sleeve.
g. Attach the 12-in. air return duct to the return air adapter / connector assembly.
h. Attach the 12-in. air outlet duct to the heater outlet duct adapter (right end in Figure 10).
i. Insert the other end of the outlet duct through the front of the winter cover / fabric wall.
j. Make sure the ducts are free of obstructions and sharp bends.
k. Hang the thermostat from one of the lower product hose clamps at a 3-way valve opposite the Operator Control Panel. Feed the cord under the front of the RO Feed Tank and out through the air duct opening in the cover / wall. Then plug the remote thermostat connector into the thermostat receptacle on the heater electrical panel.
l. Make sure the power switch on the heater electrical panel is in the OFF position.
m. Hang the general purpose transformer on the TWPS frame next to the eye wash station with the transformer facing into the equipment area.
n. Feed the transformer power cord under the RO feed tank and plug it into the cannon plug outlet at the right side of the power distribution panel (PDP).

o. Feed the heater power cord alongside of the thermostat cord and plug it into the general purpose transformer outlet.

2. Install the plenum and ducts inside the TWPS enclosure as follows (see Figure 10):
   a. Pass an 8-in. duct between the RO feed tank and the NBC filter tank. Direct the open end to discharge at the turbocharger. Connect the other end of the duct to the top of the main plenum.
   b. Place the main plenum up to the RO feed tank frame between the RO Clean Valve V-701 and the RO feed pump discharge pipe.
   c. Hang the right plenum behind the air compressor with the two straps provided. The large duct inlet points toward the main plenum and the register points down.
   d. Connect the 4-in. hot air duct to the right plenum and direct it down toward the corner by MF filter drain valves V-203 and V-403.
   e. Connect an 8-in. duct from the main plenum to the right plenum.

WARNING

Tripping hazard (A-TWPS only). After the 12-in. heater outlet duct is connected to the main plenum, the duct becomes a possible tripping hazard when entering and leaving the operator station area. Carefully step over the duct when entering and leaving the operator station area. Failure to observe this warning may result in personal injury.

   f. Connect the 12-in. heater outlet duct to the front of the main plenum.

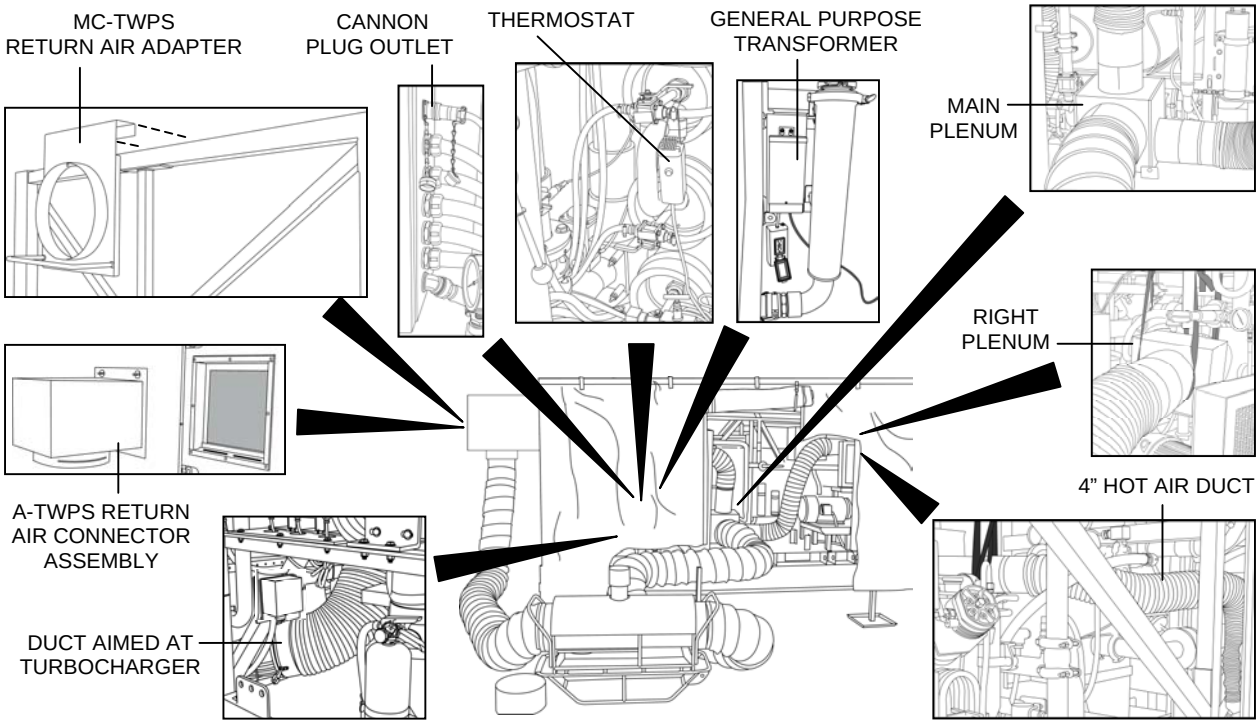

Figure 10. Diesel Heater, Plenum, and Duct Installation.

3. Start the diesel fuel-fired heater as follows (see Figure 11):

NOTE

The heater cannot be started until electrical power is established. Start the heater as soon as electrical power is established.

a. Establish electrical power to the TWPS. Refer to Refer to WP 0012, Establishing Electrical Power.
b. Check the fuel level in the diesel heater. Add fuel as needed.
c. Make sure the power switch on the heater electrical panel is in the OFF position.
d. If the remote thermostat is used, set the thermostat toggle switch on the heater electrical panel to the ON position. Then set the dial on the remote thermostat to 70 degrees F.
e. If you are not using the remote thermostat, set the thermostat toggle switch on the heater electrical panel to the OFF position. This will cause the heater to operate continuously once it is started.
f. Move the power switch on the heater electrical panel to the ON position. The heater should start up immediately (unless the remote thermostat is used and is set at a lower temperature than the surrounding air).

NOTE

If the heater should fail to ignite, or if the flame goes out during operation, the safety control will shut off all power to the heater and render the heater inoperable. The heater will automatically try to restart in 120 seconds. After three unsuccessful automatic restart attempts, the safety control will lock out. If this occurs, refer to the cold weather troubleshooting procedures in WP 0033, Operator/Crew Troubleshooting Procedures.

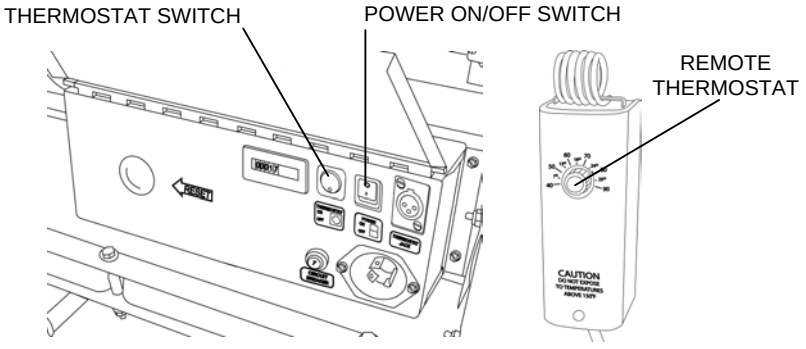

Figure 11. Diesel Fuel-Fired Heater Controls.

PLACE ITEMS TO WARM UP

1. If the diesel engine-driven pump P-1 is to be used, place it inside the TWPS to warm up until you are ready to start the engine.
2. Place the antiscalant inside the TWPS to thaw for later use.
3. Fill the priming pitcher with raw water and place inside the TWPS to heat.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS COLD WEATHER SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

0009 00

SET UP THE RAW WATER SYSTEM

NOTE

If site conditions allow, use only one pump and as few raw water hoses as possible. When only one pump is required, motor-driven P-2 pump is highly recommended. The cyclone separator is not used in cold weather conditions.

Two possible raw water system configuration cold weather set-ups are described here. They are:

- P-1 Pump to P-2 Pump Configuration Deployment.
- P-2 Pump Only Configuration Deployment.

NOTE

As the discharge hoses are laid out and connected, any excess length must be taken up in long smooth curves to avoid kinking of the hose when pressurized.

P-1 PUMP TO P-2 PUMP CONFIGURATION DEPLOYMENT

CAUTION

Potential water damage. Make note of potential tidal or river flood conditions and locate the raw water pumps to prevent the pumps and hose heating blankets from becoming submerged. Failure to observe this caution may result in water damage to the pump and diesel engine or motor.

1. Position the raw water pumps as follows (see Figure 12):

WARNING

Three person lift. Three people are required to safely lift Diesel-Driven Pump Skid P-1. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Two person lift. Two people are required to safely lift Motor-Driven Pump Skid P-2. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   a. Place a marker where the raw water diesel engine-driven P-1 pump skid is to be placed. Do not remove the diesel pump skid from the TWPS skid at this time. Keep it inside the heated enclosure.
   b. Place a pump insulating platform on the ground where the raw water Motor-Driven Pump P-2 is to be located.
   c. Move motor driven pump skid P-2 into place on top of the insulating platform.

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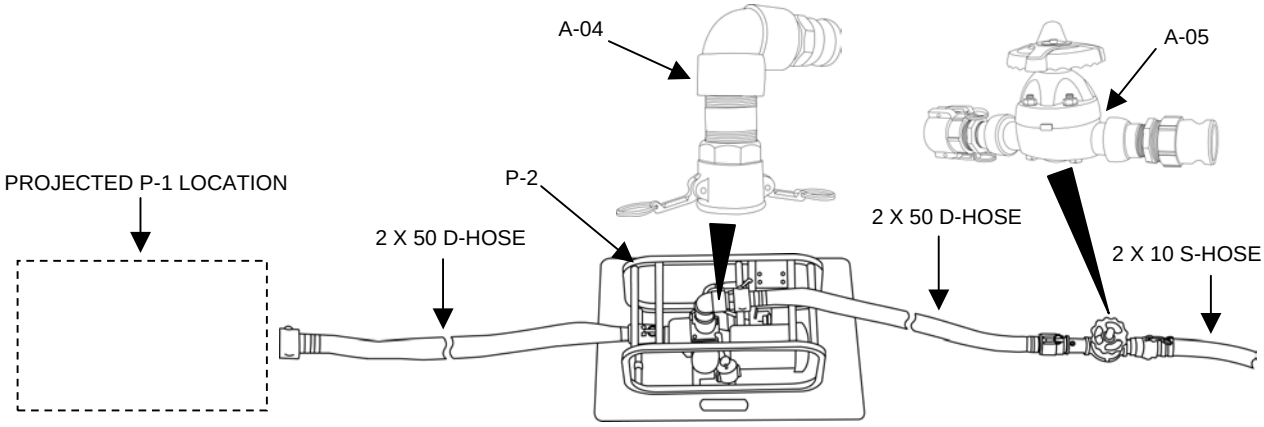

Figure 12. P-1 Pump to P-2 Pump Configuration Deployment.

2. Connect the raw water adaptors and hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following hoses and adaptor assemblies:
    1) Two to four 2 in. x 50 ft., green-banded raw water discharge hoses.
    2) One 2 in. x 10 ft., green-banded raw water suction hose.
    3) Adaptor assemblies A-04 and A-05.
b. Inspect the gaskets in the female ends of the hoses. Replace any damaged or missing gaskets.
c. Connect, as needed, one or two 2 in. x 50 ft., green-banded discharge hoses to the suction inlet of Motor-Driven Pump P-2 and lay out to the location marker for Diesel-Driven Pump P-1.
d. Attach Adaptor A-04 to the discharge outlet of the motor-driven pump.
e. Connect, as needed to reach the MF feed tank location, one or two 2 in. x 50 ft., green-banded discharge hoses to Adaptor A-04 at the discharge of Motor-Driven Pump P-2.
f. Connect Adaptor A-05 to the end of the discharge hose that is coming from P-2.
g. Connect the 2 in. x 10 ft., green-banded suction hose to Adaptor A-05.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0009 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
COLD WEATHER SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. Do NOT connect the Motor-Driven Pump P-2 electrical power cable at this time. Failure to observe this warning may result in serious injury or death from electrocution.

P-2 PUMP ONLY CONFIGURATION DEPLOYMENT

CAUTION

Potential water damage to equipment. Make note of potential tidal or river flood conditions and locate the raw water pump to prevent the pump and hose heating blankets from becoming submerged. Failure to observe this caution may result in water damage to the pump and motor.

1. Position the raw water pump as follows (see Figure 13):

WARNING

Two person lift. Two people are required to safely lift Motor-Driven Pump Skid P-2. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   a. Place a pump insulating platform on the ground where the raw water Motor-Driven Pump P-2 is to be located.
   b. Move Motor-Driven Pump Skid P-2 into place on top of the insulating platform.

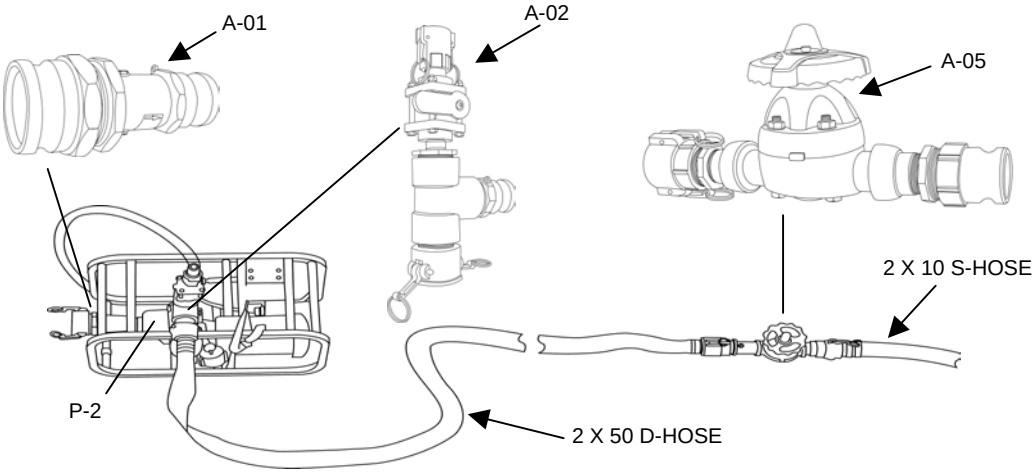

Figure 13. P-2 Pump Only Configuration Deployment.

2. Connect the raw water adaptors and hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following hoses and adaptor assemblies:
    1) One or two 2 in. x 50 ft., green-banded raw water discharge hoses.
    2) One 2 in. x 10 ft., green-banded raw water suction hose.
    3) Adaptor assemblies A-01, A-02, and A-05.
    4) One 1 in. x 5 ft. clear plastic priming vent hose.
b. Inspect the gaskets in the female ends of the hoses. Replace any damaged or missing gaskets.
c. Attach Adaptor A-01 to the suction inlet of the motor-driven pump. Position so that the bolt on the adaptor's check valve is in the vertical position. Wrap the strap around the pump frame and buckle the strap. Secure firmly to support the adaptor and hose and prevent air from entering the pump suction.
d. Attach Adaptor A-02 to the discharge outlet of the motor-driven pump.
e. Connect the priming vent hose to Adaptor A-02.
f. Connect, as needed to reach the MF feed tank location, one or two 2 in. x 50 ft., green-banded discharge hoses to Adaptor A-02 at the discharge of Motor-Driven Pump P-2.
g. Connect Adaptor A-05 to the end of the discharge hose that is coming from A-02.
h. Connect the 2 in. x 10 ft., green-banded suction hose to Adaptor A-05.

WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. Do NOT connect the Motor-Driven Pump P-2 electrical power cable at this time. Failure to observe this warning may result in serious injury or death from electrocution.

SODIUM BISULFITE SYSTEM SET-UP

CAUTION

Potential for damage to the MF elements and RO membranes. Chlorine will destroy the MF elements and RO membranes. If the raw water source is chlorinated, sodium bisulfite must be mixed into the raw water before it is pumped into the MF feed tank. Sodium bisulfite neutralizes the chlorine. Failure to observe this caution will result in the destruction of the MF elements and RO membranes.

The sodium bisulfite system MUST be set up before chlorinated raw water is pumped into the MF feed tank. The instructions for setting up the sodium bisulfite system are described in WP 0010, Other Set-Ups – Operation Under Unusual Conditions.

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COLD WEATHER SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

MICRO-FILTRATION (MF) EQUIPMENT SET-UP

Deploy the MF system equipment as follows (see Figure 14):

WARNING

Two person lift. Two people are required to lift the MF feed tank. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Three person lift. Three people are required to lift the MF feed pump. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

1. Position the MF feed tank and MF feed pump as follows:
   a. Place the MF feed tank in it's rough location (about 20 ft. from the TWPS).
   b. Unfold the ground cloth from around the tank and unfold the tank on the ground cloth.
   c. Spread the tank out to its final shape and eliminate any ridges in the bottom.
   d. Insert the MF feed tank bag strainer S-1 inside the MF feed tank. Overlap the top of the strainer over the open lip of the feed tank.
   e. Obtain the draw rope from BII and thread through the sleeves of the top of the strainer. Tighten the draw rope sufficiently to take up the slack and place it under a little tension.
   f. Pull the tank inlet and outlet connections out away from the tank bottom so that they will be clear when the tank is filled.
   g. Set up the tripod at the side of the tank where the 2x10 raw water hose will be inserted.
   h. Move motor driven MF Feed Pump Skid P-3 roughly in place as shown in Figure 14.
   i. Place the pump skid on solid footing and as nearly level as possible.

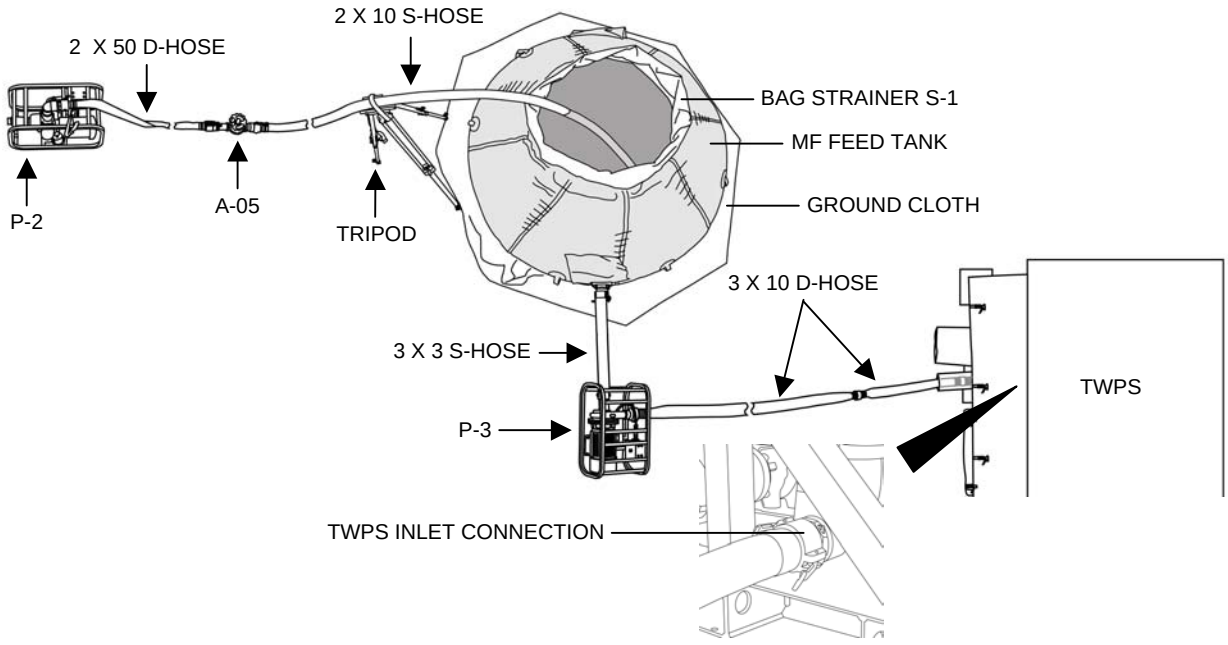

Figure 14. MF Equipment Deployment.

2. Connect the hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following hoses:
    a. One 3 in. x 3 ft., green-banded raw water suction hose.
    b. One or two 3 in. x 10 ft., green-banded raw water discharge hose.
b. Inspect the gaskets in the female ends of the hoses. Replace any damaged or missing gaskets. (Brush off any dirt before connecting).
c. Insert one end of one or two 3 in. x 10 ft., green-banded discharge hoses through the sleeve in the winter cover or fabric wall and connect it to the raw water inlet connection at the TWPS.
d. Connect the other end of the hoses to the discharge outlet of the MF feed pump.
e. Move the pump as needed to give a long smooth curve in the 3 in. discharge hose.
f. Place a pump insulating platform under the pump.
g. Connect the 3 in. x 3 ft. suction hose to the outlet of the MF feed tank and to the suction inlet of MF Feed Pump P-3. Move the tank as needed to allow the connection.
h. Place the open end of the 2 in. x 10 ft., green-banded raw water suction into the MF feed tank as far as it will go. Place the hose on top of the tripod and secure the hose to the tripod with a hook and loop strap.

WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. Do NOT connect the MF Feed Pump P-3 electrical power cable at this time. Failure to observe this warning may result in serious injury or death from electrocution.

PUMP, HOSE, AND ADAPTOR HEATERS AND PUMP SKID COVER INSTALLATION

Pump heating collars, hose heating blankets, Adaptor A-02 heating blanket, and pump skid covers are installed for cold weather operation to keep the equipment from freezing. Install the pump heating collars, hose heating blankets, Adaptor A-02 heating blanket, and pump skid covers as follows:

WARNING

Electrical hazard. Pump heating collars and hose and adaptor heating blankets operate on 208 VAC. Complete the installation of the heating collars and blankets and connect their power cables to the appropriate pump skid junction boxes. Do NOT connect the pump skid power cables to the TWPS PDP (power distribution panel) at this time. Failure to observe this warning may result in serious injury or death from electrocution.

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WARNING

Burn hazard. The pump heating collar gets very hot when it is operating. Do not touch the heating surfaces when the collar is operating and hot. Failure to observe this warning may result in burns.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

Heat damage from pump heating collar. When operating, the pump heating collar can get hot enough to melt any part of the pump insulating cover that it is in contact with. Install the pump heating collar so that its heating surface is positioned away from the sides where it could come in contact with the cover. Failure to observe this caution may result in damage to the pump insulating cover.

1. Install a pump heating collar on the raw water Motor-Driven Pump P-2 (if used) and the MF Feed Pump P-3 as follows (see Figure 15):
    a. Wrap the heating collar around the pump case with the heating surface away from the sides of the pump insulating cover and secure it with its strap.
    b. Connect the pump heating collar power cable to any one of the heater connections on its pump skid junction box. Do NOT connect the pump skid power cable to the TWPS PDP (power distribution panel) at this time.

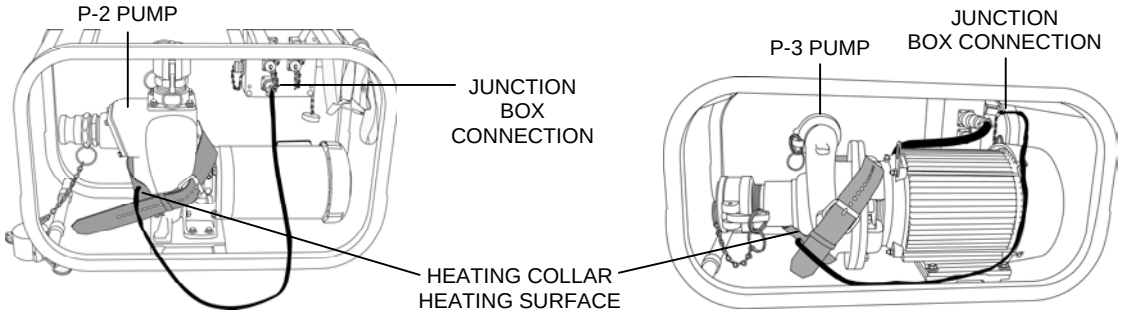

Figure 15. P-2 and P-3 Pump Heating Collar Installation.

2. Install hose heating blankets as follows (see Figure 16):

NOTE
There are no hose heating blankets for the hoses on the OISS assembly.

a. Refer to Table 6 below for a listing of the hoses that get heating blankets and the pump skid junction box to which each heating blanket power cable is connected.
b. Roll out the hose heating blanket and place the outside surface down next to the hose.
c. Lift the hose and slide the heating blanket under the hose.
d. Wrap the heating blanket around the hose and secure with the hook and loop strips.
e. When two or more heating blankets are used on hose combinations, join the blankets at the seams so that they overlap the hose couplings.
f. The straps that are removed from the rolled up blankets can be strapped around the installed blankets at the ends.
g. Heating blankets must be positioned over the couplings at the end of the hose.

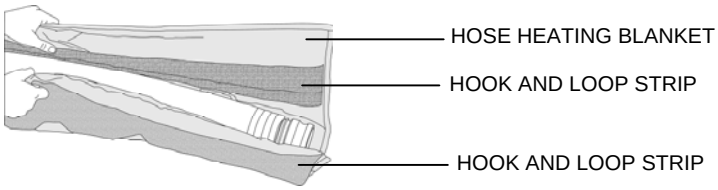

Figure 16. Hose Heating Blanket Installation.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

h. Clean the connectors and connect the hose heating blanket power cables to the hose heater terminals on the pump skid junction boxes as identified in Table 6 Figure 17 for the P-1 to P-2 raw water system configuration and Table 7 Figure 18 for the P-2 only configuration. Do NOT connect the pump skid power cables to the TWPS PDP (power distribution panel) at this time.
i. If the Diesel-Driven Pump P-1 is used, the heating blanket power cables will be connected to the P-1 junction box later.

NOTE
Lay out the hose blankets connecting to the Diesel-Driven Pump P-1 (if to be used) using the location marker as a guide. The P-1 pump will be deployed and the installation will be completed just before establishing raw water flow.

Table 6. Heating Blanket Installation List for P-1 to P-2 Raw Water Configuration.

Hose / Adaptor	Heating Blanket	Connect To
First raw water suction hose	3 in. x 5 ft.blanket F01-1, short cable	F01-2
Second raw water suction hose	3 in. x 11 ft.blanket F01-2, long cable	P-1
Adaptor A-02	A-02	P-1
First raw water discharge hose	One 2 in. x 50½ ft. blanket F03-1, long cable	A-02
Second raw water discharge hose	One 2 in. x 50½ ft. blanket F03-2, short cable	P-2
Third raw water discharge hose	One 2 in. x 50½ ft. blanket F03-2, short cable	P-2
Fourth raw water discharge hose	One 2 in. x 50½ ft. blanket F03-2, short cable	F-12
A-05 and raw water suction hose	One 2 in. x 9 ft.blanket, F12	P-3
MF Pump discharge hoses	One 3 in. x 21 ft.blanket, F07	P-3

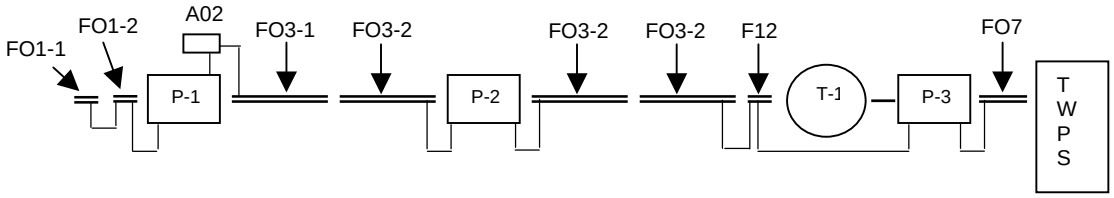

Figure 17. Heating Blanket Power Cable Connection Diagram for P-1 to P-2 Configuration.

Table 7. Heating Blanket Installation List for P-2 Only Raw Water Configuration.

Hose / Adaptor	Heating Blanket	Connect to
First raw water suction hose	3 in. x 5 ft.blanket F01-1, short cable	F01-2
Second raw water suction hose	3 in. x 11 ft.blanket F01-2, long cable	P-2
Adaptor A-02	A-02	P-2
First raw water discharge hose	One 2 in. x 50½ ft. blanket F03-1, long cable	A-02
Second raw water discharge hose	One 2 in. x 50½ ft. blanket F03-2, short cable	F12
A-05 and raw water suction hose	One 2 in. x 9 ft.blanket, F12	P-3
MF Pump discharge hoses	One 3 in. x 21 ft.blanket, F07	P-3

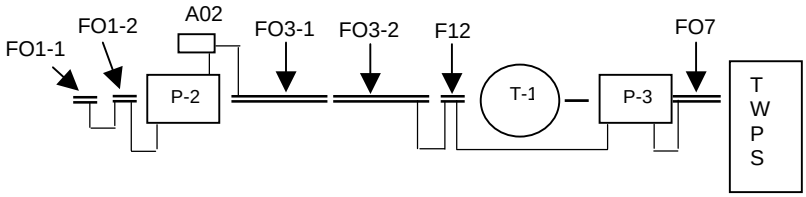

Figure 18. Heating Blanket Power Cable Connection Diagram for P-2 Only Configuration.

3. Install the Adaptor A-02 heating blanket and collar as follows:
   a. Position the Adaptor A-02 heating blanket as shown in Figure 19.
   b. Partially close the lower flap, slide the blanket down and fit the hole in the blanket over the Adaptor A-02 valve handle.
   c. Wrap the blanket flaps around the adaptor and secure with the hook and loop straps.
   d. Wrap the Adaptor A-02 collar around the adaptor discharge.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

   e. Clean the connectors and connect one adaptor heating blanket power cable to the FO3-1 hose blanket power cord connecter. Connect the other adaptor power cable to a hose heater terminal on the pump skid junction box (junction box for P-1 if used; P-2 if P-1 is not used). Do NOT connect the pump skid power cable to the TWPS PDP (power distribution panel) at this time.

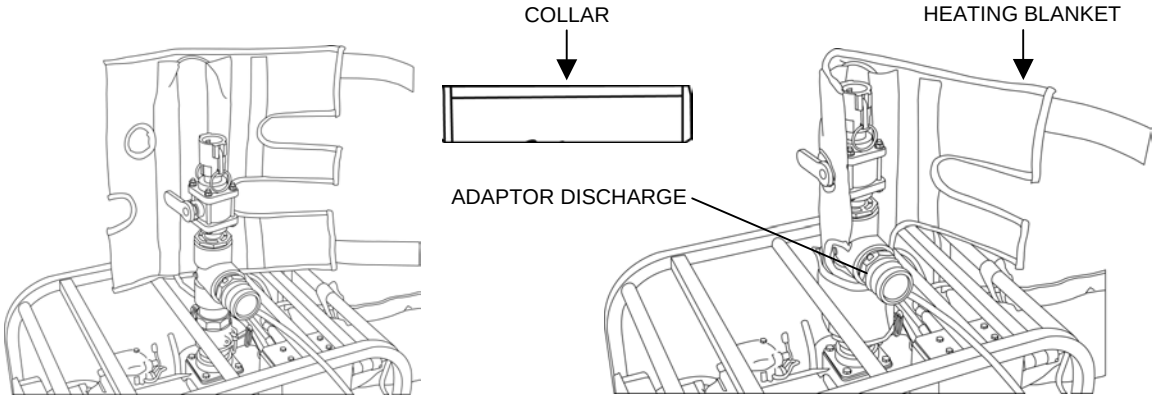

Figure 19. Adaptor A-02 Heating Blanket and Collar Installation.

4. Set out the pump power cables by pump P-2 and P-3. Set out the heat blanket power cable for pump P-1 if used. Connect the cables at the pump junction boxes (P-2 and P-3 only at this time).

WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. Do NOT connect the electrical power cables to the PDP at this time. Failure to observe this warning may result in serious injury or death from electrocution.

5. Install pump skid insulating covers on pump skids P-1 (if used), P-2, and P-3 as follows (see Figure 20):
    a. If the P-1 pump is used, perform P-1 pump PMCS in accordance with WP 0038.
    b. For Diesel-Driven Pump Skid P-1, install the corrugated exhaust hose on the muffler exhaust.
    c. Place the cover over the pump skid.
    d. For P-2 and P-3 pumps, run the power cable out around the cover at the bottom
    e. Secure the buckle to draw the bottom tight around the skid.
    f. Attach the hook and loop strips on the flaps at the hose inlet and outlet.

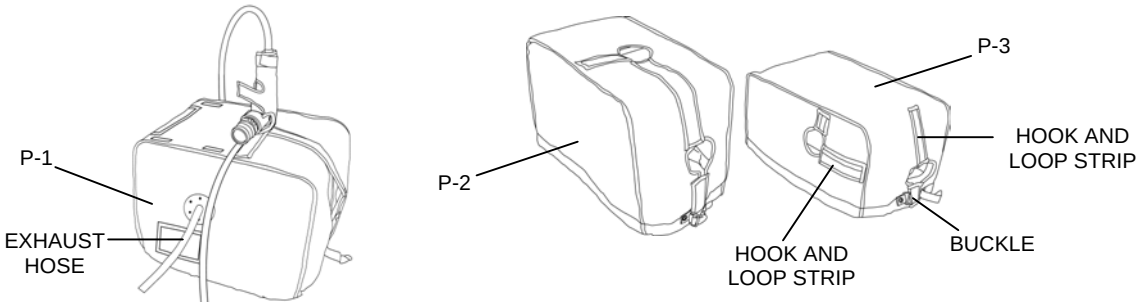

Figure 20. Pump Skid Insulating Cover Installation.

WASTE OUTLET CONNECTIONS

Install the waste outlet connection as follows (see Figure 21):

1. Collect the following adaptor and hoses.
    a. One 4 in. x 5 ft., red-banded suction hose.
    b. Waste out Adaptor A-09.
    c. One 6 in. x 50 ft., red-banded discharge hose.
2. Connect the hoses and adaptor as follows:

WARNING

Under certain conditions, air may be pushed out of the waste hose causing the end to whip. Do not make any waste hose connections while the TWPS is operating. Stand clear of the waste hose end by at least 20 ft. while the TWPS is operating. Failure to observe this warning may result in serious injury.

    a. Insert the 4 in. x 5 ft., red-banded suction hose through the sleeve in the winter cover or fabric wall and connect it to the waste outlet at the TWPS.
    b. Connect Adaptor A-09 to the end of the 4 x 5, red-banded suction hose.
    c. Connect the 6 in. x 50 ft., red-banded discharge hose to the other end of Adaptor A-09.
    d. Place the other end of the waste hose so that it discharges at least 50 ft. downstream from the raw water inlet. Remove any sharp kinks or bends in the hose.

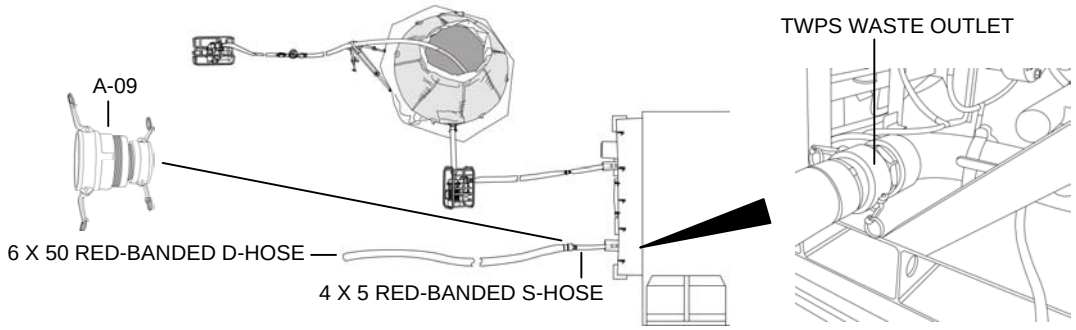

Figure 21. Waste Outlet Connection.

MAKING POWER CABLE CONNECTIONS TO THE TWPS

1. Uncoil the electrical power cables for the P-2 and P-3 pumps. (The P-1 heater power cable is uncoiled later, if the P-1 pump is used.)

WARNING

Electrical hazard. The TWPS operates on 416 Volts AC. Making electrical connections to the TWPS power distribution panel must be coordinated with the procedures for establishing electrical power to the TWPS. Do NOT connect the electrical power cables to the PDP at this time. Failure to observe this warning may result in serious injury or death from electrocution.

2. For the MC-TWPS, insert all pump power cables that are to be used through the sleeve in the winter cover at the PDP. Do NOT connect the power cables at this time.
3. For the A-TWPS, insert the power cables through the PDP access opening cover, insert the cover into the access opening and pull it flush with the flat rack panel. Do NOT connect the power cables at this time.
4. Allow the power cable ends inside the TWPS enclosure to warm for 20-30 minutes.

WARNING

Potential electrical hazard. Notify all crew members that you are ready to make pump power connections to the PDP. Do NOT connect the power cables until all personnel have been notified. Failure to observe this warning may result in injury or death due to electrocution.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

5. Connect the Motor-Driven Pump Skid P-2 and the MF Pump Skid P-3 electrical power cables to the PDP (power distribution panel) from the inside of the TWPS as described below (see Figure 22). The Diesel-Driven Pump Skid P-1 heater cable will be connected later using the same procedures.

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. FIRST connect the pump skid power cables to the pump skid junction box. NEXT, make sure the Main Breaker on the PDP is switched to OFF. LAST, connect the pump skid power cables to the PDP (power distribution panel) power outlet. Failure to observe this warning may result in serious injury or death from electrocution.

   a. The crew member who is establishing electrical power to the TWPS should make the cable connections from the pumps to the PDP. Do NOT continue with these procedures until all crew members are notified.
   b. FIRST, be sure the power cables have been connected to the pump skid junction boxes.
   c. Set the diesel heater switch to OFF.
   d. NEXT, switch the Main Breaker on the PDP to OFF.
   e. LAST, connect the power cables to their respective terminals on the PDP.

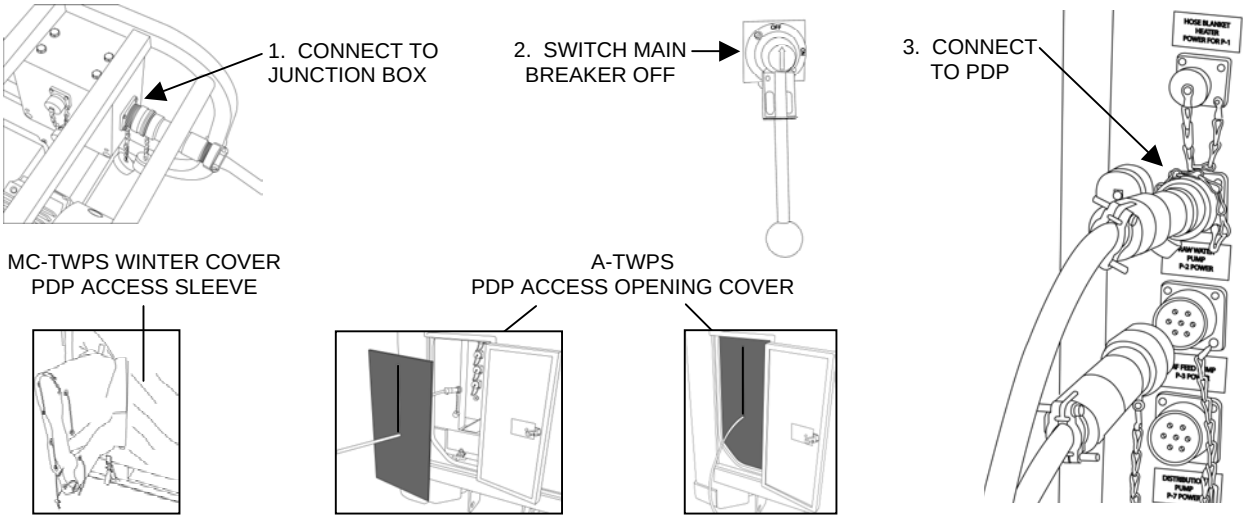

Figure 22. Making Pump Skid Power Cable Connections.

6. After making sure that all connections have been completed, switch the main breaker on the PDP back to the ON position.
7. Set the diesel heater switch back to the ON position and verify that it starts.
8. Set the Hose/Pump Heaters switch to ON.

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HEAT-UP AND OPERATING TEMPERATURE REQUIREMENTS

Allow the heater to run for at least one hour, or longer if needed to reach a temperature of at least 60 degrees Fahrenheit. A temperature gauge is attached to the frame between the HP pumps to measure ambient temperature in the TWPS (see Figure 23). Do not continue until the temperature is at least 60 degrees.

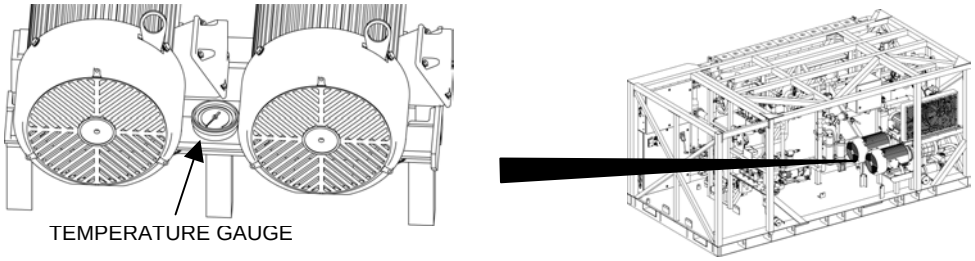

Figure 23. Temperature Gauge Between the High Pressure Pumps.

AIR COMPRESSOR START-UP

CAUTION

Do not start the compressor before the ambient temperature has reached at least 60 degrees. If not heated, the compressor oil will be too thick for safe operation. Failure to observe this caution could result in damage to the compressor.

As soon as the TWPS has been heated to the minimum temperature for startup, it is recommended that the air compressor be started up. A minimum air pressure is required for the automatic backwash operation before the TWPS can be operated. Starting the compressor as early as possible during set up allows the compressor to pressurize the air supply tank (in about 30 minutes) while other set up steps are performed.

After reaching 60 degrees Fahrenheit, check the air compressor oil. If it seems normal (and not syrupy), start the air compressor as described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained. If the air compressor belt slips or screeches, stop the compressor and wait another 30 minutes for the compressor oil to warm further. If the oil is syrupy when checked, wait 30 minutes and check again.

STANDARD DISTRIBUTION SET-UP

NOTE

All of the distribution hoses and adaptors are provided with caps or plugs for the couplings to keep the inside of the hoses and adaptors clean. The caps and plugs are not chained. They are to be removed and placed into Storage Box #3.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0009 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
COLD WEATHER SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

Deploy the standard distribution system equipment as follows (see Figure 24):

WARNING

Two person lift. Two people are required to safely lift the product water distribution water tanks and Motor-Driven Product Water Distribution Pump P-7. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

1. Position the Product Water Distribution Tanks T-3 and T-4 and the product water Distribution Pump P-7 as follows:
    a. Place the distribution tanks in their rough locations, making sure that the first tank is within 40 ft. of the TWPS product water outlet.
    b. Unfold the ground cloth from around each tank and unfold each tank on its ground cloth.
    c. Spread the tanks out to their final shape and eliminate any ridges in the bottoms.
    d. Position the tanks about 6 ft. apart with the connections facing each other.
    e. Pull the tank inlet and outlet connections out away from the tank bottoms so that they will be clear when the tanks are filled.
    f. Place a pump insulating platform on the ground where the motor-driven Distribution Pump P-7 is to be located.
    g. Move motor driven product water Distribution Pump Skid P-7 roughly in place on top of the insulating platform.

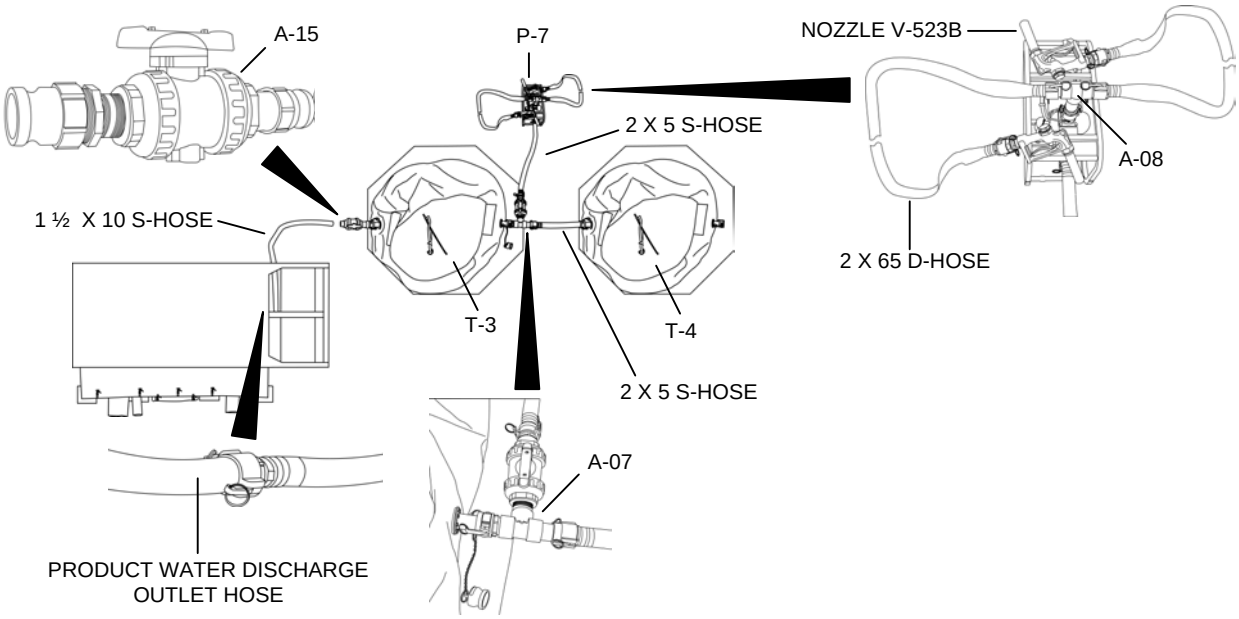

Figure 24. Product Water Distribution System Equipment Deployment.

2. Connect the hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

a. Collect the following adaptors, hoses, and dispensing nozzles:
   1) Four 1½ in. x 10 ft., blue-banded product water suction hoses.
   2) Adaptor A-15.
   3) Tee Adaptor A-07.
   4) One 2 in. x 5 ft., blue-banded product water suction hose with male couplings at each end.
   5) One 2 in. x 5 ft., blue-banded product water suction hose with female couplings at each end.
   6) Pump outlet tee Adaptor A-08.
   7) Two 2 in. x 65 ft., blue-banded product water distribution discharge hoses.
   8) Two Dispensing Nozzles V-523A and V-523B.

b. Inspect the gaskets in the female ends of the hoses and adaptors. Replace any damaged or missing gaskets.

c. Connect the four 1½ in. x 10 ft., blue-banded product water suction hoses to each other.

d. (A-TWPS only) Remove the product water door shipping cover, pull the product water hose and RO element drain tubes through the opening in the flat rack panel, and install the product water door access cover (see Figure 25).

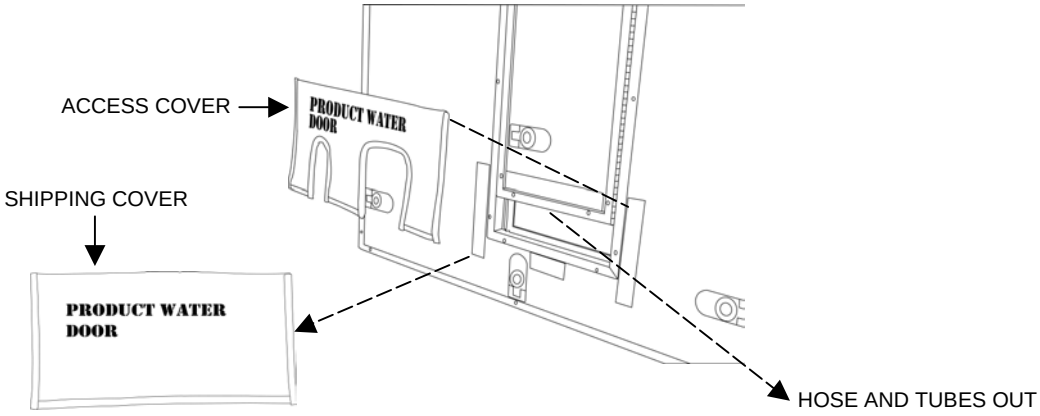

Figure 25. A-TWPS Product Water Door Access Cover Installation.

e. Connect one end of the assembled 1½ in. x 10 ft., blue-banded product water suction hoses to the product water discharge outlet hose at the TWPS.

f. Connect Adaptor A-15 to an outside inlet (not an inlet between the tanks) of the product water distribution tank closest to the TWPS product water outlet.

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Health hazard. Do not connect the product water hose to Adaptor A-15 at the product water distribution tank at this time. Initial product water from the TWPS will not pure enough to use. Do not discharge product water into the tanks until after clean product water flow is established. Failure to observe this warning could cause contamination of the product water.

g. Connect the male end of the straight section of Adaptor A-07 directly to the female outlet of one of the distribution tanks.
h. Connect the male-male 2 in. x 5 ft., blue-banded product water suction hose to the other end of the straight section of Adaptor A-07.
i. Connect the other end of the 2 in. x 5 ft. hose to the outlet of the other distribution tank.
j. Connect the female-female 2 in. x 5 ft., blue-banded suction hose to the remaining Adaptor A-07 connection and to the suction inlet of Product Water Distribution Pump P-7. Move the pump as needed to connect the hose.
k. Connect the pump outlet tee adaptor A-08 to the discharge outlet of the product water distribution pump.
l. Connect one 2 in. x 65 ft., blue-banded product water distribution hose to each end of the straight section of pump Adaptor A-08. (Note: A 5/8-in. x 50 ft. auxiliary hose and Valve V-522 may be connected in place of a distribution hose if desired.)
m. Connect a dispensing nozzle to the end of both product water distribution hoses.
n. Lay the dispensing nozzles on top of the pump frame. Do not leave them on the ground.

WARNING

Electrical hazard. The pump heating collar and hose heating blankets operate on 220 VAC. Install the heating collar and blankets and connect their power cables to the appropriate pump skid junction boxes only. Do NOT connect the pump skid power cable to the TWPS PDP (power distribution panel) at this time. Failure to observe this warning may result in serious injury or death from electrocution.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

3. Install a pump heating collar on Motor-Driven Product Water Distribution Pump P-7 as follows:
   a. Wrap the heating collar around the pump case and secure with its strap as shown in Figure 15. Make sure the collar is positioned away from the sides of the pump insulating cover so that the collar will not come in contact with the cover when the cover is installed.

b. Clean the connectors and connect the pump heating collar power cable to the pump heater terminal on its pump skid junction box. Do NOT connect the pump skid power cable to the TWPS PDP (power distribution panel) at this time.

4. Install hose heating blankets as follows:
   a. Refer to Table 8 below for a listing of the hoses that get heating blankets and the pump skid junction box to which each heating blanket power cable is connected.
   b. Roll out the hose heating blanket and place the outside surface down next to the hose.
   c. Lift the hose and slide the heating blanket under the hose.
   d. Wrap the heating blanket around the hose and secure with the hook and loop strips.
   e. When using two or more blankets on multiple hoses, join the blankets at the seams.
   f. The straps that were removed from the rolled up blankets can be strapped around the installed blankets at the ends.
   g. Heating blankets must be positioned over the couplings at the end of the hose.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

5. Clean the connectors and connect the hose heating blanket power cables to the hose heater terminals on the pump skid junction box as identified in Table 8 and as shown in Figure 26. Do NOT connect the pump skid power cables to the TWPS PDP (power distribution panel) at this time.

Table 8. Product Water Distribution Hose Heating Blanket Installation and Connection List.

Hose	Heating Blanket	Connect To
Four 10 ft. product water suction hoses P02	One 1½ in. x 41½ ft. blanket P02	P-7
5 ft. product water suction hose P03	2 in. x 6 ft. blanket P03-1, long cable	P-7
5 ft. product water suction hose P04	2 in. x 7.1 ft. blanket P04, short cable	P-7
Two 65 ft. product water discharge hoses P05	Two 2 in. x 65.5 ft. blankets P05	P-7

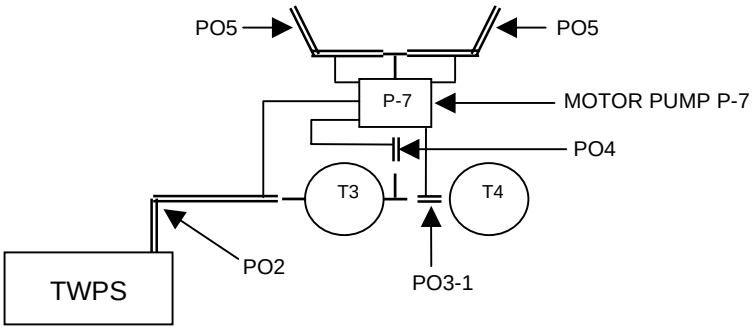

Figure 26. Product Water Distribution Hose Heating Blanket Power Cable Connection Diagram.

6. Install a pump skid insulating cover on Pump Skid P-7 as follows (see Figure 27):
   a. Unfasten the hook and loop strips on the pump cover.
   b. Place the cover over the pump skid.
   c. Secure the buckle and pull the strap tight at the base of the pump skid.
   d. Secure the hook and loop strips on the flap at the hose inlet and outlet.

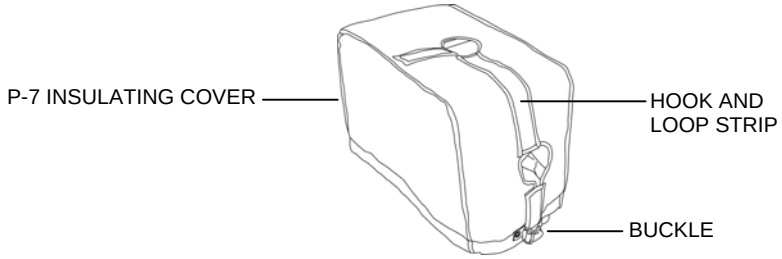

Figure 27. Distribution Pump Skid P-7 Insulating Cover Installation.

7. Connect the Motor-Driven Product Water Distribution Pump P-7 electrical power cable as follows:

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. Make sure all TWPS equipment is shut off and the main circuit breaker lever on the front of the Power Distribution Panel (PDP) is set to OFF. Connect the power cable to the P-7 pump skid before connecting it to the PDP power outlet. Failure to observe this warning may result in serious injury or death from electrocution.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

   a. At the OCP (operating control panel) switch off the air compressor
   b. Set the diesel heater switch to OFF.
   c. Set the Main Circuit Breaker (lever on the front of the Power Distribution Panel) to OFF.
   d. Uncoil the electrical power cable for the Motor-Driven Distribution Pump P-7.
   e. Be sure the power cable has been connected to the P-7 Skid Junction Box.
   f. Clean the connectors and connect the power cable to the P-7 Power Source Connector at the PDP.
   g. Set the Main Circuit Breaker (lever on the front of the Power Distribution Panel) to ON.
   h. Switch the Air Compressor to Auto.
   i. Switch the diesel fueled heater switch to ON. Check to be sure it starts.
   j. Set the Pump/Hose Heaters switch to ON.

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RAW WATER INTAKE DEPLOYMENT

The OISS may be used for raw water intake whenever the beach conditions are suitable. The floating inlet strainer should only be used when the raw water source is free of ice, or the ice is thin and the strainer can be pulled below the water surface. The ice hole strainer should be used if the raw water source is iced over and will safely support a person and the OISS is not used.

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

NOTE

If the OISS is to be used, refer to WP 0008, OISS Set-Up, for the procedures for installing the OISS.

If the raw water source is not frozen and the floating inlet strainer is used, refer to WP 0007, Set-Up - Operation Under Usual Conditions, for the procedures for installing the floating inlet strainer and anchor. Use the anchor rope to pull the strainer below the surface of the water.

If the ice hole strainer is to be used, deploy it as follows (see Figure 28):

WARNING

The blade of the ice auger is very sharp. Keep the blade cover on except when using the auger. Avoid touching the blade. Failure to observe this warning may result in severe injury.

NOTE

When selecting the location to open an ice hole, keep in mind that it is best to limit the hose that will be exposed out of water to two 10 ft. lengths. Also, deeper water will allow access to water that is above freezing.

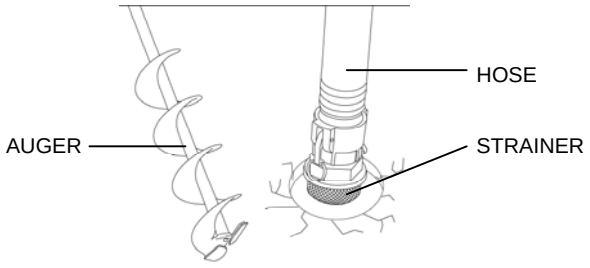

Figure 28. Ice Intake Strainer Deployment.

1. Use the ice auger to open a hole in the ice where the water is at least 5 ft. deep. Deeper is preferred.

2. Attach the ice intake strainer to a hose section.
3. Push the strainer and hose through the ice hole to a depth of 2 ft. from the bottom in shallow water less than 20 ft. deep, or 20 ft. if deeper. This helps provide water that is above freezing.
4. Connect the number of 10 ft. long suction hoses to each other that will be required to connect the ice intake strainer to Adaptor A-01 at the suction of the raw water pump. No more than two hoses should be out of the water. If the ice is stable, the pump may be set out on the ice.

COMPLETING P-1 PUMP SETUP (IF IN USE) AND ESTABLISHING RAW WATER FLOW

Do not establish raw water flow until the distribution system has been set up and you are ready to complete the startup. In cold weather operation, it is important to keep water moving to avoid freezing.

Procedures for establishing raw water flow are described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained. If Diesel-Driven Raw Water Pump P-1 is to be used, it must first be warmed for at least an hour inside of the TWPS to avoid freezing of the water when introduced into the pump. Above 0 degrees Fahrenheit, the diesel may be moved to it's location and started normally if it is started quickly after moving from the heated TWPS. Below 0 degrees Fahrenheit, it will probably require use of the electric start procedure as described in steps 1 and 2 below.

1. Ready the P-1 pump as follows:

CAUTION

When adding fuel to the tank, be careful not to push the screen filter into the tank.

   a. With the fuel tank removed from the diesel-engine skid and setting outside of the TWPS, add fuel as needed.
   b. Take the 24-volt diesel engine starting cable out of the diesel generator battery storage compartment (A-TWPS only).
   c. Lay out, but **DO NOT CONNECT** the 24-volt diesel-engine starting cable from the diesel generator 24-volt slave outlet to where the diesel engine-driven pump is to be placed.
   d. Place the pump insulating platform on the ground near the diesel generator 24-volt slave outlet.

WARNING

Three person lift. Three people are required to lift Diesel-Driven Raw Water Pump P-1. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   e. Open the flap at one end of the top of the insulating cover and the hook and loop seam at the other end and grab the frame in three places to lift the P-1 pump skid.
   f. Move the P-1 pump off of the TWPS skid to the pump insulating platform.

g. Set the fuel tank in place on top of the P-1 skid outside of the pump insulating cover (see Figure 29). Complete the fuel hose connections through the opening in the cover (red-banded supply hoses together and yellow-banded return hoses together).

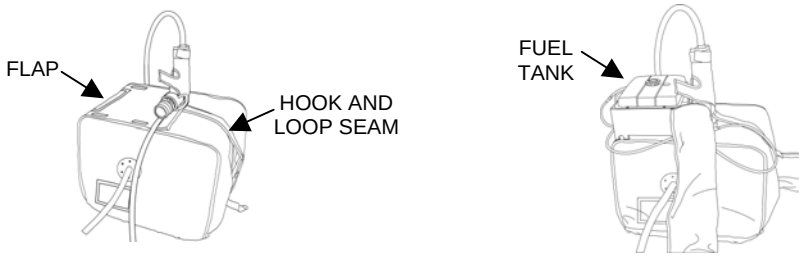

Figure 29. P-1 Fuel Tank Installation.

h. Immediately connect the 24-volt cable first to the diesel-driven pump (see Figure 30).
i. Connect the 24-volt cable to the diesel generator 24-volt slave outlet (see Figure 30).

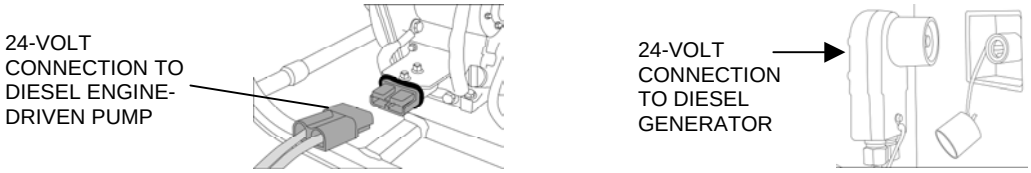

Figure 30. 24-Volt Cable Connection to the Diesel Engine-Driven Pump Skid.

j. Be sure that the plug is in the pump inlet coupling.
k. Be sure the pump drain valve is closed.
l. Open the Adaptor A-02 Vent Valve V-102 and pour the water from the priming pitcher into the pump. Close Vent Valve V-102.

2. Immediately start the diesel engine as follows:
   a. Open the fuel cock at the bottom of the tank. (The lever points down when open.)
   b. Set the engine speed lever to start.
   c. Toggle the start switch (on the pump skid junction box) up and hold until the engine starts. If it does not start after 10 seconds, wait for about 15 seconds and try again. If the engine does not start after four tries, warm the engine for another hour before trying to start it again.
   d. Set the speed back to idle.
   e. Disconnect the 24-volt cable first from the diesel generator 24-volt slave outlet.
   f. Then disconnect the 24-volt cable from the diesel-driven pump.
3. Set up the P-1 pump at its final location as follows:'
   a. Move the pump off of the pump insulating platform
   b. Move the insulating platform to the final pump location close to the raw water source.
   c. Lay an absorbent pad on the platform to absorb any oil or fuel spills.

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Three person lift. Three people are required to lift Diesel-Driven Distribution Pump P-8. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

d. With the engine running at idle, move the pump into place onto the insulating platform.
e. Attach Adaptor A-01 to the suction inlet of the motor-driven pump. Position the bolt on the adaptor's check valve in the vertical position. Wrap the strap around the pump frame and buckle the strap. Secure firmly to support the adaptor and hose and prevent air from entering the pump suction.
f. Connect the raw water suction hose to the adaptor.
g. Make sure that the suction hose heat blanket extends over the exposed surfaces of Adaptor A-01.

4. Connect the heating blanket power cables as follows:
   a. Clean the connectors and connect the suction hose heat blanket cables to the pump junction box (see Figure 17).
   b. Be sure the unconnected Adaptor A-02 cable extends out over the top of the pump cover.
   c. Connect the P-1 skid power cable to the pump junction box. (Feed the cable in under the pump insulating cover at the front.)
5. Attach the hook and loop strips on the pump insulating cover flaps and pull the bottom belt tight.
6. Connect the raw water discharge hose to Adaptor A-02.
7. Make sure that the discharge hose heating blanket extends over the exposed surfaces of the hose couplings. Clean the connectors and connect the hose heating blanket cable to the Adaptor A-02 cable.
8. If the ice intake strainer is used, push the strainer and hose through the ice hole to a depth of 2 ft. from the bottom in shallow water (less than 20 ft. deep) or to a depth of 20 ft. if the water is deeper. This helps provide water that is above freezing.

WARNING

Potential electrical hazard to other personnel. Another person is establishing electrical power at the TWPS. Let that other person know that you are ready to make pump power connections to the PDP. Do NOT connect pump power cables to the PDP until the person who is establishing electrical power tells you that the TWPS is ready for the connections to be made. Failure to observe this warning may result in injury or death due to electrocution.

Electrical hazard. The TWPS operates on 416 volts AC. FIRST connect the pump skid power cable to the pump skid junction box. NEXT, make sure the Main Breaker on the PDP is switched to OFF. LAST, connect the pump skid power cables to the PDP (power distribution panel) power outlet. Failure to observe this warning may result in serious injury or death from electrocution.

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CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

9. Clean the connectors then connect the P-1 pump skid power cable to the TWPS PDP as follows:
    a. Set the diesel heater switch to OFF.
    b. FIRST make sure the P-1 pump skid power cable is securely connected to the P-1 skid junction box.
    c. NEXT, switch the Main Breaker on the PDP to OFF.
    d. LAST, connect the power cable to its power source connector terminal at the PDP.
    e. After making sure that all connections have been completed, switch the Main Breaker on the PDP back to the ON position.
10. Set the diesel heater switch back to the ON position and verify that the heater starts.
11. Set the Hose/Pump Heaters switch to ON.
12. Leave the engine running at idle and continue with the procedures for establishing raw water flow in WP 0014.

PRE-OPERATIONAL CHECKS

Before starting the TWPS to begin producing potable water, perform the following checks:
1. Check all hose couplings and verify that the camlock connectors are locked in place.
2. Check that the ground rod has been installed and the ground connections are tight at both ends.
3. Check that all raw water, MF feed pump, and product water distribution pump power cables are properly connected.

NOTE

For the most efficient use of time, it is recommended that you proceed to WP 0013 for pre-operational diagnostic self-tests and then the appropriate start-up procedures WP before performing the Extended Distribution Set-Up procedures below. You will be instructed to return to this procedure after performing the electrical pre-operational procedures and the appropriate start-up procedures.

EXTENDED DISTRIBUTION SYSTEM SET-UP (A-TWPS)

NOTE

Warm Diesel-Driven Distribution Pump P-8 inside the TWPS before starting. It is recommended that the extended distribution system not be deployed unless absolutely needed.

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Deploy the extended product water distribution system equipment as follows (see Figure 31):

WARNING

Two person lift. Two people are required to safely lift the product water distribution water tanks. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Three person lift. Three people are required to lift Diesel-Driven Distribution Pump P-8. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

1. Position Extended Product Water Distribution Tanks T-5, T-6, and T-7 as follows:
   a. Place the distribution tanks in their rough locations. Make sure Tank T-7 is positioned close enough for Hose P02 and its heating blanket power cable to reach the T-7 Tank inlet (see Figure 32).
   b. Unfold the ground cloth from around each tank and unfold each tank on its ground cloth.
   c. Spread the tanks out to their final shape and eliminate any ridges in the bottoms. Position the tanks about 6-ft. apart with the connections facing each other.
   d. Pull the tank inlet and outlet connections out away from the tank bottoms so that they will be clear when the tanks are filled.
   e. Diesel-Driven Distribution Pump P-8 should be kept warm inside the heated TWPS enclosure until ready to start and deploy. If it was not, it must be moved inside and warmed for at least an hour to avoid freezing of water when introduced into the pump.

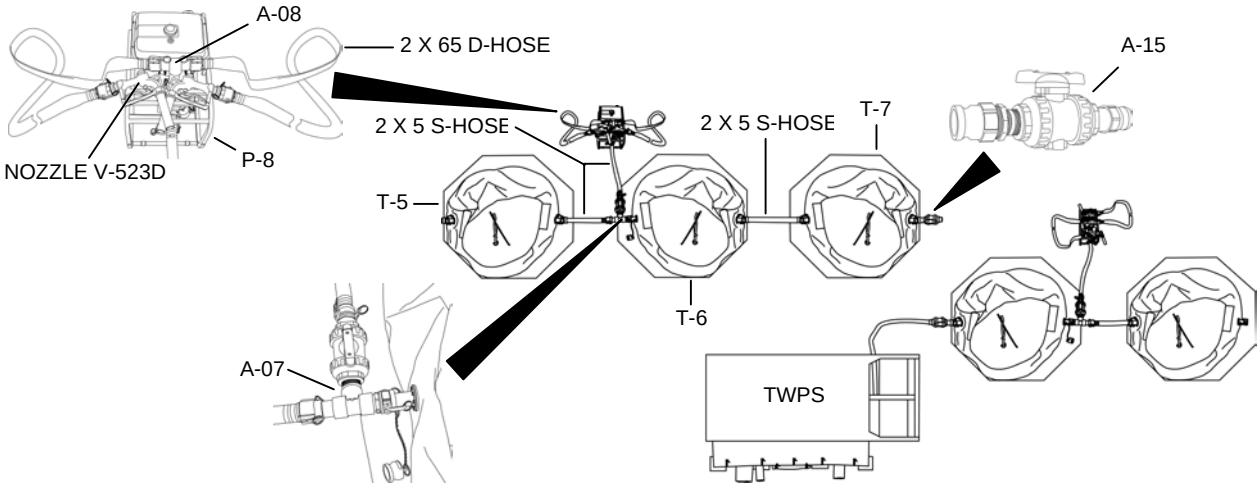

Figure 31. Extended Product Water Distribution System Equipment Deployment.

2. Connect the hoses as follows:

WARNING

Health hazard. Do not attempt to use product water hoses to handle raw water or raw water hoses to handle product water. When installed with the proper adaptors as directed, the hoses cannot be interchanged. Failure to observe this warning and mixing hoses could cause contamination of water resulting in serious illness.

   a. Collect the following adaptors, hoses, and dispensing nozzles:
      1) Adaptor A-15.
      2) Tee Adaptor A-07.
      3) Two 2 in. x 5 ft., blue-banded product water suction hoses with male couplings at both ends.
      4) One 2 in. x 5 ft., blue-banded product water suction hose with female couplings at both ends.
      5) Pump outlet tee Adaptor A-08.
      6) Two 2 in. x 65 ft., blue-banded product water distribution discharge hoses.
      7) Two Dispensing Nozzles V-523C and V-523D.
   b. Inspect the gaskets in the female ends of the hoses and adaptors. Replace any damaged or missing gaskets.
   c. Connect Adaptor A-15 to the inlet of one of the product water distribution tanks.
   d. Connect the male end of the straight section of Adaptor A-07 directly to the female outlet of one of the extended distribution tanks.
   e. Connect one of the male-male 2 in. x 5 ft., blue-banded product water suction hoses to the other end of the straight section of Adaptor A-07.
   f. Connect the other end of the 5 ft. suction hose to the outlet of the other distribution tank.
   g. Connect the female-female 5 ft., blue-banded suction hose to the remaining Adaptor A-07 connection and to the suction inlet of Product Water Distribution Pump P-8.
   h. Connect the second male-male 5 ft., blue-banded suction hose from the middle tank to the third tank.
   i. Layout the two 2 in. x 65 ft., blue-banded product water distribution discharge hoses at the general location where the P-8 pump will be set.
3. Install the hose heating blankets as follows (see Figure 16 for blanket installation drawing):
   a. Refer to Table 9 below for a listing of the hoses that get heating blankets. DO NOT attempt to connect any of the power cables at this time.
   b. Roll out the hose heating blanket and place the outside surface down next to the hose.
   c. Lift the hose and slide the heating blanket under the hose.
   d. Wrap the heating blanket around the hose and secure with the hook and loop strips.
   e. When two or more heating blankets are used on hose combinations, join the blankets at the seams.
   f. The straps that were removed from the rolled up blankets can be strapped around the installed blankets at the ends.
   g. Heating blankets must be positioned over the couplings at the end of the hose.
4. Lay out the hose heating blanket power cables to the spot where Diesel-Driven P-8 Pump Skid will be placed. The heating blanket power cables will be connected to the P-8 junction box later after the pump is brought out off the TWPS, started, and deployed in its proper location.

Table 9. Extended Distribution Hose Heating Blanket Installation and Connection List.

Hose	Heating Blanket	Connect to Pump Skid Junction Box
One 5 ft. product water suction hose P03	2 in. x 6 ft. blankets P03-1, long cable	P-8
One 5 ft. product water suction hose P03	2 in. x 6 ft. blankets P03-2 longest cable	P-8
One 5 ft. product water suction hose P04	2 in. x 7.1 ft. blankets P04, short cable	P-8
Two 65-ft product water discharge hoses P05	Two 2 in. x 65.5 ft blankets P05	P-8

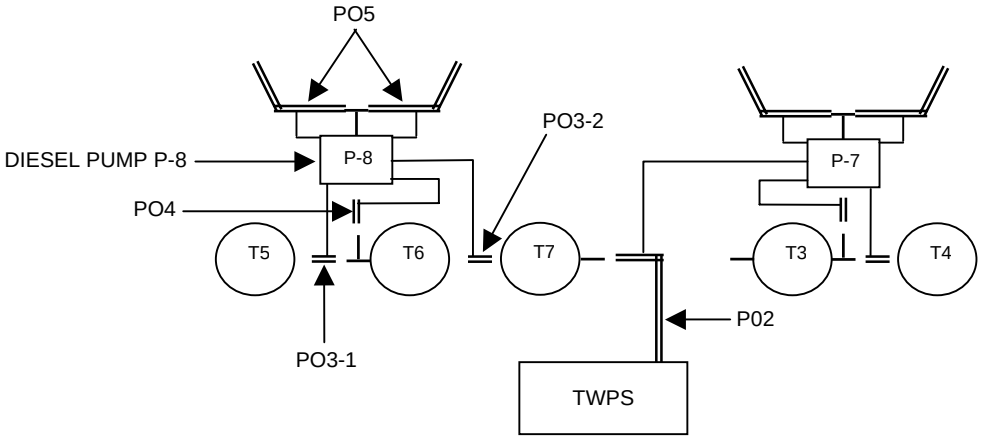

Figure 32. Extended Distribution Hose Heating Blanket Power Cable Connection Diagram.

5. Install a pump skid insulating cover on Pump Skid P-8 as follows (see Figure 33):
   a. Install the corrugated exhaust hose on the diesel engine muffler exhaust.
   b. Place the cover over the pump skid.
   c. Secure the buckle to draw the bottom tight around the skid.
   d. Secure the hook and loop seams at the hose inlet and outlet.

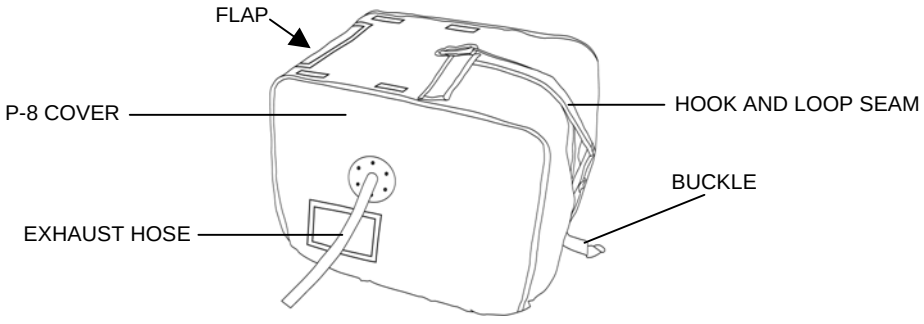

Figure 33. P-8 Pump Skid Insulating Cover Installation.

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NOTE

Do not deploy the Diesel-Engine Driven Pump P-8 until you are ready to begin filling the extended distribution tanks.

6. Ready Diesel-Driven Distribution Pump P-8.

CAUTION

When adding fuel to the tank, be careful not to push the screen filter into the tank.

   a. With the fuel tank removed from the diesel-engine skid and setting outside of the TWPS, add fuel as needed.
   b. Take the 24-volt diesel engine starting cable out of the diesel generator battery storage compartment (A-TPWS only)
   c. Lay out but **DO NOT CONNECT** the 24-volt diesel-engine starting cable from the diesel generator 24-volt slave outlet to where the diesel engine-driven pump is to be placed.
   d. Place the pump insulating platform on the ground near the diesel generator 24-volt slave outlet.

WARNING

Three person lift. Three people are required to lift Diesel-Driven Distribution Pump P-8. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   e. Open the flap at one end of the top of the insulating cover and the hook and loop seam at the other end and grab the frame in three places to lift the P-8 pump skid.
   f. Move the P-8 pump off of the TWPS skid to the pump insulating platform.
   g. Set the fuel tank in place on top of the P-8 skid outside of the pump insulating cover. Complete the fuel hose connections through the opening in the cover (red-banded supply hoses together and yellow-banded return hoses together).
   h. Immediately connect the 24-volt cable first to the diesel-driven pump (see Figure 30.)
   i. Connect the 24-volt cable to the diesel generator 24-volt slave outlet (see Figure 30.)
   j. Be sure the pump drain valve is closed.
   k. Be sure that the pump inlet connection is capped.
   l. Fill the pump with product water through the outlet connection, then cap the pump outlet.
7. Immediately start the diesel engine as follows:
   a. Open the fuel cock at the bottom of the tank. (The lever points down when open.)
   b. Set the engine speed lever to start.
   c. Toggle the start switch up (on the pump skid junction box) and hold until the engine starts. If it does not start after10 seconds, wait for about 15 seconds and try again.
   d. Set the speed back to idle.
   e. Disconnect the 24-volt cable first from the diesel generator 24-volt slave outlet.
   f. Then disconnect the 24-volt cable from the diesel-driven pump.
8. Set up the P-8 pump at its final location as follows:
   a. Move the pump off of the pump insulating platform.
   b. Move the insulating platform to the final pump location.
   c. Lay an absorbent pad on the platform to adsorb any oil or fuel spills.

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COLD WEATHER SET-UP – OPERATION UNDER UNUSUAL CONDITIONS

WARNING

Three person lift. Three people are required to lift Diesel-Driven Distribution Pump P-8. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

d. With the engine running at idle, move the pump into place on the insulating platform.

WARNING

Electrical hazard. The hose heating blankets operate on 208 VAC. Complete the installation of the blankets and connect their power cables to the P-8 pump skid junction box. Do NOT connect the P-8 pump skid power cable to the TWPS PDP (power distribution panel) at this time. Failure to observe this warning may result in serious injury or death from electrocution.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

9. Complete the hose and blanket installation (see Figure 32 for heating blanket installation and connection drawing).
    a. Connect the suction hose that extends from Adaptor A-07 to the pump inlet.
    b. Make sure that the suction hose heat blanket extends over the exposed couplings.
    c. Loosen the pump insulating cover and connect the suction hose heating blanket P04 cable to the P-8 pump junction box.
    d. Connect the P03-1 and P03-2 hose heating blanket power cables to the pump junction box.
    e. Connect the pump outlet tee Adaptor A-08 to the pump discharge.
    f. Connect the distribution hoses to Adaptor A-08. Pull the blankets over the couplings.
    g. Connect the two distribution hose blanket P05 power cables to the pump junction box.
    h. Connect the P-8 skid power cable to the P-8 skid junction box. (Feed the cable in under the pump insulating cover at the front.)
    i. Attach the hook and loop strips on the pump insulating cover flaps and pull the bottom belt tight.

10. Connect the Distribution Pump Skid P-8 power cable to the PDP as follows:

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. FIRST, make sure the P-8 pump skid power cable is connected to the pump skid junction box. NEXT, make sure all TWPS equipment is shut off and the Main Breaker on the PDP is switched to OFF. LAST, connect the power cable to the PDP power outlet. Failure to observe this warning may result in serious injury or death from electrocution.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

a. The TWPS will normally be in operation when the extended distribution system setup is completed. Be ready to complete the following steps within 10-minutes. Delay may result in freeze up.
b. Shut Down to Standby – Cold Weather (WP 0017).
c. Set the diesel heater switch to OFF.
d. Set the hose/pump heaters switch on the Operator Control Panel to OFF.
e. Set air compressor switch on the Operator Control Panel to OFF
f. Set the Main Breaker on the PDP to OFF.
g. Uncoil the junction box power cable for the Diesel Engine-Driven Distribution Pump P-8.
h. Be sure that the power cable is connected to the P-8 Skid Junction Box.
i. Connect the power cable to the P-8 Power Source connector at the PDP.
j. Set the Main Circuit Breaker (lever on the front of the Power Distribution Panel) to ON.
k. Set the hose/pump heaters switch to ON.
l. Set the air compressor switch to AUTO.
m. Set the diesel fueled heater switch to ON. Be sure that it starts.
n. Continue with Start up from Standby (WP 0015).

11. When Distribution Tanks T-3 and T-4 are filled, move the product water distribution hose from the standard distribution system tank to the extended distribution system tank as follows:
    a. Open the A-15 Adaptor valve on the extended distribution system tank.
    b. Disconnect the product hose from Adaptor A-15 at the standard distribution system tank, then close the valve on that adaptor.
    c. Connect the product hose to Adaptor A-15 on the extended distribution system tank.
    d. Leave the hose heating blanket P02 Power Cable connected to the Pump P-7 junction box when moving the hose to the extended distribution system tank.
12. The P-8 pump remains at idle until water is to be distributed from the extended distribution system.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0010 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OTHER SET-UPS - OPERATION UNDER UNUSUAL CONDITIONS

INITIAL SETUP:

Materials/Parts:
Teflon tape
Personnel Required
Three Operator/Crew
Equipment Condition
TWPS skid removed from transport vehicle and set on level ground.
Loose items unpacked (off-loaded) from the TWPS skid and placed in their general operational position.

GENERAL:

This work package contains the procedures to set up the TWPS for initial operation if the TWPS is deployed on a mission with any of the following unusual conditions:

- Chlorinated raw water source
- NBC decontamination mission
- Existing temperatures are above 90 degrees F or expected to go above 90 degrees F within the next 24 hours
- Sandy or dusty environment

Refer to WP 0009, Cold Weather Set-Up, if the existing outdoor temperature is below 32 degrees F or expected to be below 32 degrees F within the next 24 hours.

The procedures covered in this work package include:

- Sodium Bisulfite System Deployment
- Contamination Avoidance Cover (CAC) Deployment
- NBC System Deployment
- Hot Weather Condition Set-Up
- Sandy / Dusty Condition Set-Up

SODIUM BISULFITE SYSTEM DEPLOYMENT

CAUTION

Chlorinated water will rapidly destroy the fibers in the micro-filter elements and damage the membranes in the RO elements.

If the raw water source is chlorinated, the water must be treated to neutralize the chlorine before the raw water is discharged into the MF feed tank. The sodium bisulfite chemical injection system is used to inject sodium bisulfite in the raw water just before the raw water discharges into the MF feed tank. The sodium bisulfite neutralizes the chlorine in the raw water.

The sodium bisulfite system includes dry sodium bisulfite chemical packages, a five-gallon bucket in which the sodium bisulfite is mixed with water, a chemical pump with a suction tube, strainer, and ceramic weight, 3/8-in. tubing, and Adaptor A-11. Adaptor A-11 contains Chemical Injection Check Valve V-613 and a static mixer.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0010 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OTHER SET-UPS - OPERATION UNDER UNUSUAL CONDITIONS

This procedure only describes how to deploy Adaptor A-11 and the 3/8-in. tubing. The procedures for mixing the sodium bisulfite and setting up and starting the chemical pump are described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained.

The sodium bisulfite chemical injection system is set up during raw water system set-up and before establishing raw water flow to the MF feed tank. Deploy the sodium bisulfite chemical injection system as follows:

1. Set up the TWPS as described in WP 0007, Set-Up - Operation Under Usual Conditions, or as described in WP 0009, Cold Weather Set-Up, if applicable. When directed in either of these two work packages, complete these sodium bisulfite chemical injection system set-up steps.
2. Obtain Adaptor A-11 from its pack-out location under the HP Pumps.
3. Install Adaptor A-11 in the raw water system between the 2-in. x 50-ft. discharge hose and Adaptor A-05 (see Figure 1).

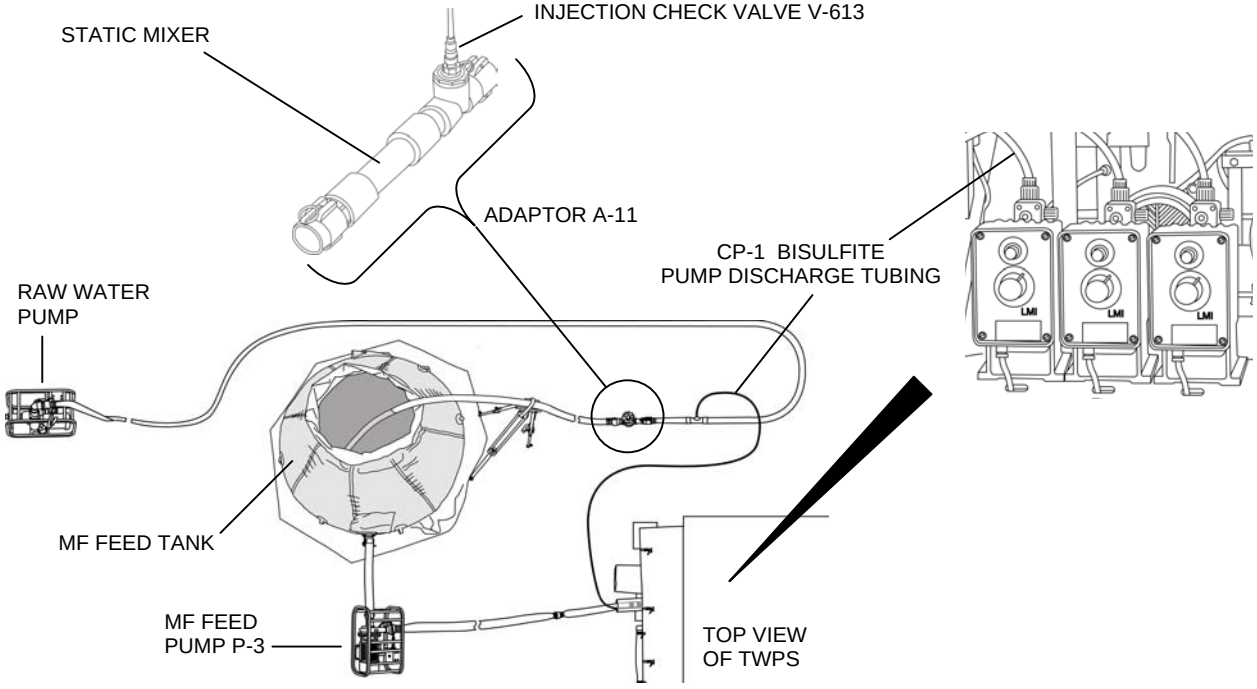


Figure 1. Adaptor A-11 Location in the Raw Water System.

4. Remove the 3/8-in. Bisulfite Chemical Pump CP-1 tubing from its strap and uncoil.
5. Lay the tube so that it passes out of the TWPS along with the 3 in. MF pump discharge hose. For cold weather set-up, the tube is run under the hose heating blanket.
6. Position the raw water hoses and the adaptors and connect the 3/8-in. tubing to the inlet of Chemical Injection Check Valve V-613 on Adaptor A-11. (See connection detail in Figure 2.)
7. Complete the rest of the set-up procedures as described in WP 0007, Set-Up – Operation Under Usual Conditions, or as described in WP 0009, Cold Weather Set-Up, if applicable.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0010 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OTHER SET-UPS - OPERATION UNDER UNUSUAL CONDITIONS

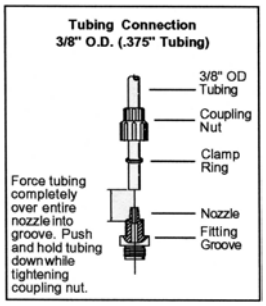


Figure 2. 3/8-In. Chemical Tubing Connections.

CONTAMINATION AVOIDANCE COVER (CAC) DEPLOYMENT

If an NBC attack is expected, deploy the CAC as follows (see Figure 3):

1. Put the TWPS in Standby Shutdown without Draining Down (WP 0017) including shutting down the Tactical Quiet Generator (TQG). If time does not permit a Standby Shutdown, press the emergency stop button on the TWPS control panel and shut down the TQG.
2. MC-TWPS only: lower and secure the operator station roof.
3. A-TWPS only: remove the fabric wall.
4. Disconnect all external hoses (and heating ducts if used) from the TWPS.
5. Pack all items you wish to protect inside the TWPS as time permits.
6. A-TWPS only: install all flat rack panels, close and secure the top panel and the deck panel.

NOTE

For the A-TWPS, do not unfold the CAC over the back of the TWPS until the operator has come down the folding steps and is on the ground.

7. Lay out the CAC on top of the TWPS and unfold it over the sides. Make sure the bottom edge of the CAC reaches the bottom of the TWPS on all sides of the TWPS.
8. Neatly tuck the CAC in at the corners and fold the flaps around the corners.
9. Tie three CAC 3/8-in. x 60-ft. ropes all the way around the CAC; one around the top, one around the middle, and one around the bottom.
10. If an NBC attack occurs, do not remove the cover. The cover and unit must be decontaminated in accordance with FM 3-5 prior to removing the cover and using the unit.

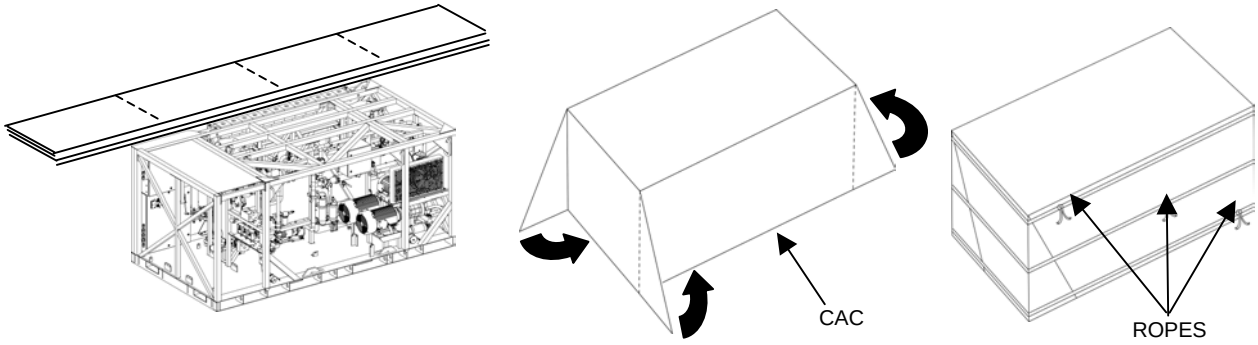


Figure 3. CAC Installation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0010 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OTHER SET-UPS - OPERATION UNDER UNUSUAL CONDITIONS

NBC SYSTEM DEPLOYMENT

The NBC (nuclear, biological, chemical) water treatment system is setup as a final product water treatment step when the raw water source is contaminated with nuclear, biological or chemical warfare agents. The NBC filter is set up in the product line between the TWPS and the product water storage tanks. The NBC water treatment system includes the following major components:

- NBC filter tank. The filter tank is supplied as standard issue for both the A-TWPS and the MC-TWPS.
- Six bags of ion exchange resin. This filter media is used for removing nuclear and chemical agents. The filter media is packed inside the filter tank on the A-TWPS and is provided in the extended capability module for the MC-TWPS.
- Four bags of carbon. This filter media is used to remove chemical and biological agents. The filter media is packed inside the filter tank on the A-TWPS and is provided in the extended capability module for the MC-TWPS.
- NBC hypochlorite injection tube, connector, injector and straps supplied inside the NBC filter tank.

The NBC system can be set up any time before start-up of the TWPS. Typically, the NBC System is set up when the product water distribution system is set up. Deploy the NBC system as follows:

1. Wear appropriate protective gear as directed.
2. Set up the TWPS as described in WP 0007, Set-Up – Operation Under Usual Conditions, or as described in WP 0009, Cold Weather Set-Up, if applicable.
3. A-TWPS only. Unclamp and remove the band holding the top of the NBC filter. Remove the top and remove the bags of media. Set the bags between the TWPS and the first distribution tank.
4. Set up the NBC system as follows (see Figure 4):
    a. Remove the straps around the NBC tank.

WARNING

Three person lift. Three people are required to safely lift the filter tank. Lift with your legs, not your back. Three handles are provided for this purpose. Failure to observe this warning may result in back injury.

    b. Lift the NBC tank off of the TWPS skid and carry to a position between the TWPS and the distribution tanks.
    c. Tip the NBC tank and remove the pack-out plate from the bottom of the filter tank.
    d. Connect the four 1 ½-in. x 10-ft. product water hoses to the NBC tank as follows:
        1) Connect the end of the second or third product water hose from the TWPS to the top of the NBC tank.

NOTE

Be sure to check product water TDS and chlorine before connecting the product hose from the outlet of the NBC tank to the distribution tank.

        2) Connect the remaining hoses from the bottom outlet of the NBC tank to the distribution tank.
    e. If the NBC tank is used during cold weather, connect the NBC tank between the last product water hose and the distribution tank so that the hose heating blanket can be installed.

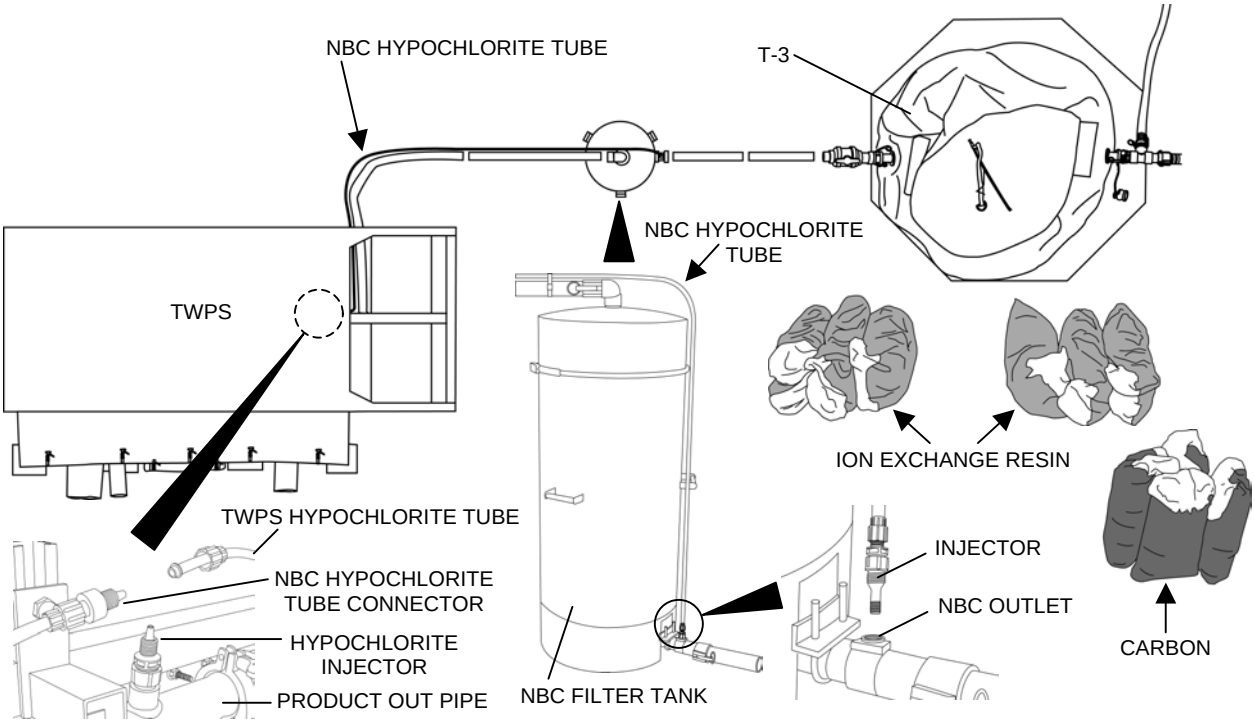


Figure 4. NBC System Deployment.

NOTE

Do not mix calcium hypochlorite or set-up and start the calcium hypochlorite chemical pump at this time. The procedures for mixing the calcium hypochlorite and setting up and starting the chemical pump are part of system start-up and are described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained.

5. Load the NBC media into the NBC tank as follows:
    a. Slowly pour each bag of AC-450 ion exchange resin into the filter. Pour the resin so that the top surface is as even as possible. There are six bags total.
    b. Slowly pour each bag of AC-460 carbon into the filter. Pour the carbon so that the top surface is as even as possible. Smooth it out by hand after all of the bags have been emptied. There are four bags total.
    c. Place the top back onto the tank and secure with the band and clamp.
6. Connect the NBC hypochlorite injection tube as follows (see Figure 4):
    a. Remove the TWPS hypochlorite tube from the injector at the end of the product out pipe.
    b. Use the tube connector supplied with the NBC hypochlorite tube to connect the NBC hypochlorite tube to the TWPS hypochlorite tube.
    c. Extend the NBC hypochlorite tube along the product hose and strap in place with the four hook and loop straps provided.
    d. Wrap pipe tape around the NBC hypochlorite injector threads and screw the injector into the threaded coupling in the NBC outlet.
    e. Connect the end of the NBC hypochlorite tube to the injector.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0010 00**
PREPARATION FOR USE AND INSTALLATION INSTRUCTIONS
OTHER SET-UPS - OPERATION UNDER UNUSUAL CONDITIONS

HOT WEATHER CONDITION SET-UP

Flow rates and other operational characteristics of the TWPS change when the source water temperatures exceed 85 degrees F. Maximum temperatures are as follows:

- Maximum deployment temperature: 120 degrees F
- Maximum storage temperature: 160 degrees F
- Maximum RO element storage temperature: 110 degrees F
- Maximum source water temperature 110 degrees F

Operation in direct sunlight during extremely hot weather should be avoided. Raw water, MF feed and distribution pump motors can overheat in extreme heat conditions. To the extent possible, position the TWPS platform and pump skids in the shade or otherwise protect them from direct sunlight.

SANDY / DUSTY CONDITION SET-UP

During TWPS set up and operation in a sandy and/or dusty environment, observe the following:

- Make sure the grounding rod is secure. Desert and sandy soils have a low moisture content making low resistance grounding difficult.
- Make sure the zippers on the product water distribution tanks are closed.
- Keep the RO feed tank lid closed.
- Keep the OCP and PDP covers closed and secured.
- Keep lids on chemical containers tightly closed.
- Keep all lubricants tightly sealed and all lubrication points clean.
- Perform lubrication procedures more frequently than listed in the lubrication schedules.
- Clean sand and dust from hose adaptors, hose connections, and air fittings as often as possible.
- Clean sand and dust off all components as often as possible.
- Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection.
- Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

GENERAL

This section describes the controls and indicators available to the TWPS operator. Beginning on the next page, a table listing the controls and their function and a drawing showing the location of the controls are provided for each of the following control panels and systems:

- Operator Control Panel
- Power Distribution Panel Door
- Power Distribution Panel
- Feed Flow Control Panel
- Chemical Injection Pump Controls
- Air System Controls and Indicators
- Instrument / Solenoid Panel
- Raw Water System Controls and Indicators
- Microfiltration System Controls and Indicators
- Reverse Osmosis System Controls and Indicators
- Standard Product Water Distribution System Controls
- Extended Product Water Distribution System
- Cold Weather Kit Controls
- Tactical Quiet Generator Controls and Indicators

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

OPERATOR CONTROL PANEL (OCP)

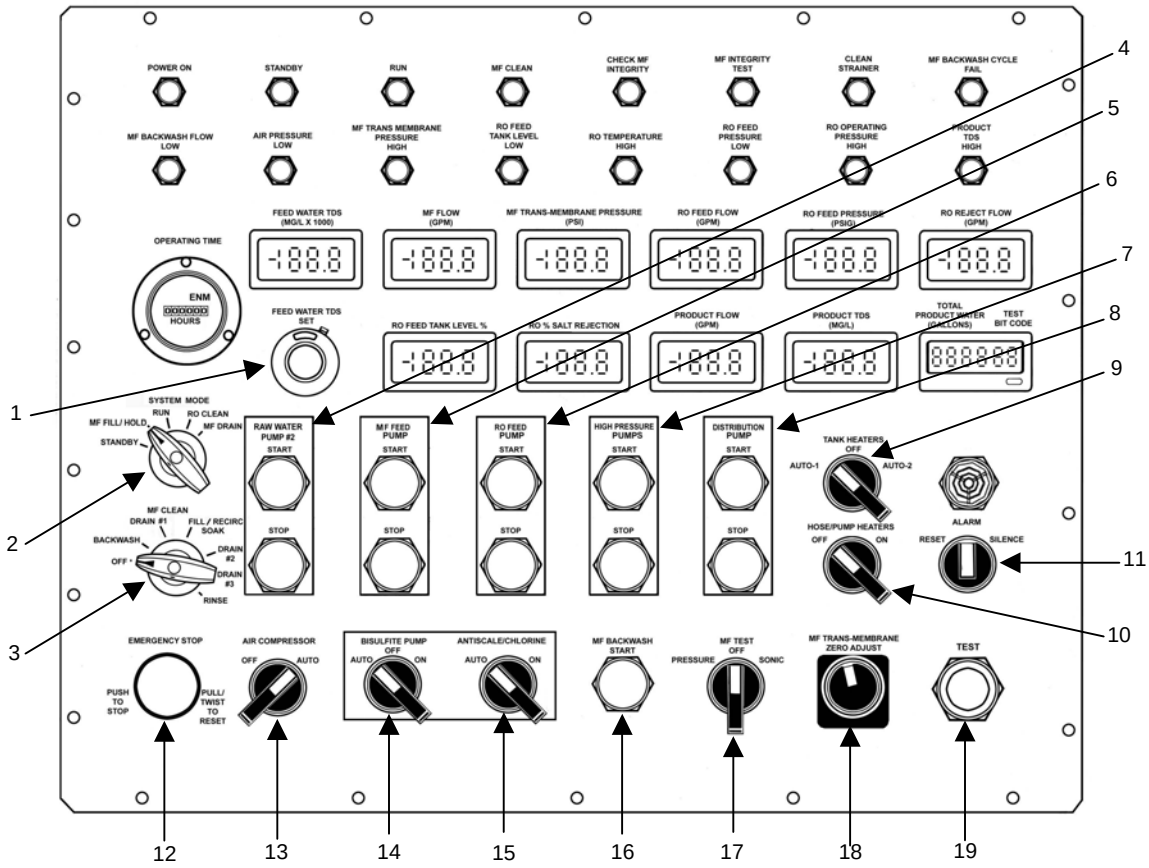


Figure 1. Location of Switches on the Operator Control Panel.

Table 1. Operator Control Panel (OCP) Switches.

ITEM	CONTROL	FUNCTION
1	FEED WATER TDS SET	Dial provides operator input of feed water TDS reading obtained from the portable TDS meter.
2	SYSTEM MODE	Provides TWPS operating mode control: • Standby • MF Fill/Hold • Run • RO Clean • MF Drain

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

0011 00

OPERATOR CONTROL PANEL (OCP) CONTINUED

Table 1. Operator Control Panel (OCP) Switches. – Continued.

3	MF CLEAN	Provides control of the MF cleaning operation: • Off • Backwash • Drain # 1 • Fill/Recirc • Soak • Drain # 2 • Drain # 3 • Rinse
4	RAW WATER PUMP # 2	Provides pushbutton start/stop control; stop switch red light comes on if protective circuit breaker trips or motor relay goes into overload condition
5	MF FEED PUMP	Provides pushbutton start/stop control; stop switch red light comes on if protective circuit breaker trips or motor relay goes into overload condition
6	RO FEED PUMP	Provides pushbutton start/stop control; stop switch red light comes on if protective circuit breaker trips or motor relay goes into overload condition
7	HIGH PRESSURE PUMPS	Provides pushbutton start/stop control; stop switch red light comes on if protective circuit breaker trips or motor relay goes into overload condition
8	DISTRIBUTION PUMP	Provides pushbutton start/stop control; stop switch red light comes on if protective circuit breaker trips or motor relay goes into overload condition
9	TANK HEATERS	Provides control of the MF tank heaters: • Off • Auto – 1 (one heater) • Auto – 2 (two heaters)
10	HOSE/PUMP HEATERS	Provides control of Cold Weather Kit Electric Heaters: • On • Off
11	ALARM	Provides control of function reset: • Neutral • Silence • Reset
12	EMERGENCY STOP (PUSH TO STOP) (PULL/ TWIST TO RESET)	Provides emergency stop of all TWPS operations.
13	AIR COMPRESSOR	Provides control of compressor: • Off • Auto Switch light comes on if protective circuit breaker trips or motor relay goes into overload condition
14	BISULFITE PUMP SWITCH	Provides manual/automatic control of bisulfite chemical pump: • Off • Auto • On
15	ANTISCALE/CHLORINE	Provides manual/automatic control of antiscale/chlorine chemical pumps: • Auto • On
16	MF BACKWASH	Provides pushbutton start of backwash cycle.
17	MF TEST	Provides test control of the MF system: • Off • Pressure Hold Test • Sonic Test
18	MF TRANS-MEMBRANE ZER0 ADJUST	Permits calibration zero adjustment of trans-membrane pressure.
19	TEST	Multi-sequencing BIT testing of OCP and PLC functions.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

OPERATOR CONTROL PANEL (OCP) CONTINUED

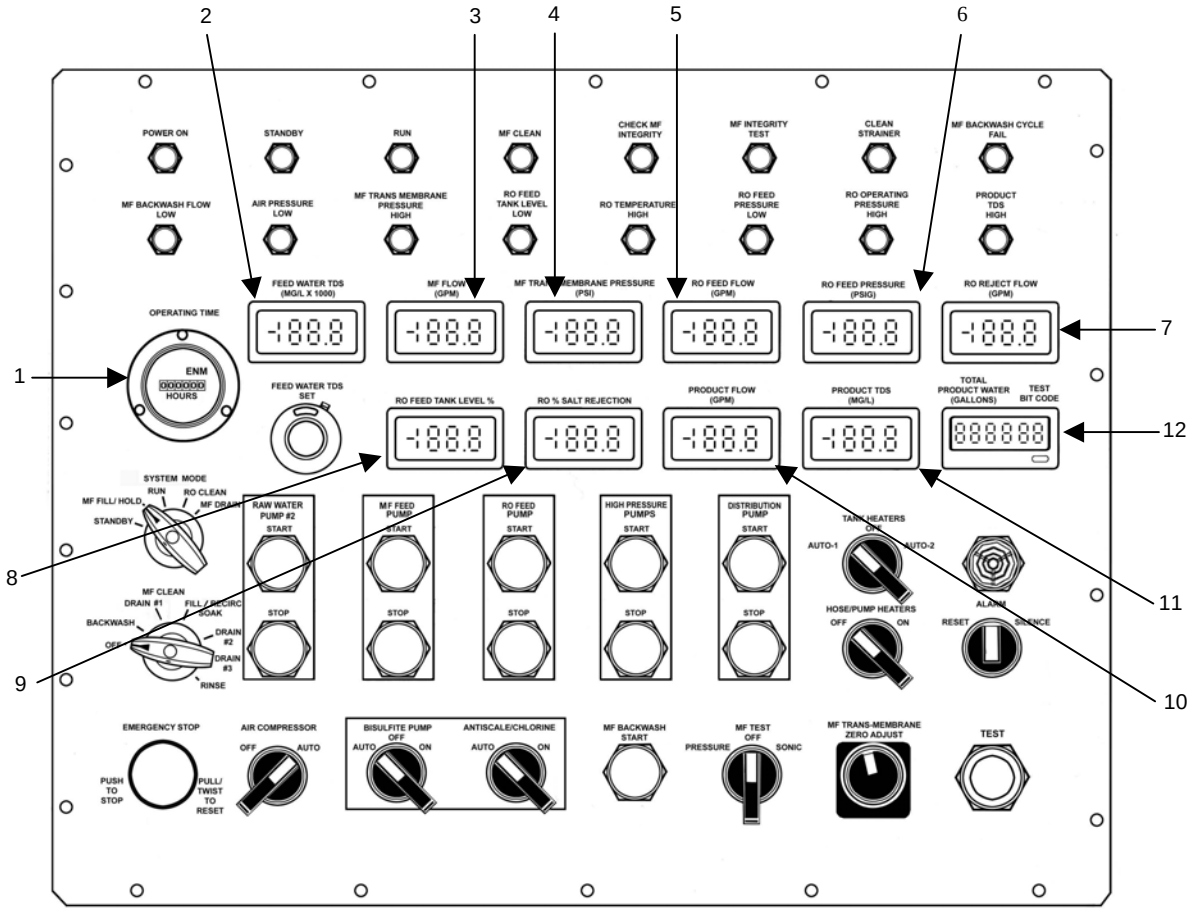


Table 2. Operator Control Panel (OCP) LED Displays.

ITEM	LED DISPLAY	FUNCTION
1	OPERATING TIME	Provides a current indication of cumulative operating time based on the HP Pumps.
2	FEED WATER TDS, MG/L X 1000	Displays the total dissolved solids in the raw feed water as set by the operator.
3	MF FLOW (GPM)	Presents a measurement of the rate of MF flow during filtration cycle or rate of backwash flow.
4	MF TRANS-MEMBRANE PRESSURE (PSI)	Presents a measurement of MF differential pressure (TMP).
5	RO FEED FLOW (GPM)	Displays a PLC calculation of the rate of RO feed flow.
6	RO FEED PRESSURE (PSIG)	Displays output pressure of the turbocharger.
7	RO REJECT FLOW (GPM)	Displays the flow rate of reject water from the RO vessels.
8	RO FEED TANK LEVEL (%)	Displays the level in the RO Feed Tank. Normal operating level is 95-105%.
9	RO % SALT REJECTION	Presents a PLC calculation of the percentage of salt that is rejected by the RO elements.
10	PRODUCT FLOW (GPM)	Presents a measurement of the product water flow in GPM.
11	PRODUCT TDS (MG/L)	Displays the amount of total dissolved solids in the product water.
12	TOTAL PRODUCT WATER (GALLONS) / TEST BIT CODE	Presents a PLC calculation of totalized water production.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

OPERATOR CONTROL PANEL (OCP) CONTINUED

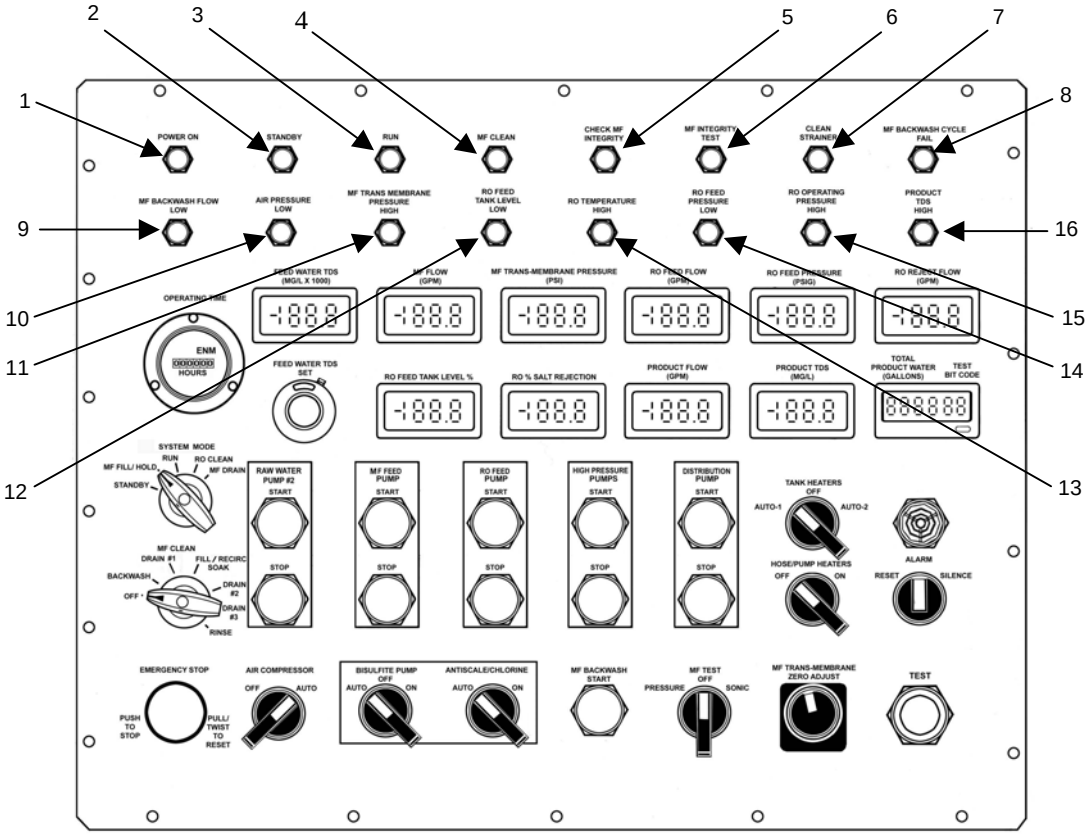


Table 3. Operator Control Panel (OCP) Indicators.

ITEM	INDICATOR	FUNCTION
1	POWER ON (green)	Indicates power has been applied to the unit.
2	STANDBY (yellow)	Indicates unit in standby mode with no water production.
3	RUN (green)	Indicates unit is in one of the operating modes.
4	MF CLEAN (yellow)	Indicates unit is sequencing through the MF clean cycle. Stays on during the cycle.
5	CHECK MF INTEGRITY (red)	Not used.
6	MF INTEGRITY TEST (yellow)	Lights when integrity test is complete. Flashing light indicates test failure.
7	CLEAN STRAINER (red)	Indicates a warning during the high flow shell sweep step that the strainer is fouled restricting the water flow. Alarms below 210 gpm but above 190 gpm.
8	MF BACKWASH CYCLE FAIL (red)	Indicates a system failure during the backwash step.
9	MF BACKWASH FLOW LOW (red)	Indicates less than 190 GPM during high flow shell sweep step.
10	AIR PRESSURE LOW (red)	Indicates MF backwash is called for while compressor is running.
11	MF TRANS-MEMBRANE PRESSURE HIGH (red)	Indicates Trans-Membrane Pressure high, indicating need to clean the MF within the next 40 operating hours.
12	RO FEED TANK LEVEL LOW (red)	Indicates RO feed tank level is low. Stops RO feed pump and heaters if on.
13	RO TEMPERATURE HIGH (red)	Indicates that the temperature of the RO feed water is above 110° F and that heaters during cleaning have been turned off.
14	RO FEED PRESSURE LOW (red)	Indicates low feed pump pressure in the RUN mode. HP pumps are stopped.
15	RO OPERATING PRESSURE HIGH (red)	Indicates high RO pressure above 1225 psig at the output of the turbocharger. HP pumps are stopped.
16	PRODUCT TDS HIGH (red)	Indicates the amount of total dissolved solids in the product water is exceeding 1000 mg/l. Also may indicate a low % Salt Rejection value.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

POWER DISTRIBUTION PANEL DOOR

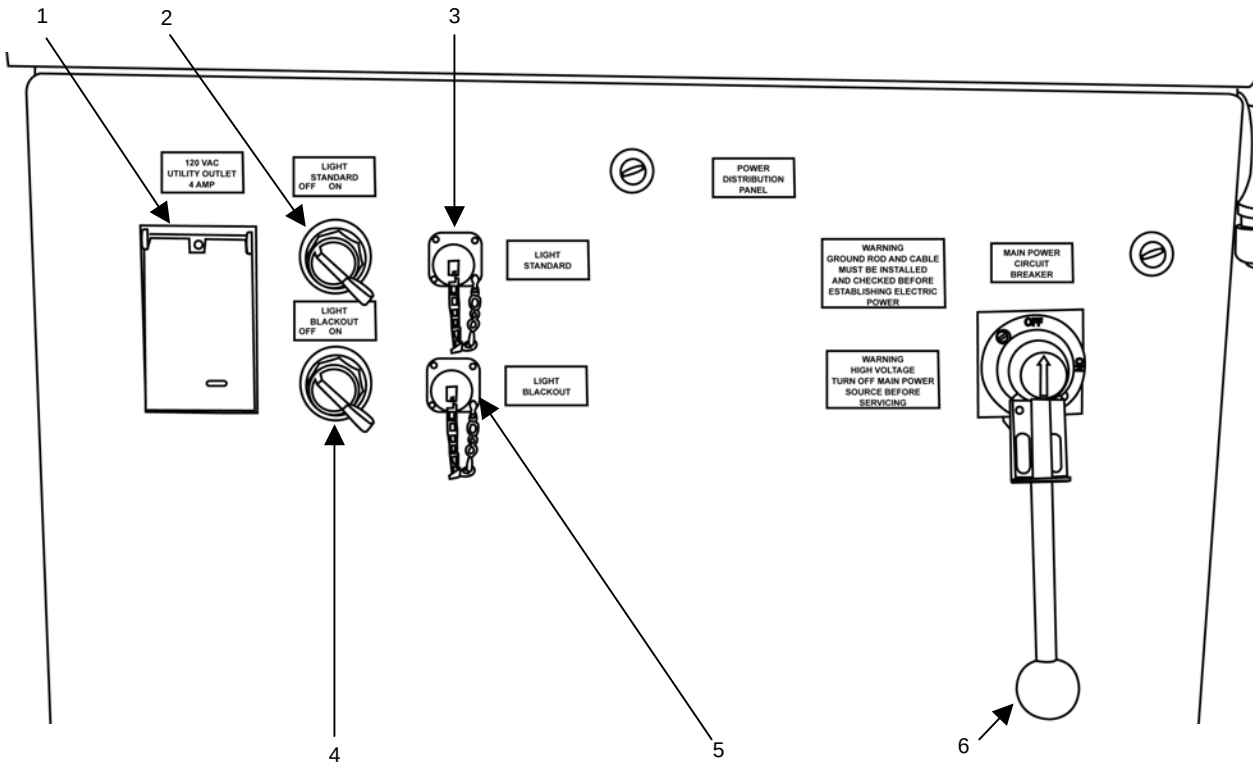
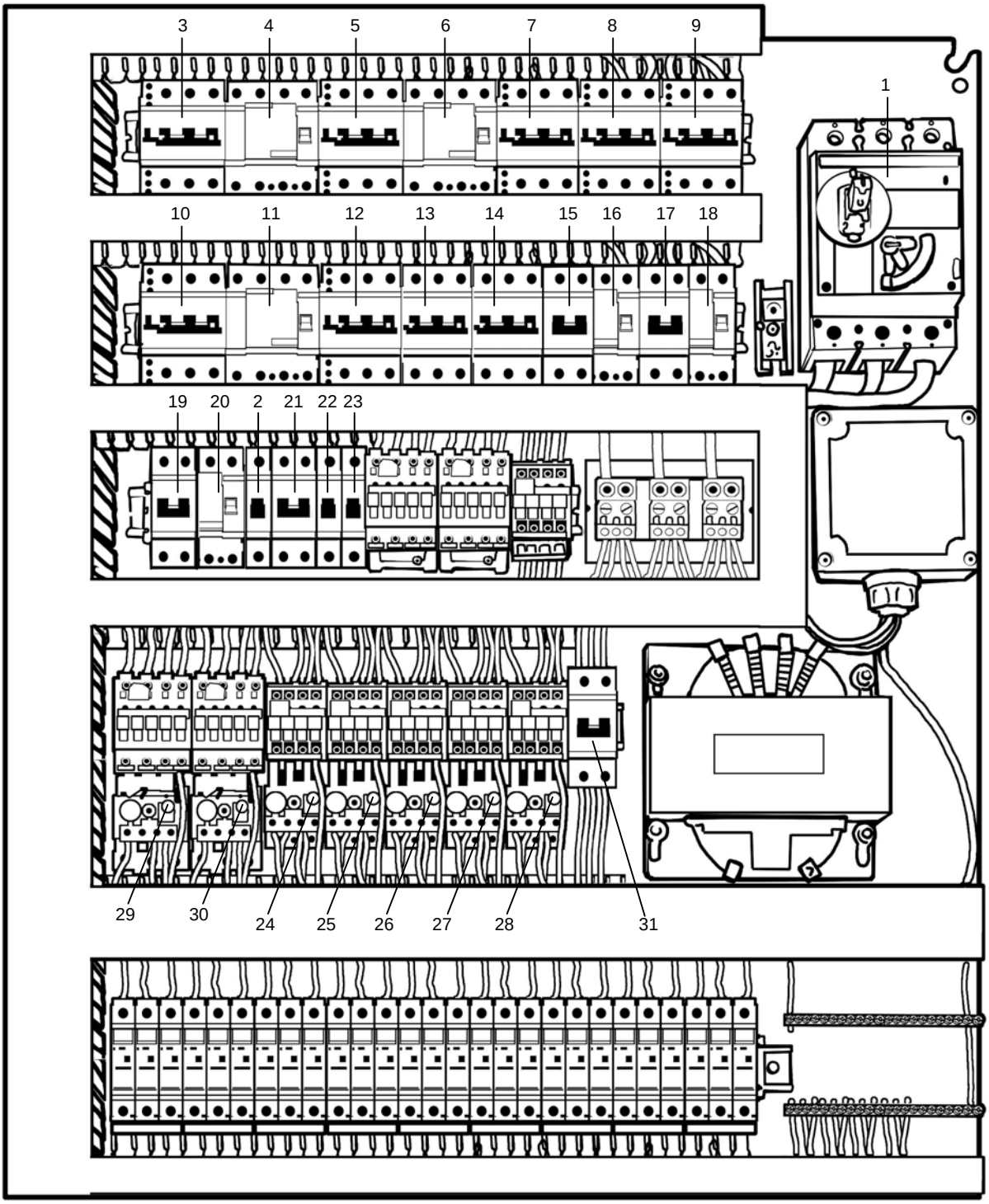


Table 4. Power Distribution Panel Door Controls.

ITEM	CONTROL/INDICATOR	FUNCTION
1	120-VOLT / 4 AMP UTILITY OUTLET	General purpose and diesel fueled heater power
2	LIGHT SWITCH	General purpose light ON/OFF
3	LIGHT ELECTRICAL CONNECTION	Power for general purpose light
4	LIGHT SWITCH	General purpose light ON/OFF
5	LIGHT ELECTRICAL CONNECTION	Power for general purpose light
6	MAIN CIRCUIT BREAKER	416-volt power to TWPS ON/OFF

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

POWER DISTRIBUTION PANEL (PDP)



POWER DISTRIBUTION PANEL CONTINUED

Table 5. Power Distribution Panel Controls and Indicators.

ITEM	CONTROL/INDICATOR	FUNCTION
1	MAIN CIRCUIT BREAKER	Main power (125-amp) • On • Off
2	CIRCUIT BREAKER 102	OCP Space heater circuit breaker (2-amp, 1-pole)
3	CIRCUIT BREAKER 106	Raw Water Pump P-2 circuit breaker (63-amp, 3-pole)
4	GROUND FAULT BREAKER 106	Raw Water Pump P-2 ground fault breaker (300-mA, 4-pole)
5	CIRCUIT BREAKER 111	MF Feed Pump P-3 circuit breaker (20-amp, 3-pole)
6	GROUND FAULT BREAKER 111	MF Feed Pump ground fault breaker (300-mA, 4-pole)
7	CIRCUIT BREAKER 116	RO Feed Pump P-4 circuit breaker (16-amp, 3-pole)
8	CIRCUIT BREAKER 122	HP Feed Pump P-5 circuit breaker (63-amp, 3-pole)
9	CIRCUIT BREAKER 125	HP Feed Pump P-6 circuit breaker (63-amp, 3-pole)
10	CIRCUIT BREAKER 128	Distribution Pump P-7 circuit breaker (10-amp, 3-pole)
11	GROUND FAULT BREAKER 128	Distribution Pump P-7 ground fault breaker (300-mA, 4-pole)
12	CIRCUIT BREAKER 133	Air Compressor circuit breaker (16-amp, 3-pole)
13	CIRCUIT BREAKER 201	RO Feed Tank Heater 1 circuit breaker (25-amp, 3-pole)
14	CIRCUIT BREAKER 204	RO Feed Tank Heater 2 circuit breaker (25-amp, 3-pole)
15	CIRCUIT BREAKER 207	Distribution Pump Skid P-7 hose heating blanket and pump heating collar circuit breaker (16-amp, 2-pole)
16	GROUND FAULT BREAKER 207	Distribution Pump Skid P-7 hose heating blanket and pump heating collar ground fault breaker (30-mA, 2-pole)
17	CIRCUIT BREAKER 209	MF Feed Pump Skid P-3 hose heating blanket and pump heating collar and (A-TWPS only) extended distribution system Diesel-Driven Pump Skid P-8 hose heating blanket circuit breaker (16-amp, 2-pole)
18	GROUND FAULT BREAKER 209	MF Feed Pump Skid P-3 hose heating blanket and pump heating collar and (A-TWPS only) extended distribution system Diesel-Driven Pump Skid P-8 hose heating blanket ground fault breaker (30-mA, 2-pole)
19	CIRCUIT BREAKER 211	Raw Water Pump Skids P-1 and P-2 hose heating blanket and pump heating collar circuit breaker (16-amp, 2-pole)
20	GROUND FAULT BREAKER 211	Raw Water Pump Skids P-1 and P-2 hose heating blanket and pump heating collar ground fault breaker (30-mA, 2-pole)
21	CIRCUIT BREAKER 214	120-volt transformer primary circuit breaker (4-amp, 2-pole)
22	CIRCUIT BREAKER 215	120-volt outlets circuit breaker (20-amp, 1-pole)
23	CIRCUIT BREAKER 216	120-volt transformer secondary circuit breaker (4-amp, 1-pole)
24	CONTACTOR M501 OVERLOAD RESET	Raw Water Pump P-2 overload reset push button on contactor (5-HP, 3-pole)
25	CONTACTOR M502 OVERLOAD RESET	MF Feed Pump P-3 overload reset push button on contactor (7½-HP, 3-pole)
26	CONTACTOR M503 OVERLOAD RESET	RO Feed Pump P-4 overload reset push button on contactor (5-HP, 3-pole)
27	CONTACTOR M506 OVERLOAD RESET	Distribution Pump P-7 overload reset push button on contactor (4-HP, 3-pole)
28	CONTACTOR M510 OVERLOAD RESET	Air Compressor overload reset push button on contactor (4-HP, 3-pole)
29	CONTACTOR M504 OVERLOAD RESET	HP Feed Pump P-5 overload reset push button on contactor (20-HP, 3-pole)
30	CONTACTOR M505 OVERLOAD RESET	HP Feed Pump P-6 overload reset push button on contactor (20-HP, 3-pole)
31	CIRCUIT BREAKER 137	General Purpose Transformer circuit breaker (6-amp. 2-pole)

FEED FLOW CONTROL PANEL

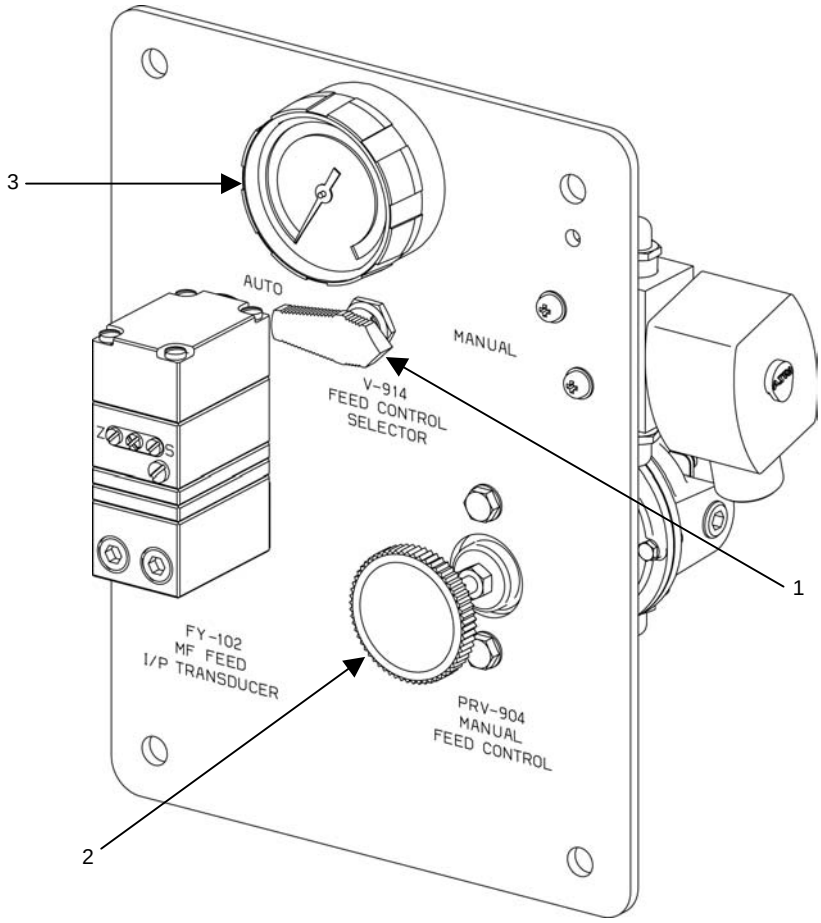


Table 6. Feed Flow Control Panel Controls and Indicators.

ITEM	CONTROL/INDICATOR	FUNCTION
1	FEED FLOW CONTROL SELECTOR V-914	Allows selection between manual and automatic control of Feed Flow Control Valve V-202
2	PRV-904 MANUAL FEED FLOW CONTROL	Manual control for Feed Flow Control Valve V-202
3	PRESSURE GAUGE PI-904	Displays the amount of pressure 0-15 psig going to Feed Flow Control Valve V-202

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

CHEMICAL INJECTION PUMP CONTROLS

The TWPS uses three identical chemical injection pumps, one for each of three different purposes. The controls on each of the three pumps are the same. The three pumps are:

- Sodium Bisulfite Chemical Pump: Dispenses a measured amount of Sodium Bisulfite into the raw water before it is discharged into the MF feed tank when the raw water contains chlorine in order to neutralize the chlorine.
- Antiscalant Chemical Pump: Dispenses a measured amount of Antiscalant into the filtrate to inhibit salt scale formation on the RO membranes.
- Calcium Hypochlorite Chemical Pump: Dispenses a measured amount of Calcium Hypochlorite into the product water before it is discharged to the distribution tanks to kill and prevent microbial growth and contamination in the product water.

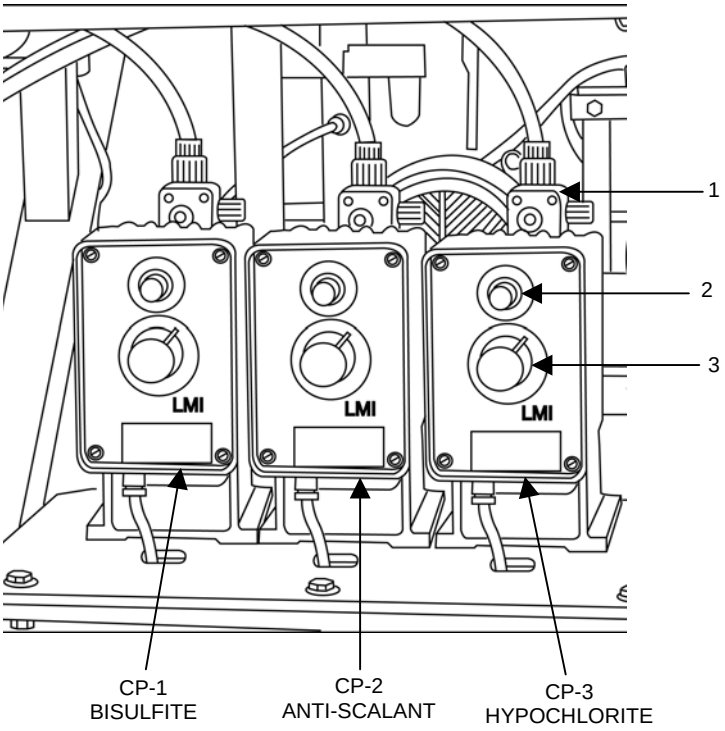


Table 7. Chemical Injection Pump Controls.

ITEM	CONTROLS	FUNCTION
1	FOUR FUNCTION VALVE.	This valve provides Pressure relief, priming, backpressure and anti-siphoning function.
2	SPEED CONTROL/ON OFF KNOB.	Turns pump on and off and provide adjustment of the percent of maximum strokes per minute. Turn clockwise to increase and counter clockwise to decrease strokes per minute.
3	STROKE CONTROL KNOB.	Provides adjustment of the percent maximum of solution discharged during each pump actuation. Turning the knob clockwise increases solution displacement and counter clockwise to decrease.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

0011 00

AIR SYSTEM CONTROLS AND INDICATORS

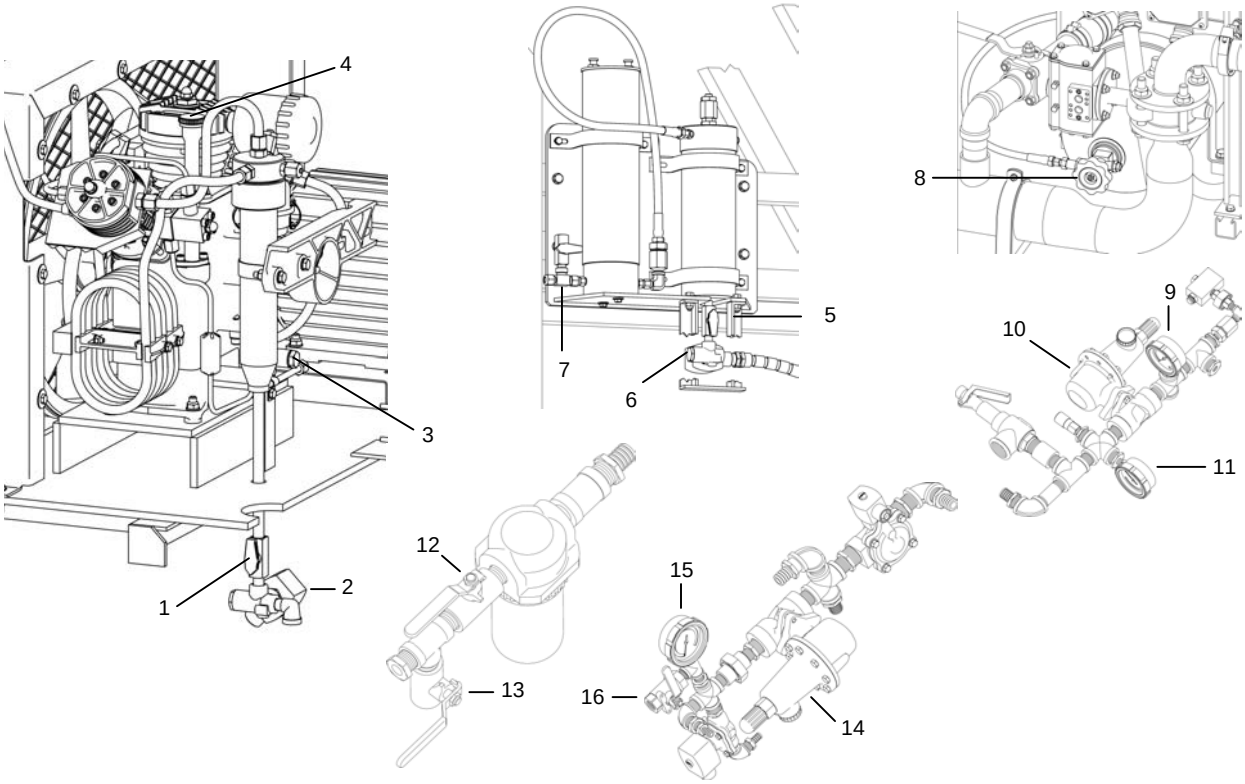


Table 8. Air System Controls and Indicators.

ITEM	CONTROLS AND INDICATORS	FUNCTION
1	AIR COMPRESSOR INTERMEDIATE FILTER MANUAL DRAIN VALVE V-901.	Normally Open. Used during operation if automatic Drain Valve XV-910 is defective.
2	AIR COMPRESSOR INTERMEDIATE FILTER AUTOMATIC DRAIN VALVE XV-910.	Automatically drains the intermediate filter every 15 minutes.
3	AIR COMPRESSOR OIL DRAIN PLUG.	Allows for draining of air compressor oil.
4	AIR COMPRESSOR OIL LEVEL DIP STICK.	Indicates air compressor oil level.
5	COALESCER CO1 MANUAL DRAIN VALVE V-902.	Normally open. Used during operation if automatic Drain Valve XV-911 is defective.
6	COALESCER CO1 AUTOMATIC DRAIN VALVE XV-911.	Automatically drains Coalescer CO1 every 15 minutes.
7	HIGH PRESSURE VENT VALVE V-904.	Opened to drain high-pressure air system and before replacing filter AF2 or CO1 coalescer.
8	AIR TANK SHUT OFF VALVE V-907.	Closed to retain air pressure in tank during shutdown.
9	PRESSURE GAUGE PI-901.	Indicates air tank pressure
10	PRESSURE REGULATING VALVE PRV-901.	Regulates air pressure to 100 psig for backwash and automatic valve operation.
11	PRESSURE GAUGE PI-902.	Indicates setting of PRV-901.
12	AIR MANIFOLD MAINTENANCE SHUT OFF VALVE V-909.	Used to shut off 100 psig air to the air manifold assembly and V-202 for maintenance.
13	LOW PRESSURE VENT VALVE V-910.	Open to drain LP air system.
14	PRESSURE REGULATING VALVE PRV-902.	Regulates 100 psig air pressure to 15 psig for MF shell purge steps.
15	PRESSURE GAUGE PI-903.	Indicates the setting of PRV-902.
16	LOW PRESSURE VENT VALVE V-915	Opened manually to vent air when it is necessary to adjust pressure PRV-902 to provide a 15 psig reading at PI-903.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

INSTRUMENT/SOLENOID PANEL

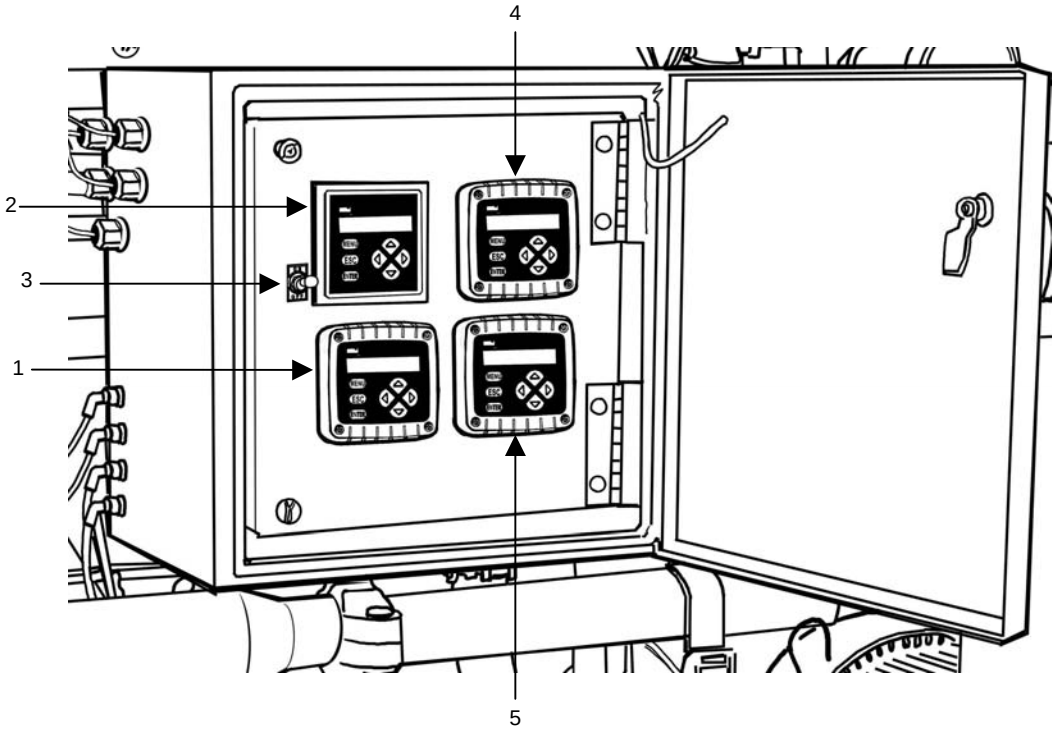


Table 9. Instrument/Solenoid Panel

ITEM	CONTROLS AND INDICATORS	FUNCTION
1	RO Reject Flow Transmitter FT-401.	Works with Flow Element FE-401 in the RO System to measure the reject flow from the RO vessels. Reject flow is displayed at the operator control panel (OCP).
2	Conductivity Indicating Transmitter (Analyzer) CIT-501.	Uses inputs from Conductivity Elements CE-501A and CE-501B in the RO System and provides an output to the PLC to determine total dissolved solids (TDS) in the product water. Product TDS is displayed at the OCP.
3	Conductivity Transmitter ON/OFF switch.	Used to turn the conductivity transmitter off for deployments requiring low EMI and to turn the transmitter on as required for conductivity data collection.
4	MF Feed Flow Transmitter FT-101	Works with Flow Element FE-101 in the MF System to measure the MF flow (feed flow to the MF assembly when filtering, backwash flow to the MF assembly during backwash). This flow is displayed at the operator control panel (OCP).
5	Product Flow Transmitter FT-501.	Works with Flow Element FE-501 in the RO System to measure product flow. The flow is displayed at the OCP.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0011 00
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

RAW WATER SYSTEM CONTROLS AND INDICATORS

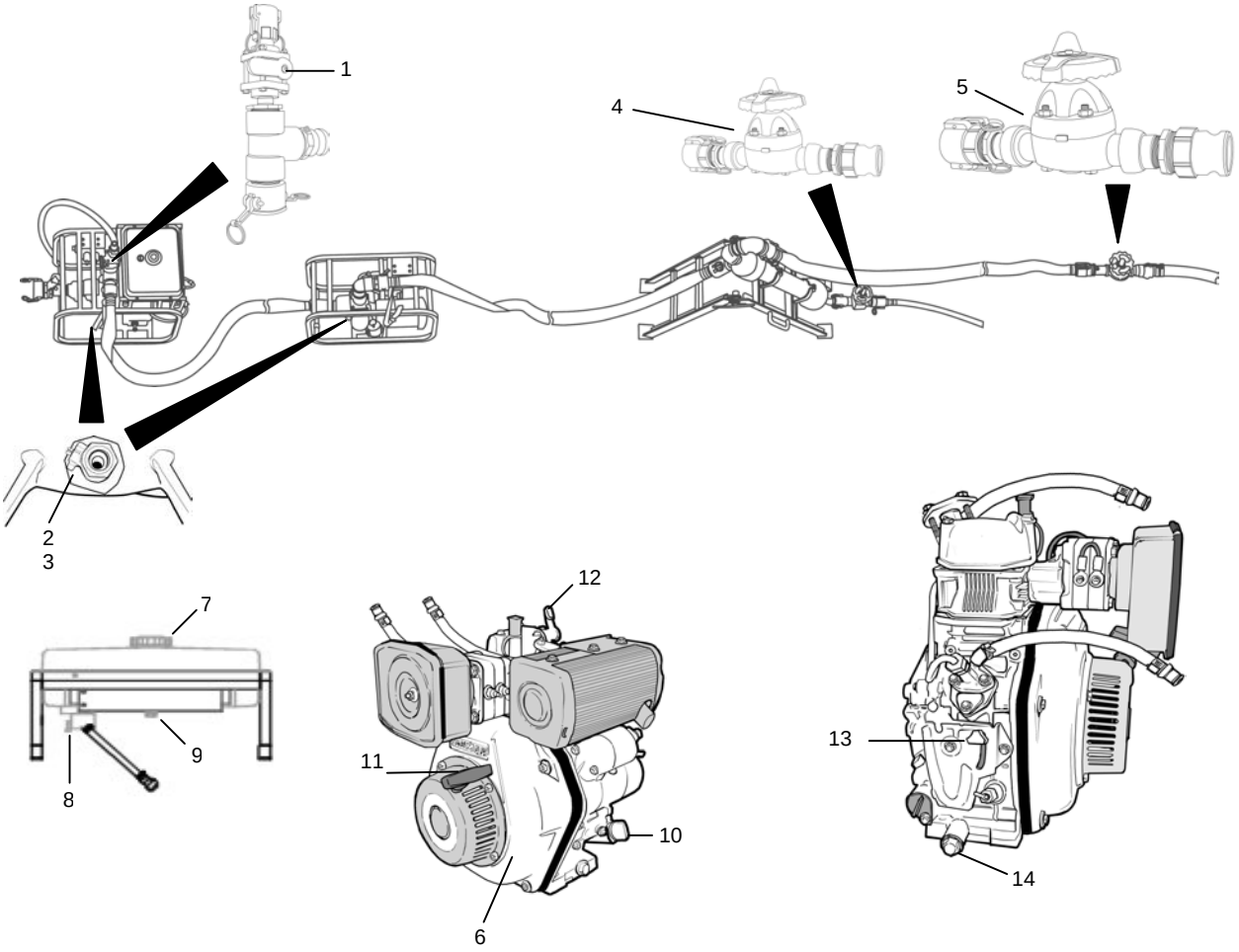


Table 10. Raw Water System Controls.

ITEM	CONTROLS AND INDICATORS	FUNCTION
1	PRIMING VALVE V-102.	Part of Adapter A-02. Used to vent air when priming the raw water pump
2	DRAIN VALVE V-103 (P-1 DIESEL PUMP).	Used to Drain P-1 Pump for maintenance and at the end of the mission.
3	DRAIN VALVE V-105 (P-2 MOTOR-DRIVEN RAW WATER PUMP)	Allows for draining of the P-2 Motor-Driven Raw Water Pump for maintenance or at the end of the mission.
4	CYCLONE SEPARATOR FLOW CONTROL VALVE V-104.	Controls the flow of the raw water, carrying the sand from the separator. Part of Adapter A-03.
5	MANUAL FLOW CONTROL VALVE V-107	Raw water flow valve. Manually adjusted to maintain proper level of raw water in the MF feed tank. Part of Adapter A-05.
6	P-1 DIESEL PUMP ENGINE	First pump in the raw water system when two pumps are required.
7	FUEL CAP	Allows for adding diesel fuel to P-1 Diesel Engine.
8	FUEL COCK	Allows for opening and closing of the fuel flow to P-1 Diesel Engine.
9	FUEL DRAIN PLUG	Allows for removing diesel fuel from P-1 Diesel Engine Fuel Tank.
10	OIL LEVEL DIP STICK	Displays oil level in P-1 Pump Diesel Engine.
11	RECOIL STARTER HANDLE	Allows for manual starting of P-1 Diesel Engine.
12	ENGINE DECOMPRESSION LEVER	Relieves P-1 Diesel Engine compression for starting.
13	ENGINE CONTROL LEVER	Controls the engine speed of P-1 Diesel Engine.
14	OIL DRAIN PLUG.	Allows for draining oil in P-1 Pump Diesel Engine.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

MICRO-FILTRATION SYSTEM CONTROLS AND INDICATORS

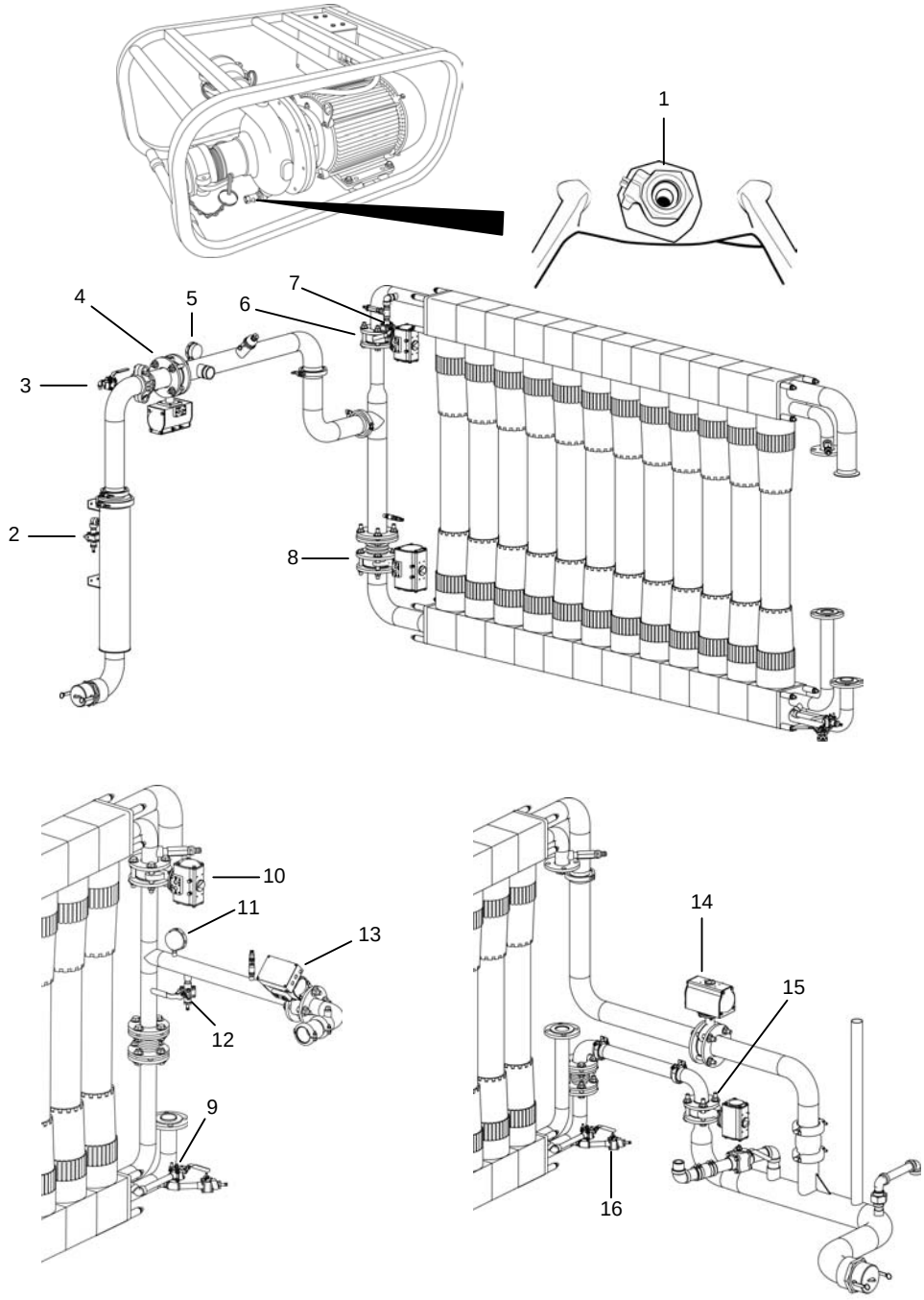


Figure 2. Location of Controls and Indicators in the Micro-Filtration System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

0011 00

Table 11. Micro-Filtration System Controls and Indicators.

ITEM	CONTROLS AND INDICATORS	FUNCTION
1	DRAIN VALVE V-108 (P-3 MOTOR-DRIVEN RAW WATER PUMP).	Used to drain the MF Pump P-3 for maintenance or at end of mission.
2	STRAINER DRAIN VALVE V-109.	Drains Strainer Basket S-2.
3	VENT VALVE V-110.	Used as vent when Draining Strainer S-2 and as sample valve for measuring raw water conductivity.
4	AUTOMATIC MF INLET FEED VALVE V-111.	Prevents feed water from flowing back into feed tank during backwash. Normal de-energized valve position is open. Energized valve position is closed. Arrow indicates valve position.
5	PRESSURE INDICATOR PI-101.	Indicates feed pressure to the MF micro-filter assembly.
6	AUTOMATIC MF UPPER FEED INLET VALVE V-112.	Opens and closes automatically to control feed flow to MF filters and for backwash. Normal de-energized valve position is open. Energized valve position is closed. Arrow indicates valve position.
7	MF VENT VALVE V-114.	Open for shutdown drain.
8	AUTOMATIC MF LOWER FEED INLET VALVE V-113.	Opens and closes automatically to control feed flow to MF filters and for backwash. Normal de-energized valve position is closed to a preset stop. Energized valve position is open. Arrow indicates valve position.
9	FILTRATE DRAIN VALVE V-203.	Open for shut down drain.
10	AUTOMATIC MF UPPER FILTRATE VALVE V-201.	Opens and closes automatically to control filtrate flow from MF filters and for backwash. Normal de-energized valve position is open. Energized valve position is closed. Arrow indicates valve position.
11	PRESSURE INDICATOR PI-201.	Indicates the filtrate pressure leaving MF filters.
12	FILTRATE SAMPLE VALVE V-204.	Allows for sampling filtrate flow
13	AUTOMATIC FILTRATE FLOW CONTROL VALVE V-202.	Controls filtrate flow to RO Tank to fill the tank and maintain RO tank normal level after filling. Arrow indicates valve position.
14	AUTOMATIC MF UPPER BACKWASH OUT VALVE V-401.	Opens and closes automatically to control backwash flow from MF filters. Normal de-energized valve position is closed. Energized valve position is open. Arrow indicates valve position.
15	AUTOMATIC MF LOWER SHELL OUT VALVE V-402.	Opens and closes automatically to control backwash flow from MF filters. Normal de-energized valve position is closed. Energized valve position is open. Arrow indicates valve position.
16	SHELL DRAIN VALVE V-403.	Opened for shutdown drain.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

REVERSE OSMOSIS SYSTEM CONTROLS AND INDICATORS

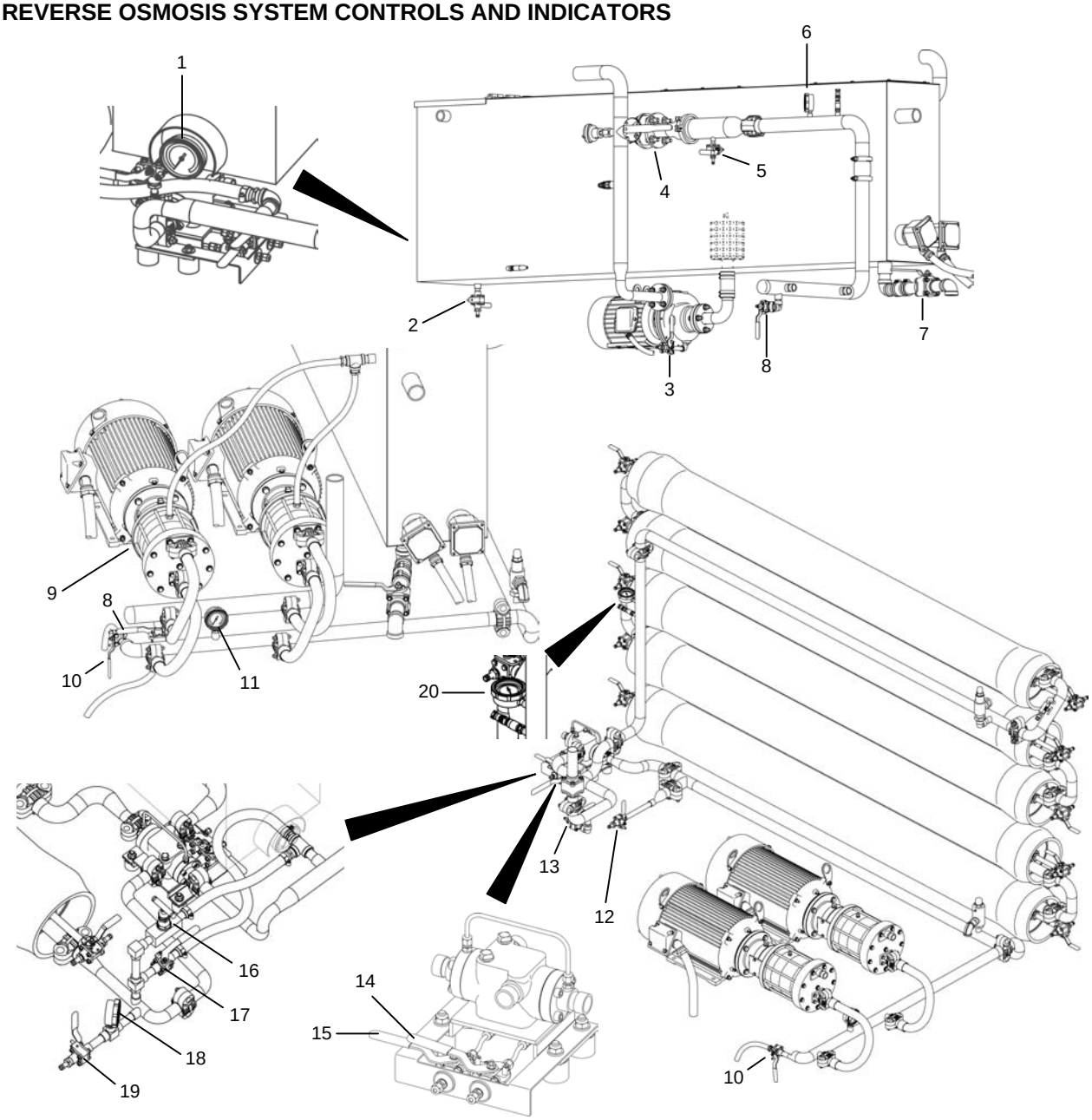


Figure 3. Location of Controls and Indicators in the Reverse Osmosis System.

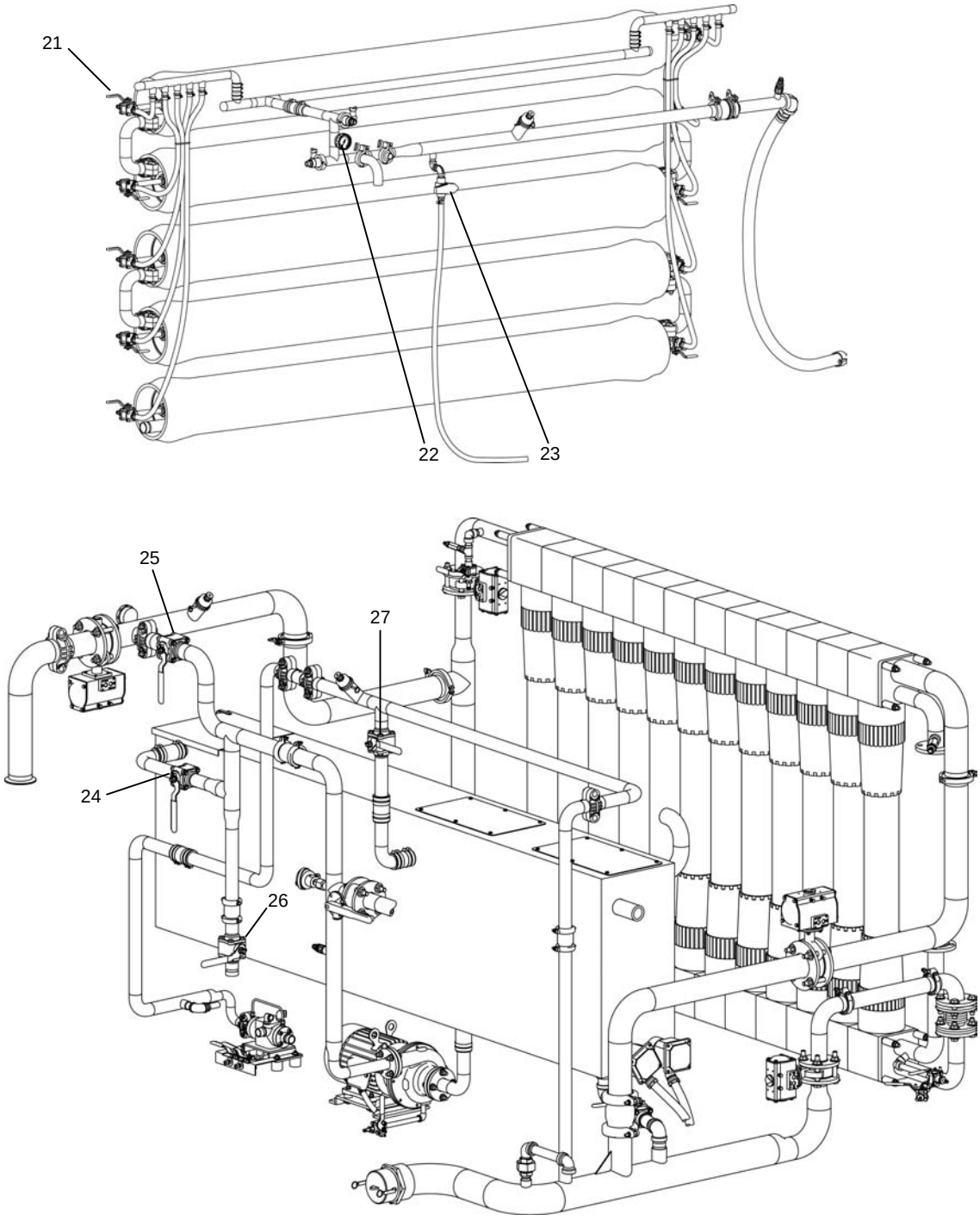


Figure 4. Location of Controls and Indicators in the Reverse Osmosis System Continued.

Table 12. Reverse Osmosis System Controls and Indicators.

ITEM	CONTROLS AND INDICATORS	FUNCTION
1	RO FEED TANK TEMPERATURE INDICATOR TI-202	Indicates the temperature of the fluid inside the RO feed tank. Used to monitor cleaning solution temperature during cleaning operations.
2	RO FEED TANK AUX DRAIN V-210.	Normally closed. Opened for shutdown drain.
3	RO FEED PUMP DRAIN VALVE V-211.	Normally closed. Opened for shutdown drain.
4	HIGH PRESSURE PUMP INLET VALVE V-212.	Normally open. Closed for cleaning.
5	S-4 STRAINER DRAIN VALVE V-213.	Normally closed. Opened to drain strainer S-4.
6	PRESSURE INDICATOR PI-202.	Indicates pressure from RO feed pump.
7	RO FEED TANK DRAIN TO WASTE VALVE V-412	Normally closed. Opened to drain cleaning solutions and for shutdown.
8	HIGH PRESSURE PUMP INLET DRAIN VALVE V-214.	Normally closed. Opened for shutdown drain.
9	HIGH PRESSURE PUMP CASE DRAIN VALVE V-215.	Normally closed. Opened for pump maintenance and shutdown drain.
10	HIGH PRESSURE PUMP OUTLET DRAIN VALVE V-301	Normally closed. Opened fro shutdown drain.
11	PRESSURE INDICATOR PI-301.	Indicates HP pump discharge pressure.
12	HP PUMP OUTLET DRAIN VALVE V-302.	Normally closed. Opened for shutdown drain.
13	FEED PIPING DRAIN VALVE V-304.	Normally closed. Opened for shutdown drain.
14	TURBOCHARGER FEED SIDE DRAIN VALVE V-303.	Normally closed. Opened for shutdown drain.
15	TURBOCHARGER REJECT SIDE DRAIN VALVE V-410.	Normally closed. Opened for shutdown drain.
16	MAIN PRESSURE CONTROL VALVE HCV-401.	Manual valve used to bypass some of the reject water around the turbocharger to waste outlet and thus adjust the pressure boost to the RO feed.
17	AUXILIARY PRESSURE CONTROL VALVE HCV-401A	Manual valve used to bypass some of the reject water around the turbocharger to waste outlet and thus adjust the pressure boost to the RO feed.
18	REJECT PRESSURE GAGE PI-401	Indicates the reject pressure in the line from the RO vessel reject outlet to the turbocharger.
19	RO VESSEL DRAIN VALVE V-408	Used to drain water out of the RO vessels.
20	RO FEED PRESSURE GAGE PI-304	Indicates RO feed pressure.
21	THREE-WAY RO PRODUCT VALVES V-501 TO V-510.	Normal position, directs flow to manifold. Sample position, directs flow to sample port. Drain position, drains to sample port.
22	RO PRODUCT PRESSURE GAUGE PI-501.	Indicates product water discharge pressure.
23	PRODUCT UTILITY VALVE V-511.	Provides utility water for filling chemical tanks and general use.
24	CLEAN MIXING VALVE V-703.	Normally closed. Opened to circulate from RO feed pump directly back to RO feed tank to mix cleaning solution.
25	MF CLEAN FEED VALVE V-704.	Normally closed. Opened to circulate cleaning solution to MF.
26	RO CLEAN FEED VALVE V-701.	Normally closed. Opened for circulate cleaning solution to RO.
27	RO CLEAN RETURN VALVE V-702.	Normally closed. Opened for cleaning recirculate to RO feed tank.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

STANDARD PRODUCT WATER DISTRIBUTION SYSTEM CONTROLS

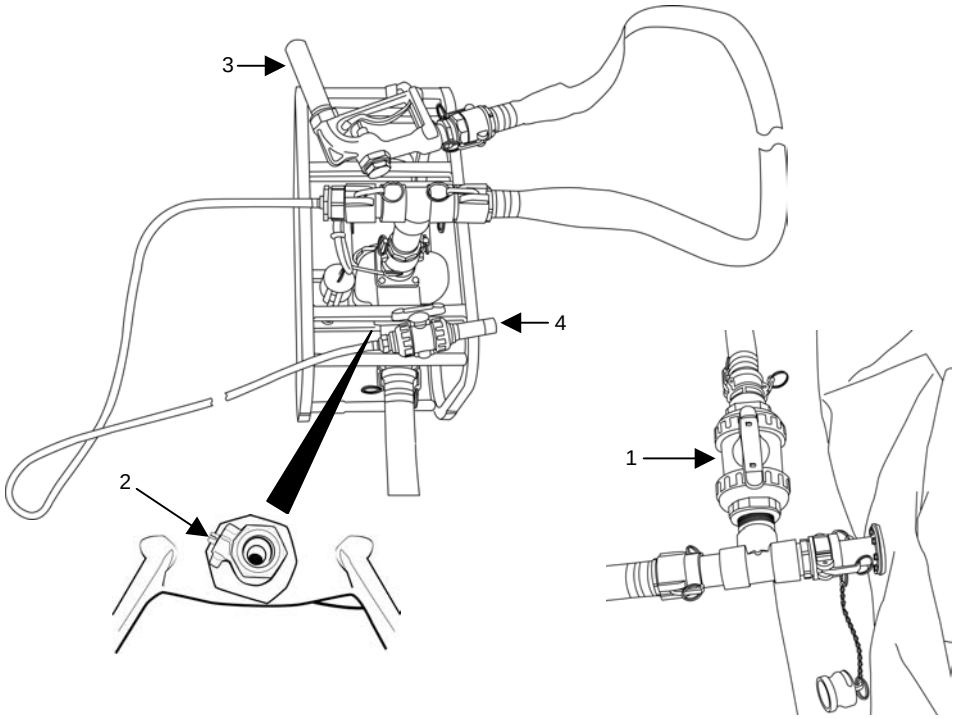


Table 13. Water Distribution System Controls.

ITEM	CONTROL	FUNCTION
1	ADAPTOR A-07 SHUT-OFF VALVE V-521.	Normally open. Closed when needed to stop flow from distribution tanks, such as to replace a distribution hose with the auxiliary hose.
2	P-7 MOTOR-DRIVEN RAW WATER PUMP DRAIN VALVE V-520.	Normally closed. Open for shutdown. Drain requires screwdriver to operate.
3	DISTRIBUTION NOZZLES V-523A AND V-523B.	Used for distribution of product water.
4	AUX HOSE VALVE V-522.	Used for RO feed tank fill for cleaning and general purpose water use.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

EXTENDED PRODUCT WATER DISTRIBUTION SYSTEM CONTROLS

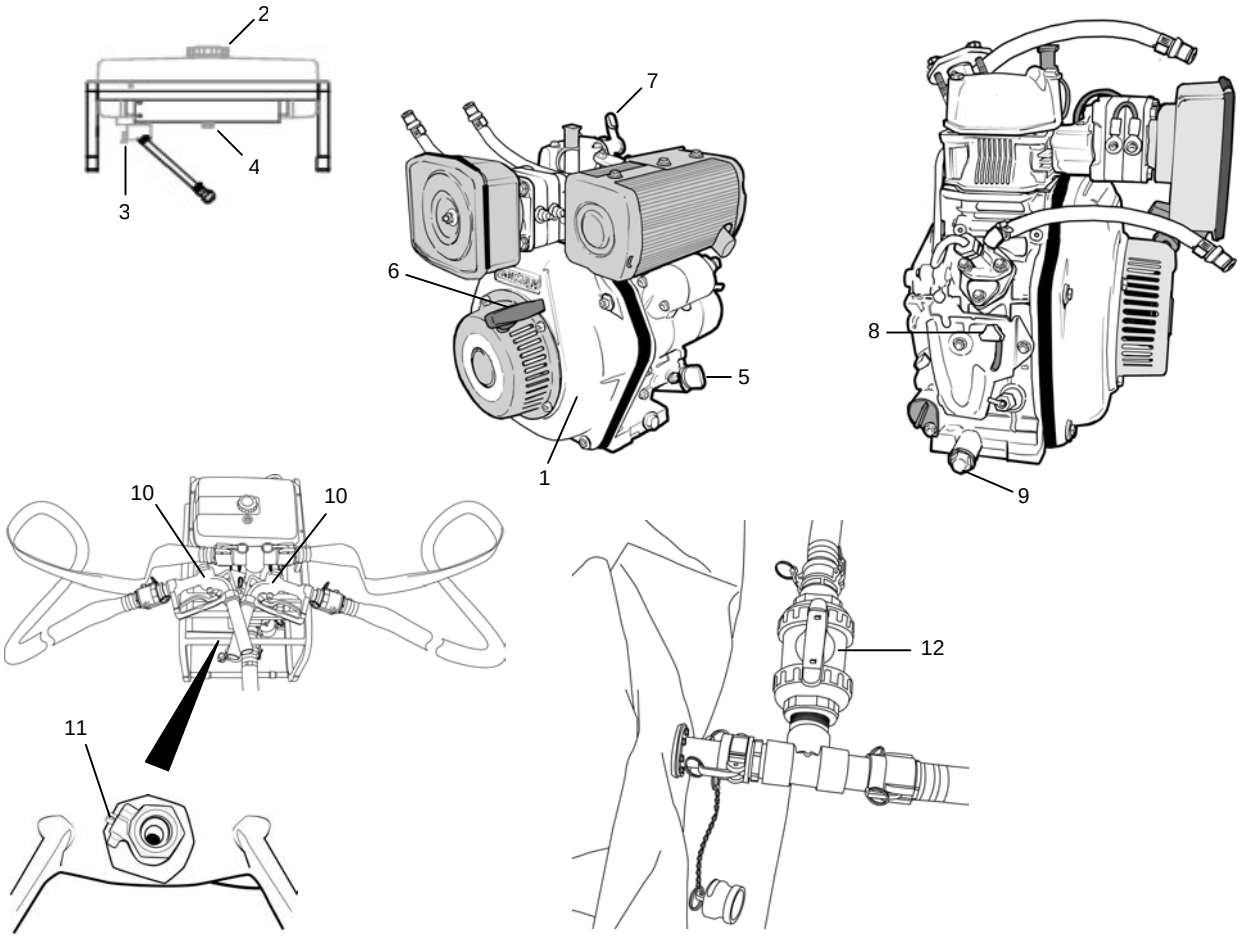


Table 14. Water Distribution System (9000 Gallon) Controls.

ITEM	CONTROLS AND INDICATORS	FUNCTION
1	P-1 DIESEL PUMP ENGINE	First pump in the raw water system when two pumps are required.
2	FUEL CAP	Allows for adding diesel fuel to P-1 Diesel Engine.
3	FUEL COCK	Allows for opening and closing of the fuel flow to P-1 Diesel Engine.
4	FUEL DRAIN PLUG	Allows for removing diesel fuel from P-1 Diesel Engine fuel tank.
5	OIL LEVEL DIP STICK	Displays oil level in P-1 Pump Diesel Engine.
6	RECOIL STARTER HANDLE	Allows for manual starting of P-1 Diesel Engine.
7	ENGINE DECOMPRESSION LEVER	Relieves P-1 diesel engine compression for starting.
8	ENGINE CONTROL LEVER	Controls the engine speed of P-1 Diesel Engine.
9	OIL DRAIN PLUG.	Allows for draining oil in P-1 Pump Diesel Engine.
10	DISTRIBUTION NOZZLES V-523C AND V-523D.	Used for distribution of product water.
11	P8 DIESEL PUMP DRAIN VALVE V-524.	Normally closed. Open for shutdown. Drain requires screw driver to operate.
12	ADAPTOR A-07 SHUT-OFF VALVE V-521.	Normally open. Closed when needed to stop flow from distribution tanks, such as to replace a distribution hose with the auxiliary hose.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

COLD WEATHER KIT CONTROLS

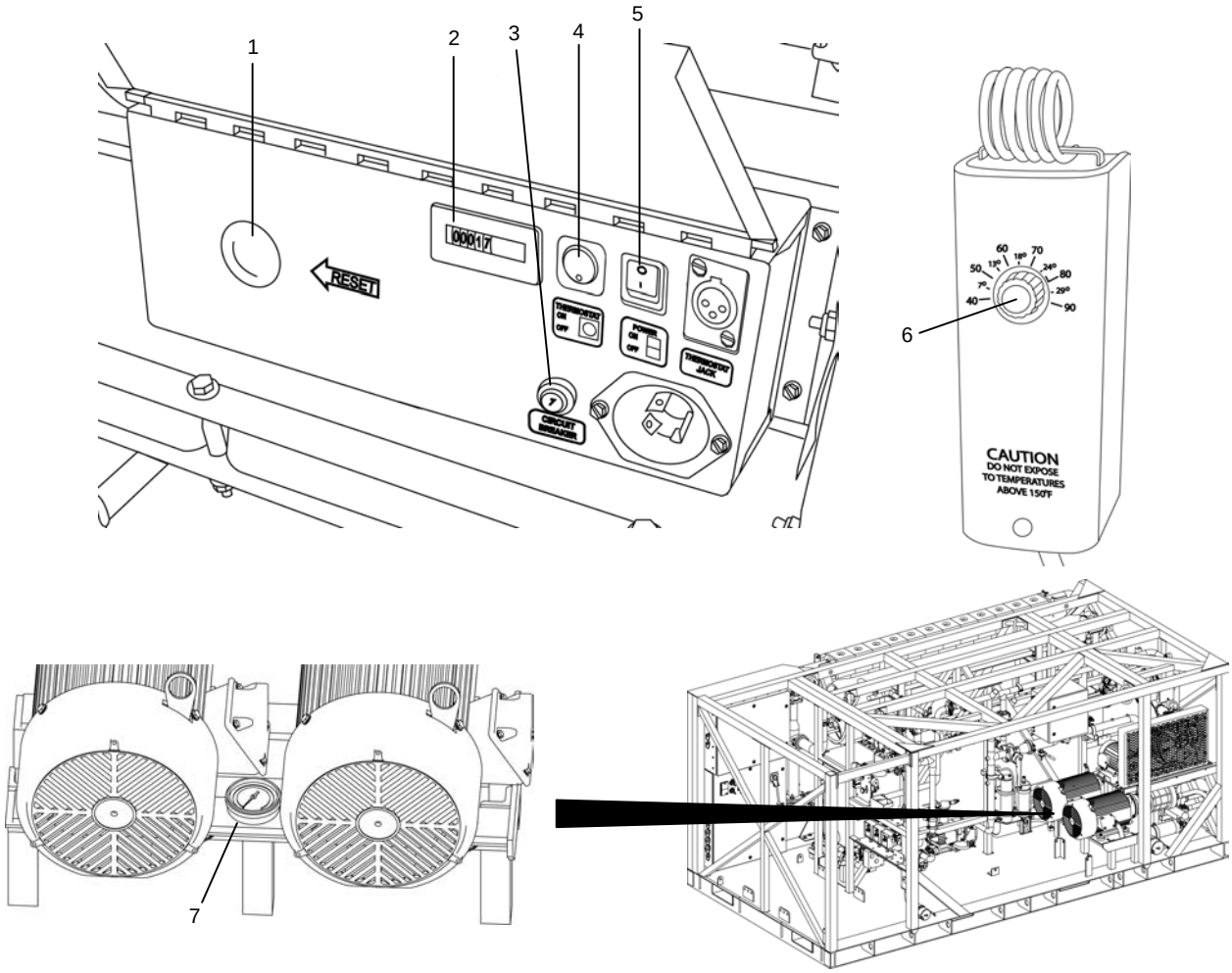


Table 15. Cold Weather Kit Controls.

ITEM	CONTROLS AND INDICATORS	FUNCTION
1	SAFETY CONTROL RESET	Reset the control circuits after an automatic space heater shut-down due to failure of the heater to ignite, the flame going out, duct temperature in excess of about 275 degrees F, or the heater tilting more than 30 degrees from level.
2	ELAPSED TIME METER	Meters the time that the diesel heater is in operation.
3	CIRCUIT BREAKER, 7 AMP	Protects the space heater circuits from excessive current.
4	THERMOSTAT ON/OFF	In the ON position, thermostat controls space heater on and off to hold set temperature. In the OFF position, the space heater runs continuously.
5	POWER ON/OFF SWITCH	Start and stop the diesel-fired space heater.
6	THERMOSTAT	Controls the operation of the space heater to maintain temperature inside the TWPS.
7	TEMPERATURE GAUGE	Indicates air temperature inside the TWPS. Standard on both A-TWPS and MC-TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0011 00**
OPERATOR INSTRUCTIONS
DESCRIPTION & USE OF OPERATOR CONTROLS & INDICATORS

TACTICAL QUIET GENERATOR CONTROLS AND INDICATORS

See Army TM 5-6115-545-12 for the Operator Controls and Indicators.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS ESTABLISHING ELECTRICAL POWER – OPERATION UNDER USUAL CONDITIONS

0012 00

INITIAL SETUP

Personnel Required
One Operator/Crew
Equipment Condition:
TWPS skid removed from transport vehicle and set on level ground.
Loose items unpacked (off-loaded) from the TWPS skid and placed in their general operational position.
Set-up started.

GENERAL:

Electrical power to the TWPS must be established as early as possible during TWPS set-up. The reason for this is the time required to fill the MF feed tank and the time required to pressurize the air tank. A sufficient MF feed water supply is required to support potable water production and the automatic backwash operation before water can be processed through the TWPS. If the motor-operated raw water pump is used, electrical power is required to run the pump. A minimum air pressure is required for the automatic backwash operation before the TWPS can be operated. Electrical power is required to run the compressor that pressurizes the air tank. For these reasons, in order to get the TWPS producing clean water in the shortest time possible, it is recommended that one person perform the steps described in this WP for establishing electrical power while others set up the equipment. Refer to the planning guide provided in WP 0007.

This WP contains the procedures for establishing electrical power at the TWPS. The procedures covered in this work package include:

- Generator Voltage Selection and Cable Connection
- Ground Rod Assembly Installation
- Preparing the TWPS for Power
- Tactical Quiet Generator Start-Up
- Energizing the TWPS Power Distribution Panel

GENERATOR VOLTAGE SELECTION AND CABLE CONNECTION

CAUTION

Potential electrical component damage. The generator must be set up to provide 416-volts. If set for 220-volts, electrical controls and motors will be damaged.

1. Refer to Tactical Quiet Generator (TQG) TM 5-6115-545-12 and move the output voltage selector plate to 416-Volts (High Wye).
2. Connect the TWPS power cable leads to the L1, L2, L3 lugs according to the labels.
3. Connect the TWPS power cable white lead to the Neutral lug and the green lead to the Ground lug.
4. When the air compressor is started, check the direction of rotation. The correct rotation is counter-clockwise.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS ESTABLISHING ELECTRICAL POWER – OPERATION UNDER USUAL CONDITIONS **0012 00**

GROUND ROD ASSEMBLY INSTALLATION

The ground rod assembly is used to ground the Tactical Quiet Generator (TQG) and the TWPS to protect operators and equipment. Ground the TQG and TWPS using the ground rod assembly as follows:

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. A good ground is required to protect operators and equipment. The ground rod must be driven into the ground at least 8 ft. and the grounding cable must be securely attached to the grounding lugs to ensure a good electrical ground. Failure to properly ground the generator and the TWPS container could result in injury or death from electrical shock.

1. Gather the following components (see Figure 2):
    a. Three ground-rod sections with three collars and one cable clamp.
    b. Slide rod.
    c. Slide hammer.
    d. Ground rod installation hardware package (striker plate, two nuts, and one lock washer).
    e. One ground cable.

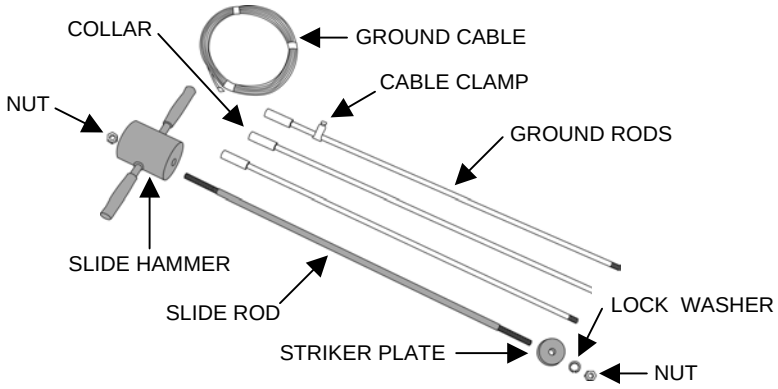


Figure 1. Ground Rod Assembly Components.

2. Select a location to install the ground rod assembly that meets the following criteria:
    a. The assembled ground rods can be sunk into the earth at least 8 ft.
    b. The ground cables will not be ripped loose by vehicle travel.
    c. The ground rods and cables will not present a safety hazard to personnel.
3. Assemble the slide hammer assembly as follows (see Figure 2):
    a. Thread the striker plate completely on to one end of the slide rod.
    b. Secure the striker plate to the slide rod with a lock washer and nut. Thread the nut all the way onto the rod.
    c. Slide the hammer down over the other end of the slide rod.

d. Thread the second nut onto the end of the slide rod. (The hammer should be able to slide freely up and down the slide rod between the striker plate on the one end and the nut on the other end.)

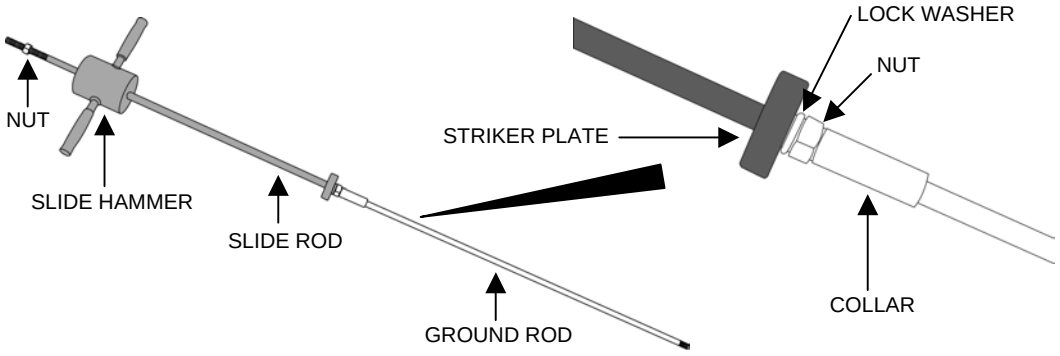


Figure 2. Slide Hammer Assembled to Drive the First Ground Rod.

WARNING

To prevent damage to the slide rod, ground rod, or collar threads, make sure that the slide rod and ground rods bottom out against each other (are threaded completely together.) Any slop in the connection will lead to damaged threads.

4. Drive the first ground rod into the ground as follows:
   a. Thread the striker plate end of the slide hammer assembly all the way into the collar of the first ground rod until the slide rod bottoms out against the ground rod.
   b. Using the slide hammer, drive the first ground rod into the ground leaving about 3 in. exposed.
5. Thread a second ground rod onto the first ground rod and drive both into the ground as follows:
   a. Unthread the slide hammer assembly from the collar of the first ground rod.
   b. Thread a second ground rod all the way into the collar of the first ground rod that is already in the ground.
   c. Thread the slide hammer assembly all the way into the collar at the top of the second ground rod until the slide rod bottoms out against the ground rod.
   d. Drive the assembled first and second rods into the ground leaving approximately 3 in. of the second ground rod exposed.
6. Thread a third ground rod onto the second ground rod and drive into the ground as follows:
   a. Unthread the slide hammer assembly from the collar of the second ground rod.
   b. Thread a third ground rod all the way into the collar at the top of the second ground rod.
   c. Thread the slide hammer assembly all the way into the collar at the top of the third ground rod until the slide rod bottoms out against the ground rod.
   d. Drive the assembled first, second, and third ground rods into the ground leaving approximately one foot of the third ground rod exposed.
7. Uncoil the ground cable. Secure one end of the cable to the rod using the cable clamp. Unscrew the nut from the grounding lug to expose the slot in the lug.
8. Connect the other end of the ground cable to the generator ground lug and tighten the lug nut securely.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0012 00**
OPERATOR INSTRUCTIONS
ESTABLISHING ELECTRICAL POWER – OPERATION UNDER USUAL CONDITIONS

PREPARING THE TWPS FOR POWER

Perform the following steps before starting the TQG.

1. (A-TWPS only) Make sure the bail bar is lowered (WP 0007)
2. Perform all "BEFORE" PMCS (preventive maintenance checks and services) listed in the PMCS WP 0038.
3. Place the fire extinguisher near the ground rod if not already moved to this location.
4. Set the Main Circuit Breaker (lever on the front of the Power Distribution Panel – PDP) to OFF (see Figure 3).

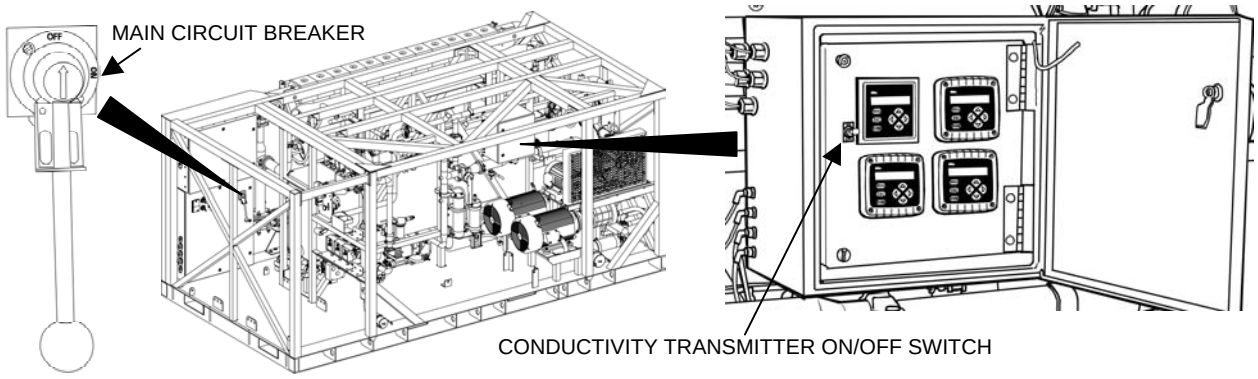


Figure 3. Main Circuit Breaker OFF.

5. Set the following Operator Control Panel switches to the positions indicated:
   a. Mode to STANDBY
   b. MF Clean to OFF
   c. Emergency Stop to OUT
   d. Air Compressor to OFF
   e. Bisulfite Pump to OFF
   f. Antiscale/Chlorine to AUTO
   g. MF Test to OFF
   h. Hose/Pump Heaters to OFF
   i. Tank Heaters to OFF
6. Open the instrument/solenoid panel and make sure the conductivity transmitter ON/OFF switch is at the ON position (see Figure 3).

TACTICAL QUIET GENERATOR START-UP

WARNING

High voltage electrical hazard. Do not attempt to start the generator set if it has not been properly grounded. Failure to observe this warning could result in electrocution.

High voltage electrical hazard. High voltage is produced when the generator set is in operation. Improper operation could result in personal injury or death.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0012 00
OPERATOR INSTRUCTIONS
ESTABLISHING ELECTRICAL POWER – OPERATION UNDER USUAL CONDITIONS

CAUTION

Potential starter damage. Do not crank the generator engine in excess of fifteen seconds. Allow the starter to cool at least fifteen seconds between attempted starts. Failure to observe this caution could result in damage to the starter.

1. Make sure all generator set access doors, except the control panel access door, are closed.
2. Start up the Tactical Quiet Generator (TQG) as described in TM 5-6115-545-12.

ENERGIZING THE TWPS POWER DISTRIBUTION PANEL

WARNING

Potential electrical hazard. Other personnel are setting up the raw water system of the TWPS. Part of this set-up includes connecting raw water and MF feed pump skid power cords to the PDP. Let the other set-up personnel know when you are ready to make any pump power cable connections to the PDP. The panel may be energized to power the air compressor (and the heater during cold weather deployment) before the pump power cable connections are completed. The PDP must be de-energized by switching the Main Breaker to OFF before making pump power cable connections. Failure to observe this warning may result in injury or death due to electrocution.

Energize the PDP as follows:

1. Perform the following notifications and checks:
    a. Tell the other set-up personnel that you are ready to establish electrical power.
    b. If the pump power cables are connected, check that the raw water and MF feed pump power cable(s) has/have been properly connected at the pump skid(s) and at the PDP.
2. Energize the PDP as follows:
    a. Switch the Main Circuit Breaker on the PDP to ON.
    b. Check that the Power On light on the Operator Control Panel (OCP) is on. If it is not on, check that the Emergency Stop button is pulled out.
    c. If the alarm horn goes on, toggle the Alarm Switch to RESET to clear the power-up alarms, then set the switch to SILENCE.
3. Notify the other set-up personnel that the PDP has been energized.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0013 00**
OPERATOR INSTRUCTIONS
PRE-OPERATIONAL DIAGNOSTIC SELF TEST PROCEDURES –
OPERATION UNDER USUAL CONDITIONS

INITIAL SETUP

Personnel Required:
One Operator/Crew
Equipment Condition:
Electrical power to the TWPS has been established.
The air compressor has been started.
Pressure gauge PI-902 reads over 90 psig.

GENERAL

This section describes the TWPS Electrical Pre-Operational Diagnostic Self-Test Procedures. These built-in-tests (BIT) check the operation of the lamps, displays, and alarm horn on the OCP (Operator Control Panel). The tests also check the operation of automatic (PLC operated) valves on the TWPS. It is not necessary for water to be in the TWPS to perform the Diagnostic Self-Tests, but a minimum air pressure of 90 psig is required for the TWPS to operate the automatic valves.

A single-page summary of the tests is included in Table 1 at the end of this Work Package.

DIAGNOSTIC SELF-TESTS

Perform the diagnostic self-tests as follows:

1. Make sure that electrical power to the TWPS has been established as described in WP 0012, Establishing Electrical Power.
2. Make sure that the Air Compressor had been started as described in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained.
3. Check the pressure reading at backwash and actuator air pressure gauge PI-902 (see Figure 1). The pressure must read over 90 psig before the diagnostic self-tests can be run. If the pressure is not over 90 psig, make sure the air compressor is on and wait until gauge PI-902 reads over 90 psig.

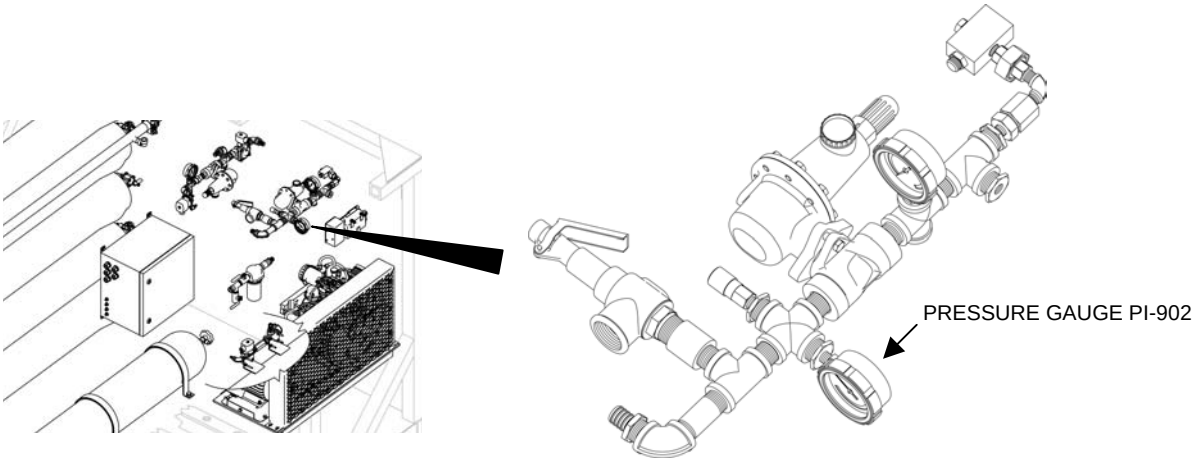

Figure 1. Pressure Gauge PI-902 Location.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0013 00**
OPERATOR INSTRUCTIONS
PRE-OPERATIONAL DIAGNOSTIC SELF TEST PROCEDURES –
OPERATION UNDER USUAL CONDITIONS

4. Make sure the SYSTEM MODE SWITCH on the OCP is switched to STANDBY.
5. Perform Test # 1 (Lamp Test) as follows:
    a. Press the TEST button on the OCP and hold until the number one (1) is displayed at the Test BIT Code LCD (about 5 seconds).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions and notify Unit Maintenance about the failed lamp(s).

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
1	Lamp	All indicator lamps along the top two rows of the OCP and the MF Backwash Start pushbutton lamp in the bottom row and the compressor switch should be lit.	Continue with operation. Notify Unit Maintenance about failed lamp.

6. Perform Test #2 (Display Test) as follows:
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number two (2).
    b. Check the expected result shown below for each LCD display. If the test fails, perform the "Action on Failure" instructions and notify Unit Maintenance about the failed LCD.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
2	Feed Water TDS LCD Display	Display should count up from zero.	Continue with operation. Use portable TDS meter.
	MF Flow LCD Display	Display should count up from zero.	Continue with operation.
	MF Trans-Membrane Pressure LCD Display	Display should count up from zero.	Continue with operation. Subtract MF Filtrate Pressure Gauge PI-201 reading from MF Feed Pressure Gauge PI-101 reading to calculate the TMP.
	RO Feed Flow LCD Display	Display should count up from zero.	Continue with operation.
	RO Feed Pressure LCD Display	Display should count up from zero.	Continue with operation. Use RO Feed Pressure Gauge PI-304 when RO feed pressure is needed during operation.
	RO Reject Flow LCD Display	Display should count up from zero.	Continue with operation.
	RO Feed Tank Level % LCD Display	Display should count up from zero.	Continue with operation.
	RO % Salt Rejection LCD Display	Display should count up from zero.	Continue with operation.
	Product Flow LCD Display	Display should count up from zero.	Continue with operation. Subtract the reject flow reading from 56 (feed flow) to obtain an estimate of the product flow when product flow is needed during operation.
	Product TDS LCD Display	Display should count up from zero.	Continue with operation. Use portable TDS meter when TDS readings are needed.
	Total Product Water LCD Display	Display shows test sequence number.	Continue with operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0013 00**
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7. Check that each of the following automatic valves are in the indicated de-energized position (see Figure 2 for valve location). If they are not in the correct position, refer to troubleshooting:
   - V-111 De-energized Open (yellow arrow on top of actuator points inline with pipe)
   - V-112 De-energized Open (yellow arrow on top of actuator points inline with pipe)
   - V-113 De-energized partially closed (yellow arrow on top of actuator not quite inline with pipe)
   - V-201 De-energized Open (yellow arrow on top of actuator points inline with pipe)
   - V-202 De-energized Open (window on top of actuator is yellow)
   - V-401 De-energized Closed (yellow arrow on top of actuator points away from pipe)
   - V-402 De-energized Closed (yellow arrow on top of actuator points away from pipe)

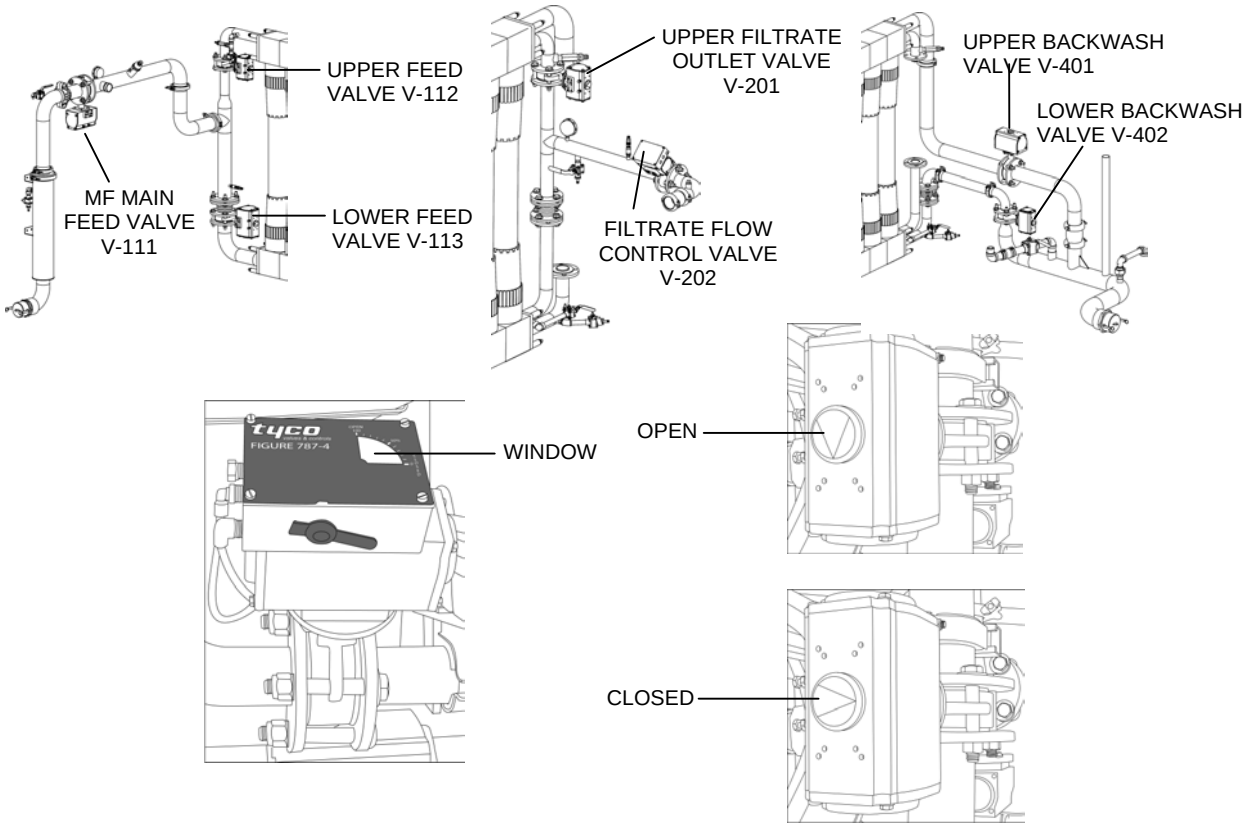

Figure 2. Automatic Valves.

8. Perform Test #3 (Alarm Horn Test) as follows:
   a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number three (3).
   b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions and notify Unit Maintenance about the failed alarm horn.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
3	Alarm Horn	Alarm horn sounds until BIT Test 4 is started.	Continue with operation

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0013 00**
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9. Perform Test #4 (V-111 Valve Cycle Test) as follows (see Figure 2 for valve location):
    a. Press the test button to silence the alarm and advance the test sequence number at the Test BIT Code LCD to the number four (4).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
4	V-111 Valve Cycle	V-111 closes (yellow arrow on top of actuator points away from pipe)	Refer to troubleshooting

10. Perform Test #5 (V-112 Valve Cycle Test) as follows (see Figure 2 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number five (5).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
5	V-112 Valve Cycle	V-112 closes (yellow arrow on top of actuator points away from pipe)	Refer to troubleshooting

11. Perform Test #6 (V-113 Valve Cycle Test) as follows (see Figure 2 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number six (6).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
6	V-113 Valve Cycle	V-113 opens (yellow arrow on top of actuator points inline with pipe)	Refer to troubleshooting

12. Perform Test #7 (V-201 Valve Cycle Test) as follows (see Figure 2 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number seven (7).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
7	V-201 Valve Cycle	V-201 closes (yellow arrow on top of actuator points away from pipe)	Refer to troubleshooting

13. Perform Test #8 (V-202 Valve Cycle Test) as follows (see Figure 2 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number eight (8).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
8	V-202 Valve Cycle	V-202 closes (window on top of actuator is black)	Refer to troubleshooting

14. Perform Test #9 (V-401 Valve Cycle Test) as follows (see Figure 2 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number nine (9).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
9	V-401 Valve Cycle	V-401 opens (yellow arrow on top of actuator points inline with pipe)	Refer to troubleshooting

15. Perform Test #10 (V-402 Valve Cycle Test) as follows (see Figure 2 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number ten (10).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
10	V-402 Valve Cycle	V-402 opens (yellow arrow on top of actuator points inline with pipe)	Refer to troubleshooting

16. Perform Test #11 (XV-901 Valve Cycle Test) as follows (see Figure 3 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number eleven (11).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
11	XV-901 Valve Cycle	XV-901 cycles on and off three times	Refer to troubleshooting

17. Perform Test #12 (XV-902 Valve Cycle Test) as follows (see Figure 3 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number twelve (12).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
12	XV-902 Valve Cycle	XV-902 cycles on and off three times	Refer to troubleshooting

18. Perform Test #13 (XV-903 Valve Cycle Test) as follows (see Figure 3 for valve location):
    a. Press the test button to advance the test sequence number at the Test BIT Code LCD to the number thirteen (13).
    b. Check the expected result shown below. If the test fails, perform the "Action on Failure" instructions.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
13	XV-903 Valve Cycle	XV-903 cycles on and off three times	Refer to troubleshooting

19. Press the test button to exit the diagnostics. All valves return to their de-energized positions and the BIT Code LCD returns to the number zero (0).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0013 00**
OPERATOR INSTRUCTIONS
PRE-OPERATIONAL DIAGNOSTIC SELF TEST PROCEDURES –
OPERATION UNDER USUAL CONDITIONS

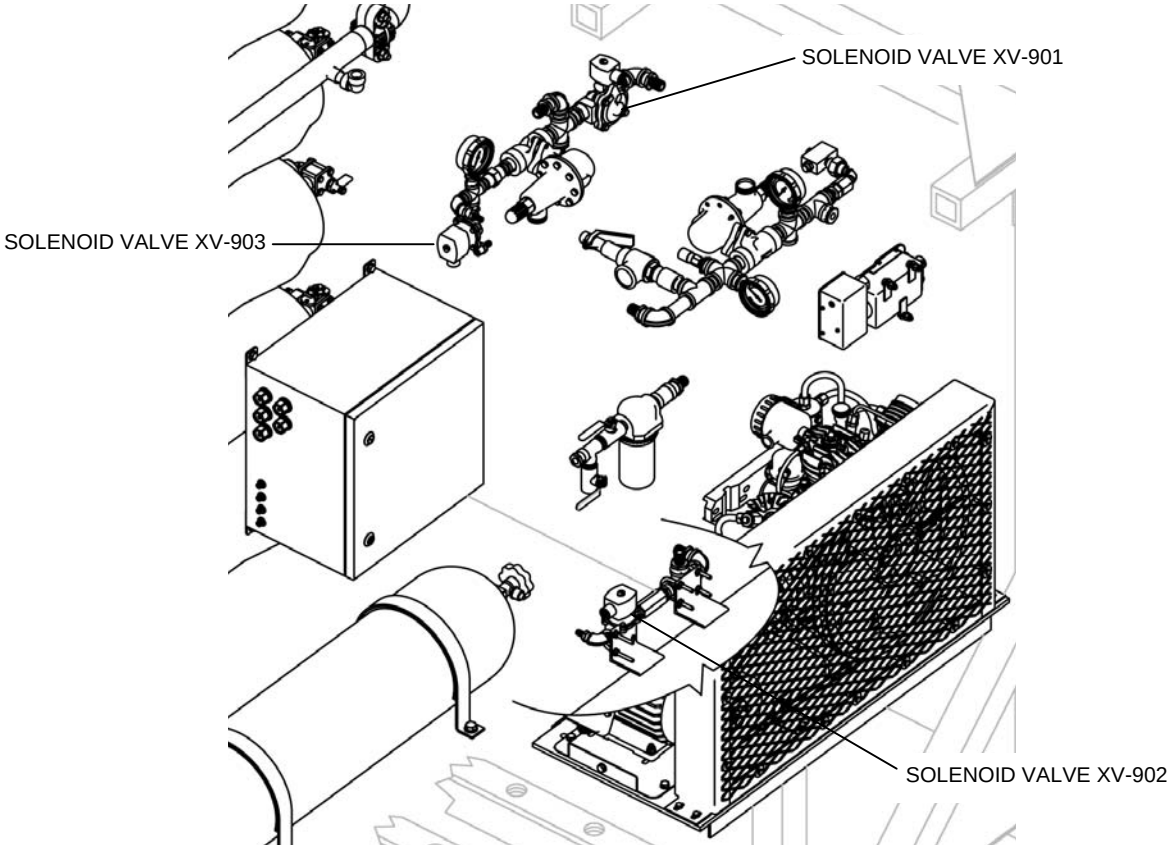

Figure 3. Solenoid Valves XV-901, XV-902, and XV-903 Location.

START-UP PROCEDURES

If this is an initial start-up or if the TWPS has been shut down for more than 54 hours with the unit fully drained and preserved, refer to WP 0014, Initial Start-Up or Start-Up with the System Fully Drained, to start the TWPS. If the TWPS has been shut down for less than 54 hours without being drained, refer to WP 0015, Start-Up After a Short Term or Standby Shut-Down without Draining, to start the TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS PRE-OPERATIONAL DIAGNOSTIC SELF TEST PROCEDURES – OPERATION UNDER USUAL CONDITIONS

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Table 1. Diagnostic Self-Tests Summary.

TEST #	TEST	EXPECTED RESULT	ACTION ON FAILURE
1	Lamp	All indicator lamps along the top two rows of the OCP and the MF Backwash Start pushbutton lamp in the bottom row and the compressor switch should be lit.	Continue with operation. Notify Unit Maintenance about failed lamp.
2	Feed Water TDS LCD Display	Display should count up from zero.	Continue with operation. Use portable TDS meter.
	MF Flow LCD Display	Display should count up from zero.	Continue with operation.
	MF Trans-Membrane Pressure LCD Display	Display should count up from zero.	Continue with operation.
	RO Feed Flow LCD Display	Display should count up from zero.	Continue with operation.
	RO Feed Pressure LCD Display	Display should count up from zero.	Continue with operation. Use RO Feed Pressure Gauge PI-304 when RO feed pressure is needed during operation.
	RO Reject Flow LCD Display	Display should count up from zero.	Continue with operation.
	RO Feed Tank Level % LCD Display	Display should count up from zero.	Continue with operation.
	RO % Salt Rejection LCD Display	Display should count up from zero.	Continue with operation.
	Product Flow LCD Display	Display should count up from zero.	Continue with operation. Subtract the reject flow reading from 56 (feed flow) to obtain an estimate of the product flow when product flow is needed during operation.
	Product TDS LCD Display	Display should count up from zero.	Continue with operation. Use portable TDS meter when TDS readings are needed.
	Total Product Water LCD Display	Display shows test sequence number.	Continue with operation.

Check that the following automatic valves are in the indicated positions:			
	V-111 MF Main Feed Valve	Open	Refer to troubleshooting
	V-112 Upper Feed Valve	Open	Refer to troubleshooting
	V-113 Lower Feed Valve	Partially Closed	Refer to troubleshooting
	V-201 Upper Filtrate Outlet Valve	Open	Refer to troubleshooting
	V-202 Filtrate Flow Control Valve	Open	Refer to troubleshooting
	V-401 Shell Backwash Upper Outlet Valve	Closed	Refer to troubleshooting
	V-402 Shell Backwash Lower Outlet Valve	Closed	Refer to troubleshooting

3	Alarm Horn	Alarm horn sounds until BIT Test 4 is started.	Continue with operation
4	V-111 Valve Cycle	V-111 closes (yellow arrow on top of actuator points away from pipe)	Refer to troubleshooting
5	V-112 Valve Cycle	V-112 closes (yellow arrow on top of actuator points away from pipe)	Refer to troubleshooting
6	V-113 Valve Cycle	V-113 opens (yellow arrow on top of actuator points inline with pipe)	Refer to troubleshooting
7	V-201 Valve Cycle	V-201 closes (yellow arrow on top of actuator points away from pipe)	Refer to troubleshooting
8	V-202 Valve Cycle	V-202 closes (window on top of actuator is black)	Refer to troubleshooting
9	V-401 Valve Cycle	V-401 opens (yellow arrow on top of actuator points inline with pipe)	Refer to troubleshooting
10	V-402 Valve Cycle	V-402 opens (yellow arrow on top of actuator points inline with pipe)	Refer to troubleshooting
11	XV-901 Valve Cycle	XV-901 cycles on and off three times	Refer to troubleshooting
12	XV-902 Valve Cycle	XV-902 cycles on and off three times	Refer to troubleshooting
13	XV-903 Valve Cycle	XV-903 cycles on and off three times	Refer to troubleshooting

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0013 00**
OPERATOR INSTRUCTIONS
PRE-OPERATIONAL DIAGNOSTIC SELF TEST PROCEDURES –
OPERATION UNDER USUAL CONDITIONS

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED – OPERATION UNDER USUAL CONDITIONS

0014 00

INITIAL SETUP

Reference:
A-TWPS WQAS-P TM 10-6630-222-12 & P
Personnel Required
One Operator/Crew
Equipment Condition:
System fully set up and drained. All applicable PMCS has been performed.

INTRODUCTION

This work package contains the procedures for the initial start-up of the TWPS unit or the start-up of the TWPS unit when the system is fully drained. The procedures describe start-up under usual conditions using one or both raw water pumps and either the floating intake or the OISS.

The procedures covered in this work package include:

- PMCS (WP 0038)
- Establishing Electrical Power (WP 0012)
- Air Compressor Start-Up
- Initial Inspections, Checks and Adjustments
- Performing Pre-Operational Diagnostic Self-Tests (WP 0013)
- Sodium Bisulfite Chemical System Start-Up
- Establishing Raw Water Flow with Both Raw Water Pumps
- Establishing Raw Water Flow with Only the Electric Raw Water Pump
- Flushing Preservative/ Cleaning Solution
- Micro-Filtration System Start-Up
- RO System Start-Up
- Antiscalant and Hypochlorite Chemical Systems Start-Up
- Completing Start-Up

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0014 00**
OPERATOR INSTRUCTIONS
INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED – OPERATION UNDER USUAL CONDITIONS

INITIAL INSPECTIONS, CHECKS AND ADJUSTMENTS

Make sure the applicable Preventive Maintenance Checks and Services (PMCS) have been performed in accordance with WP 0038, PMCS.

ESTABLISHING ELECTRICAL POWER

Make sure that electrical power to the TWPS has been established as described in WP 0012, Establishing Electrical Power.

AIR COMPRESSOR START-UP

Start up the compressor as follows:

1. Check the oil level dipstick. If the oil level is below the add oil mark, add oil to the top of the mark.
2. Start the air compressor as follows:
    a. Make sure LP Air Vent Valve V-910 is closed.
    b. Make sure High Pressure Air Vent Valve V-904 is closed.
    c. Make sure the Air Receiver Tank Valve V-907 is open.
    d. Turn the AIR COMPRESSOR SWITCH on the OCP to AUTO.

INITIAL INSPECTIONS, CHECKS AND ADJUSTMENTS

1. Make sure that the product water hose is disconnected from the product water distribution tank.
2. Using Table 1 and Figure 2, check that the valves are in the indicated start-up position. On the TWPS skid, the valves are listed starting from the Operator Control Station moving counter clockwise around the skid.

NOTE

Direct all drain hose ends off the TWPS when checking the position of drain valves.

The Product RO Element 3-Way Valves are in the normal position when the middle pointer on the valve handle is pointing to the black product hose (see Figure 1). The handle itself may be pointing toward or away from the product pipe depending on the RO vessel.

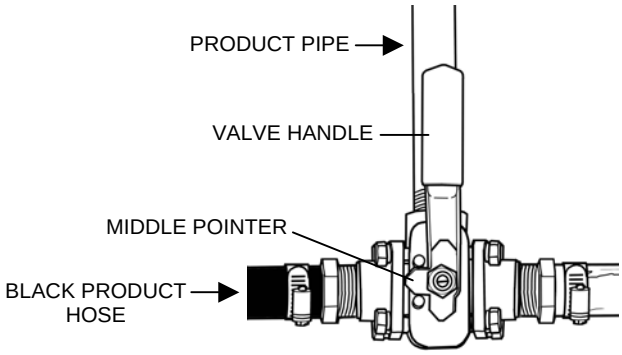

Figure 1. RO Element 3-Way Valve in the Normal Position.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0014 00**
OPERATOR INSTRUCTIONS
INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED – OPERATION UNDER USUAL CONDITIONS

Table 1. Valve Start-Up Position – Initial Startup or Fully Drained.

✓	VALVE NAME AND NUMBER	POSITION
	P-1 Diesel Pump Drain Valve V-103	Closed
	P-2 Electric Pump Drain Valve V-105	Closed
	P-3 Electric MF Feed Pump Drain Valve V-108	Closed
	MF Vent Valve V-114	Closed
	Product RO Element 3-Way Valves, left end, V-502, 503, 506, 507, 510	Normal
	RO Vessel Drain Valve V-408	Closed
	Main Pressure Control Valve HCV-401	Full Open
	Auxiliary Pressure Control Valve HCV-401A	Open
	RO Feed Tank Auxiliary Drain Valve V-210	Closed
	Turbocharger Reject Drain Valve V-410	Closed
	Turbocharger Feed Drain Valve V-303	Closed
	Feed Control Selector Valve V-914	Auto
	Strainer S-2 Vent /Sample Valve V-110	Closed
	Strainer S-2 Drain Valve V-109	Closed
	MF Cleaning Feed Valve V-704	Closed
	Clean Mixing Valve V-703	Closed
	RO Clean Feed Valve V-701	Closed
	Clean Return Valve V-702	Closed
	Product Utility Valve V-511	Closed
	Feed Piping Drain Valve V-304	Closed
	HP Pump Outlet Drain Valve V-302	Closed
	HP Pump Inlet Valve V-212	Open
	Strainer S-4 Drain Valve V-213	Closed
	RO Feed pump P-4 Drain Valve V-211	Closed
	Low Pressure Air Vent Valve V-915	Closed
	LP Air Shutoff Valve V-909	Open
	Low Press Air Vent Valve V-910	Closed
	High Press Air Vent Valve V-904	Closed
	Coalescer CO1 Drain Shutoff Valve V-902	Open
	HP Pumps Case Drain Valve V-215	Closed
	HP Pump P-5 and P-6 Inlet Drain Valve V-214	Closed
	HP Pump P-5 and P-6 Outlet Drain Valve V-301	Closed
	Air Compressor Intermediate Filter Drain Valve V-901	Open
	Product RO Element 3-Way Valves, right end, V-501, 504, 505, 508, 509	Normal
	Air Receiver Tank Valve V-907	Open
	RO Feed Tank Main Drain Valve V-412	Closed
	RO Air Purge Valve V-913	Closed
	MF Filtrate Sample/Drain Valve V-204	Closed
	MF Filtrate Drain Valve V-203	Closed
	MF Shell Drain Valve V-403	Closed
	P-7 Electric Pump Drain Valve V-520	Closed
	Auxiliary Hose Valve V-522 (If attached)	Closed
	Distribution Nozzles V-523 A&B	Closed
	P-8 Diesel Pump Drain Valve V-524	Closed
	Distribution Nozzles V-523 C&D	Closed

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0014 00**
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INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED –
OPERATION UNDER USUAL CONDITIONS

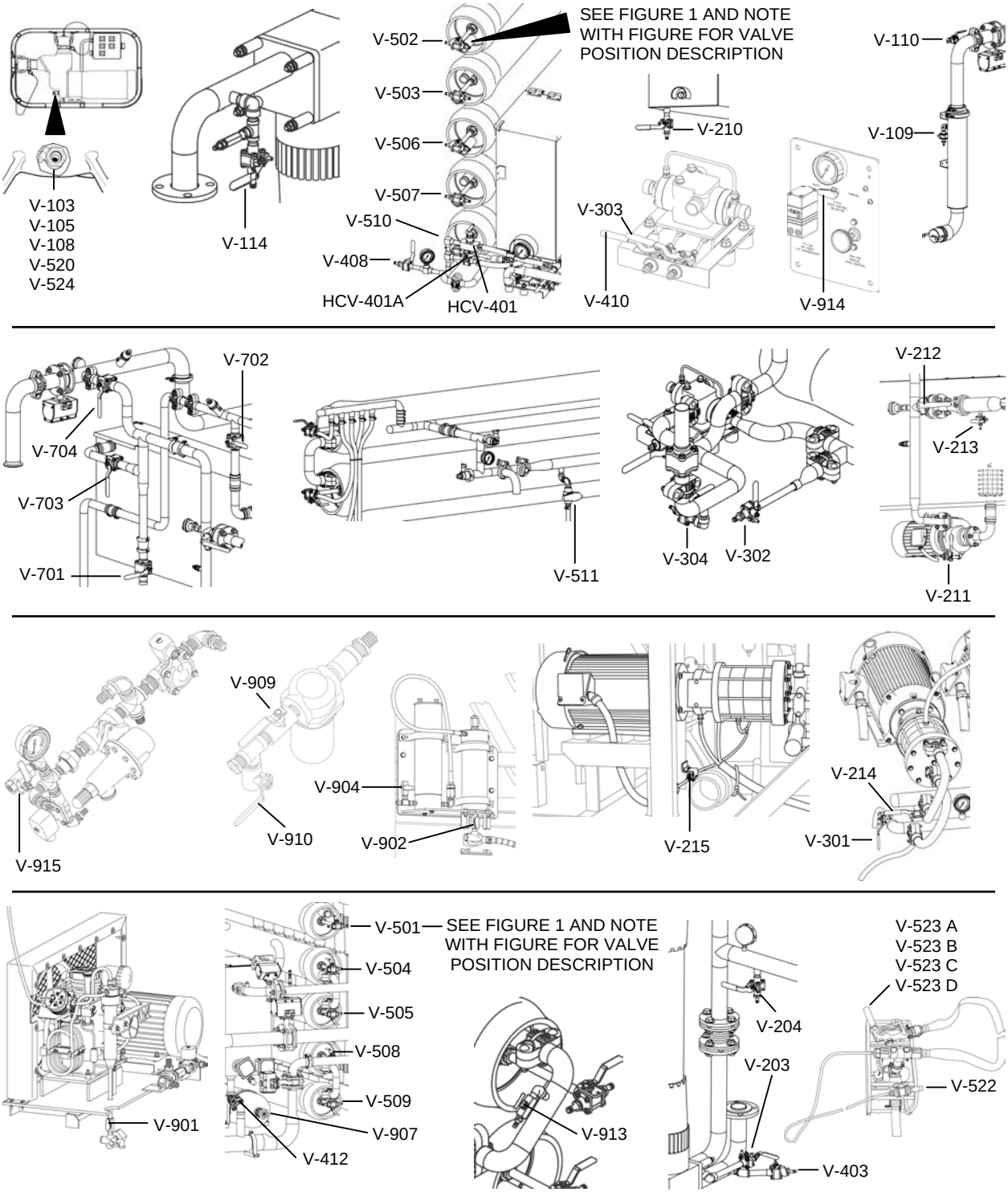

Figure 2. Location of Valves for Start-Up.

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PERFORMING PRE-OPERATIONAL DIAGNOSTIC SELF-TESTS

Perform the pre-operational diagnostic self-test procedure (built-in-tests or BIT) as described in WP 0013.

SODIUM BISULFITE CHEMICAL SYSTEM START-UP

CAUTION

If the raw water source is chlorinated water or well water, the sodium bisulfite chemical system must be set up and started before raw water flow is established. Failure to provide sodium bisulfite injection will result in the destruction of the MF and RO membranes.

NOTE

If the raw water source is NOT chlorinated water or well water, skip this procedure and move on to ESTABLISHING RAW WATER FLOW WITH BOTH RAW WATER PUMPS or ESTABLISHING RAW WATER FLOW WITH ONLY THE ELECTRIC RAW WATER PUMP, depending on how you set up the raw water system.

If the raw water source is chlorinated water or well water, start-up the sodium bisulfite chemical system as follows:

1. Make sure that the sodium bisulfite injection system has been deployed as described in the procedures for **SODIUM BISULFITE INJECTION SYSTEM DEPLOYMENT** in WP 0010, Other Set-Ups – Operation Under Unusual Conditions.
2. Set the Bisulfite Pump switch on the OCP to ON.
3. Make sure that the speed dial on the sodium bisulfite chemical pump is set to OFF (fully counterclockwise) (see Figure 3).
4. Fill the bucket with the blue cover with raw water to the 5-gallon level.

WARNING

Hazardous chemical dust and/or fumes. Wear the protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in irritation of the nose, throat, eyes, and skin.

5. Rinse the mixing paddle with raw water.
6. Pour one 12-ounce packet of sodium bisulfite into the bucket and mix with the water using the mixing paddle.
7. Place the chemical injection pump suction tube and return line hose through the cover hole and into the chemical bucket. Be sure the suction hose inlet rests near the bottom of the bucket, but not flat on the bottom.
8. Turn the speed dial on the chemical pump to 80, note that the pump has started, and then rotate the stroke dial to 80.
9. Rotate the black knob on the priming valve one-half turn.
10. Note that the chemical solution is drawing up the suction tube and entering the pump housing.
11. Rotate the black knob on the priming valve back to its original position when discharge is noted back to the tank and air is not noted in the suction tube or the pump head. The pump is now primed.
12. Set the speed dial to 70%.

13. Set the stroke dial to 60%.
14. Turn the Bisulfite Pump switch on the OCP to AUTO.

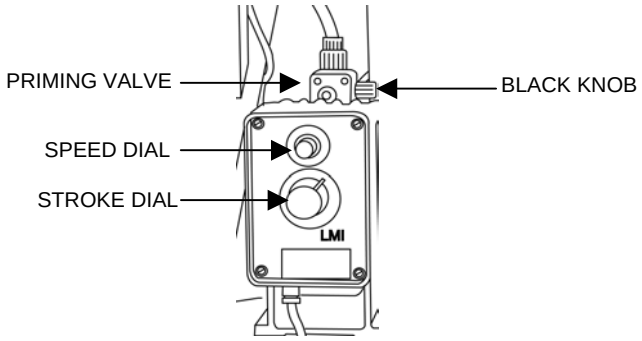

Figure 3. Chemical Pump Controls.

ESTABLISHING RAW WATER FLOW WITH BOTH RAW WATER PUMPS

NOTE

If only the electric raw water pump is deployed, see the procedures for "Establishing Raw Water Flow with Only the Motor-Driven Raw Water Pump" that immediately follow these procedures for "Establishing Raw Water Flow with Both Raw Water Pumps".

1. Set valve positions as follows (see Figure 4 for valve location):
    a. Partially OPEN Raw Water Flow Control Valve V-107 on Adaptor A-05.
    b. Fully OPEN Vent Valve V-102 on Adaptor A-02.
    c. Check that pump Drain Valve V-103 on the diesel-driven pump skid is closed.
2. Disconnect the pump vent hose from the top of Adaptor A-02.
3. Use the priming pitcher to pour water through Vent Valve V-102 until the pump case is full.
4. Reconnect the vent hose.

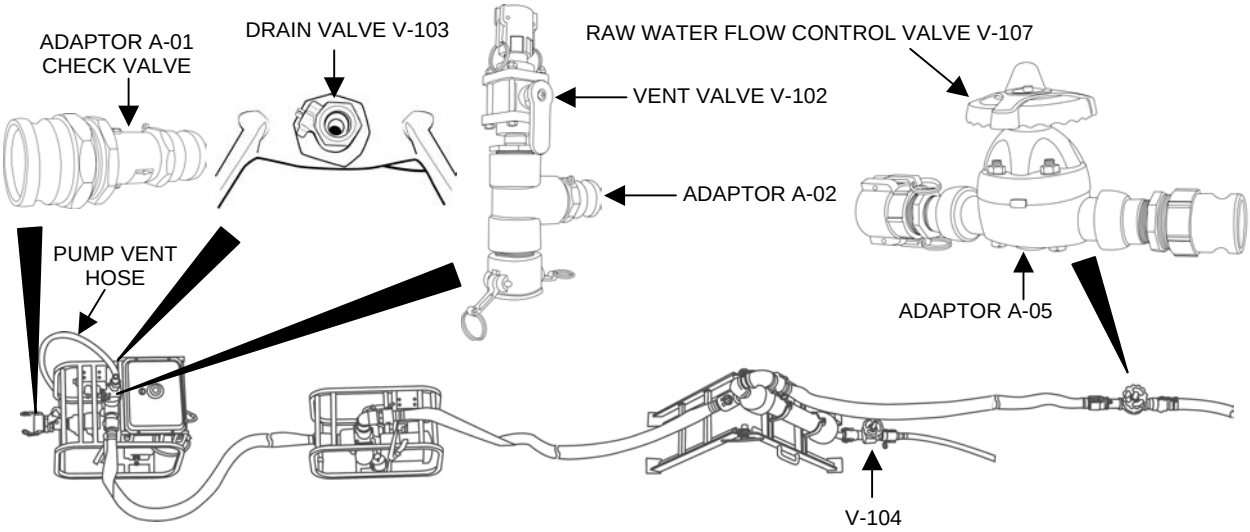

Figure 4. Raw Water System with Both Raw Water Pumps.

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WARNING

Combustion hazard. Fuel the diesel engine in a well ventilated area with the engine stopped. Do not smoke or allow flames or sparks in the area where the engine is fueled or where the fuel is stored. Failure to observe this warning may result in fire and severe injury.

Combustion hazard. Do not overfill the fuel tank. Make sure the filler cap is securely closed after fueling. Be careful not to spill fuel when fueling. If any fuel is spilled, make sure the area is dry before starting the engine. Failure to observe this warning may result in fire and severe injury.

CAUTION

Potential for engine damage. The diesel engine may be damaged if operated with insufficient lube oil. It is also dangerous to supply too much lube oil to the engine because a sudden increase in engine rpm could be caused by its combustion. Failure to observe this caution may result in engine damage.

Potential for engine damage. Only use the correct diesel fuel. Use of the wrong fuel may cause engine damage.

When adding fuel to the fuel tank, be careful not to push the fuel screen filter into the tank.

5. Before starting the diesel engine pump, check the diesel fuel level and engine oil levels in accordance with the PMCS schedule, WP 0038. When checking the oil level, make sure the engine is on a level surface with the engine stopped.
6. Start the diesel engine using the following procedure (see Figure 5).
    a. Set the fuel cock clockwise to the OPEN position.
    b. Put the engine speed lever in the START Position.
    c. Slowly pull out the recoil-starting handle until you feel strong resistance, then return it to the initial position.
    d. Push down the decompression lever. If the lever does not stay down by itself, it may be necessary to pull the recoil starting handle out a little more. The decompression lever will return to the up position automatically when the recoil starter is pulled all the way out to start the engine.
    e. Pull out the recoil starting handle briskly with both hands to start the engine
    f. If the engine fails to start; return to step c (initial start of a new engine may require 6 or more pulls to clear the air from the fuel lines.)
    g. Move the engine speed lever to a middle position to reduce the engine speed to idle.
7. Warm up the engine at idle for about three (3) minutes. Then set the speed lever to START.
8. The pump will draw the air out of the suction hose and pump it through the open Vent Valve V-102 and the vent hose. As the air is removed the water follows.
9. When pressurized water is observed discharging from the vent hose, the pump is primed. Close Vent Valve V-102.

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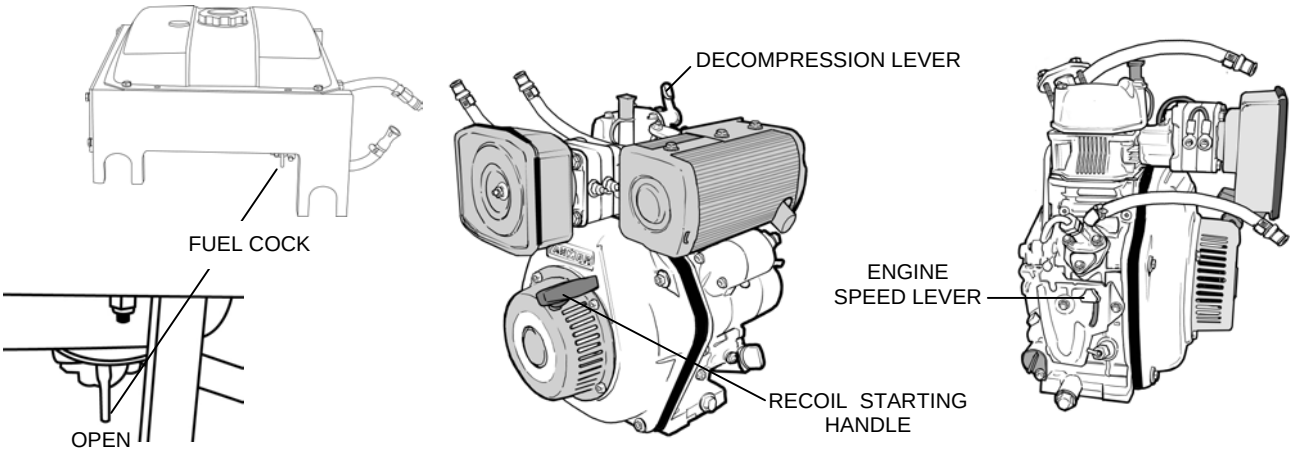

Figure 5. Diesel Engine Controls.

NOTE

The time required to prime the pump will depend on the elevation of the pump (suction lift) and on the length of hose out of the water. The listing below provides typical times to be expected with 30 feet of hose out of water.

Suction Lift (Ft)	Priming Time (Minutes)
5	3 to 5
10	5 to 10
15	10 to 15
20	15 to 20

CAUTION

Potential for overheating. While the pump is evacuating air from the suction hose, the priming water circulates in the pump. After a period of time, the water and pump may get hot. Check the pump regularly with your hand for heating. If the pump starts getting hot, remove the vent hose, add more water to the pump, then reinstall the vent hose. Repeat as needed to keep the pump cool until it begins pumping water. Failure to observe this caution may result in overheating and damage to the pump.

10. If the expected time for priming is exceeded, stop the pump and check all of the hose couplings that are out of the water. Specifically check the gaskets to be certain that they are free of sand and dirt. Remove Check Valve Adaptor A-01 (see Figure 4) from the pump skid and make certain that the flapper seat is clean. Install and fill the pump again and repeat. If after 20 minutes, the pump has not primed, refer to WP 0033, Troubleshooting.
11. When using both pumps, start the Motor-Driven Pump P-2 after the discharge hose from P-1 pump is pressurized. Start the P-2 pump by pushing the Raw Water Pump #2 START button on the OCP.

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12. Once the P-1 and P-2 pumps are operating and the system is primed, adjust Raw Water Flow Control Valve V-107 (see Figure 4 for valve location) about half open to provide a steady flow of raw water into the MF Feed Tank. Depending on the elevation, if the valve is opened too much initially, the pump could lose prime.
13. If the Cyclone Separator is in use, adjust the Cyclone Separator Flow Control Valve V-104 on adaptor A-03 (see Figure 4 for valve location) to at least 5 gpm. A 5-gallon chemical bucket can be used to provide measurement. Check the cyclone drain periodically to make sure there is good flow coming out the cyclone drain.

CAUTION

Do not leave the P-1 pump running with V-107 closed without cracking open the Vent Valve V-102. Failure to observe this caution will cause the pump to overheat and damage the shaft seal.

14. If the MF Feed Tank reaches 3/4 full and you are not ready to continue with start-up, close Raw Water Flow Control Valve V-107, stop motor driven raw water pump P-2 (if in use as the second pump), crack open Vent Valve V-102 and leave the Diesel-Driven Raw Water Pump P-1 running at idle.
15. Take a raw water sample from the MF Feed Tank and measure the TDS using the TDS meter provided with the MC-TWPS or from the WQAS-P on the A-TWPS. Refer to **Water Quality Measurement** in WP 0016. Adjust the feed water TDS Set Dial on the OCP until the Feed Water TDS display indicates the measured TDS.

ESTABLISHING RAW WATER FLOW WITH ONLY THE MOTOR-DRIVEN RAW WATER PUMP

1. Set valve positions as follows (see Figure 6 for valve location):
    a. Partially OPEN Raw Water Flow Control Valve V-107 on Adaptor A-05.
    b. Fully OPEN Vent Valve V-102 on Adaptor A-02.
    c. Check that the pump Drain Valve V-105 on Motor-Driven Pump P-2 is closed.

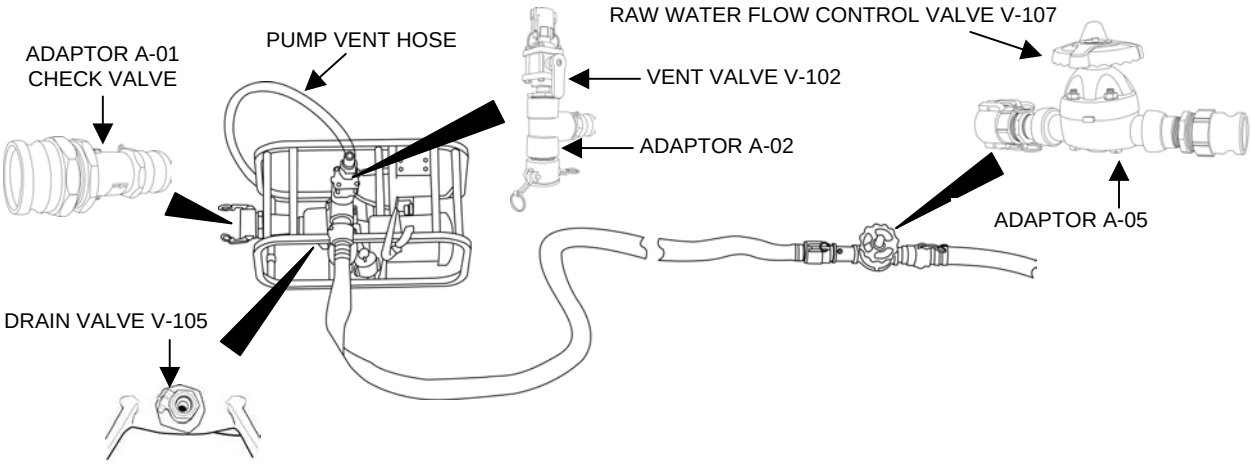

Figure 6. Raw Water System with Only the Motor-Driven Raw Water Pump.

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2. Disconnect the pump vent hose from the top of Adaptor A-02.
3. Use the priming pitcher to pour water through Vent Valve V-102 until the pump case is full. Connect the vent hose after priming.
4. Start the P-2 pump by pushing the Raw Water Pump #2 START button on the OCP.
5. The pump will draw the air out of the suction hose and pump it through the open Vent Valve V-102 and the vent hose. As the air is removed the water follows.
6. When pressurized water is observed discharging from the vent hose, the pump is primed. Close Vent Valve V-102.

NOTE

The time required to prime the pump will depend on the elevation of the pump (suction lift) and on the length of hose out of the water. The listing below provides typical times to be expected with 30 feet of hose out of water.

Suction Lift (Ft)	Priming Time (Minutes)
5	3 to 5
10	5 to 10
15	10 to 15
20	15 to 20

CAUTION

Potential for overheating. While the pump is evacuating air from the suction hose, the priming water circulates in the pump. After a period of time, the water and pump may get hot. Check the pump regularly with your hand for heating. If the pump starts getting hot, remove the vent hose, add more water to the pump, then reinstall the vent hose. Repeat as needed to keep the pump cool until it begins pumping water. Failure to observe this caution may result in overheating and damage to the pump.

7. If the expected time for priming is exceeded, stop the pump and check all of the hose couplings that are out of the water. Specifically check the gaskets to be certain that they are free of sand and dirt. Remove Check Valve Adaptor A-01 (see Figure 6) from the pump skid and make certain that the flapper seat is clean. Install and fill the pump again and repeat. If after 20 minutes, the pump has not primed, refer to WP 0033, Troubleshooting.
8. Once P-2 is operating and the system is primed, adjust Raw Water Flow Control Valve V-107 (see Figure 6 for valve location) about half open to provide a steady flow of raw water into the MF Feed Tank. Depending on the elevation, if the valve is opened too much initially, the pump could lose prime.
9. Take a raw water sample from the MF Feed Tank and measure the TDS using the TDS meter provided with the MC-TWPS or from the WQAS-P on the A-TWPS. Refer to **Water Quality Measurement** in WP 0016. Adjust the feed water TDS Set Dial on the OCP until the Feed Water TDS display indicates the measured TDS.

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FLUSHING PRESERVATIVE/CLEANING SOLUTION

If the TWPS unit was preserved for an extended shut-down (longer than 54 hours; WP 018, Extended Shut-Down During Deployment) the MF contains caustic. If the TWPS unit was cleaned (WP 0020, Cleaning and Preservation Introduction), the MF contains caustic and detergent. Caustic and detergent must be flushed from the MF before starting up the MF system.

NOTE

If the MF does NOT contain preservative or cleaning solution, skip this procedure and move on to MICRO-FILTRATION SYSTEM START-UP.

NOTE

The following are common mistakes made during start-up:
- **MODE switch is put in the wrong position**
- **MF feed pump manually started or stopped at the wrong time**
- **MF feed tank runs out of water during initial startup or during a backwash**
- **Air Pressure Low alarm sounds during initial backwash**
- **RO feed tank runs out of water during initial startup or during a backwash**
- **RO Feed Pressure Low alarm sounds during initial startup or during a backwash**

If any of the above or similar errors occur, perform the following steps to re-initialize (or reset) the PLC.
- **Return the system mode switch the STANDBY**
- **Drain the RO feed tank**
- **Power down the system by opening the MAIN Circuit Breaker at the PDP (switch to OFF)**
- **Power up the system by closing the MAIN Circuit Breaker at the PDP (switch to ON)**
- **Wait for the air compressor to stop**
- **Proceed with a normal startup**

Flush preservative/cleaning solution from the MF as follows:

1. Collect the following items (if using):
    - 1500-gallon cleaning waste storage tank
    - Three 2 in. x 10 ft., red-banded, suction cleaning waste hoses
    - Adaptor A-10
    - Adaptor A-12
    - Two A-16 Adaptors
2. Set up the Cleaning Waste Storage Tank if using (see Figure 7).
    a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
    b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
    c. Connect an A-16 Adaptor to both connections on the waste tank.

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3. Put citric acid in the tank for neutralizing the preservative/cleaning solution when the solution is flushed into the tank as follows:

WARNING

Acid chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

   a. Make sure a bucket of water is placed near the cleaning waste tank to rinse any area of skin or clothing that comes in contact with citric acid.
   b. Open the cleaning waste tank zipper.
   c. Open the AC-210 Citric Acid bucket. Using the priming pitcher, measure out 2 lbs (600 mL) of AC-210 Citric Acid and pour it into the cleaning waste tank.
   d. Close the cleaning waste tank zipper.
   e. Rinse the pitcher and chemical gloves in the bucket of water before removing the gloves.
4. Set up the waste hoses as follows (see Figure 7):
   a. Disconnect 4 x 6 in. Adaptor A-09 and the 6 in. red-banded waste out hose from the 4 in x 5 ft. waste outlet hose of the TWPS
   b. Connect 4 x 2 in. Adaptor A-10 to the 4 in x 5 ft. waste outlet hose.
   c. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 7):
      1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
      2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
      3) Connect Adaptor A-12 to the end of the last hose.
      4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and open these two valves.
      5) Leave Valve V-706 on the other Adaptor A-16 closed.

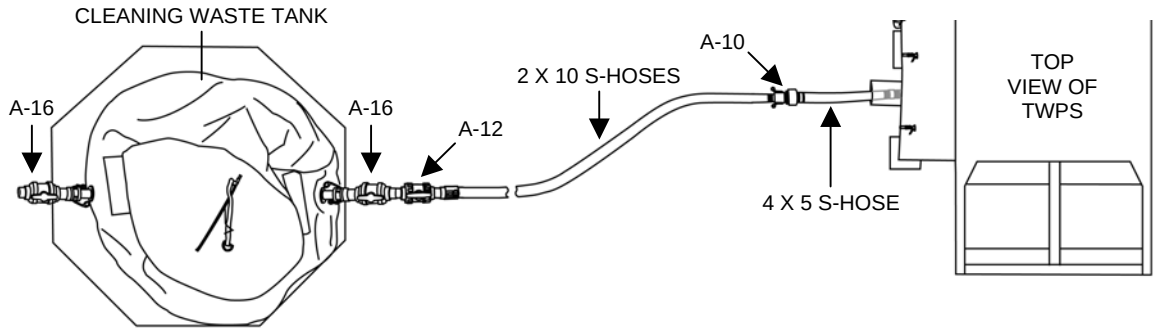

Figure 7. Cleaning Waste Hose Set-Up With the Cleaning Waste Tank.

d. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 8):
    1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
    2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
    3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
    4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
    5) Open Adaptor A-12 Valve V-705.
    6) Direct A-12 discharge into a depression in the ground away from the TWPS.

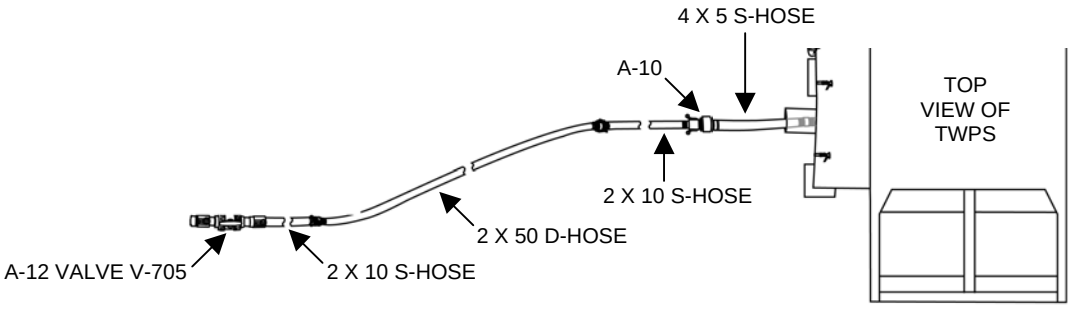

Figure 8. Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

5. Ready the Micro-filter assembly as follows:
    a. Make sure Strainer S-2 Drain Valve V-109 is closed (see Figure 2 for valve location).
    b. Check the MF Trans-Membrane Pressure reading on the OCP. If it is not 0.0, turn the MF Trans-Membrane Zero adjust dial until a reading of 0.0 is obtained.
    c. Check to be sure that the SYSTEM MODE SWITCH is set to STANDBY
6. If raw water flow has stopped, re-establish raw water flow and partially open the Raw Water Flow Control Valve V-107 (see Figure 4 for valve location).

NOTE

The PLC automatic control moves through the cycle steps and controls the MF feed pump as needed to fill and flush the MF modules. The time required is 45 seconds. The blinking STANDBY light indicates cycle completion. The MF feed pump will shut down.

After the MF feed pump comes on, check the MF filtrate flow indicator to make sure flow is indicated. If no flow, refer to troubleshooting, WP 0033.

7. Set the SYSTEM MODE SWITCH to MF FILL/HOLD. Adjust the Raw Water Flow Control Valve as necessary to maintain the MF Feed Tank about three quarters (3/4) full.
8. When Fill/Hold is complete (MF Feed Pump “START” button light goes off), set the SYSTEM MODE SWITCH back to STANDBY.
9. After the Standby light comes on, set the SYSTEM MODE SWITCH to MF FILL/HOLD for a second fill. This procedure will flush most of the preservative solution out of the MF.
10. Repeat steps 6 and 7 one more time.

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11. Open Main RO Feed Tank Drain Valve V-412 (see Figure 2 for valve location). Close when drained.
12. After the RO Feed Tank is drained, replace the cleaning waste hoses as follows:
    a. If using the cleaning waste tank, perform the following steps:
        1) Close the Adaptor A-16 valve at the waste tank and then Adaptor A-12 valve at the end of the waste hose.
        2) Disconnect Adaptor A-12 from Adaptor A-16.
        3) Direct the cleaning waste hose into an empty bucket, open Adaptor A-12 Valve V-705 and drain the contents of the hose into the bucket.
        4) When drained, disconnect the cleaning waste hose.
        5) Remove Adaptor A-10.
        6) Install Adaptor A-09 and the 6-inch red-banded waste out hose.
        7) Open the top of the waste tank and empty the bucket into the waste tank.
    b. If not using the cleaning waste tank, perform the following steps:
        1) Remove Adaptor A-10, the cleaning waste hoses, and Adaptor A-12.
        2) Install Adaptor A-09 and the 6-inch red-banded waste out hose.
13. Refer to WP 0020, Cleaning, Preservation, and Cleaning Waste Neutralization and Pump-Out, for the procedures to neutralize the waste water and pump it out of the cleaning waste storage tank.
14. Fill, Flush and Fill RO Feed Tank
    a. Set the SYSTEM MODE SWITCH to MF Fill/Hold.
    b. When Fill/Hold is complete (MF Feed Pump “START” button light goes off), set the SYSTEM MODE SWITCH to RUN.
    c. After the RUN light comes on, start the MF Feed Pump.

NOTE
The pump will not start if the MF FILL/HOLD step has not been completed.

    d. Be sure RO Feed Tank Drain Valve V-412 is closed. When the RO Feed Tank level reaches the high level setting, the MF Feed Pump will stop. Wait for this before continuing.
    e. Open RO Feed Tank Drain Valve V-412. Close when drained.
    f. Set the SYSTEM MODE SWITCH back to STANDBY.
    g. Set the SYSTEM MODE SWITCH to FILL/HOLD. When Fill/Hold is complete (MF Feed Pump “START” button light goes off), set the SYSTEM MODE SWITCH to RUN.
    h. After the RUN light comes on, start the MF Feed Pump.
    i. Be sure RO Feed Tank Drain Valve V-412 is closed. When the RO Feed Tank level reaches the high level setting, the MF Feed Pump will stop. Wait for this before continuing.
    j. Continue with RO System startup.

NOTE
If you performed the preceding FLUSHING PRESERVATIVE/CLEANING SOLUTION procedures, the necessary MF start-up steps were included. You would skip the MICRO-FILTRATION SYSTEM START-UP procedures listed below and continue with the procedures for RO SYSTEM START-UP.

If you did NOT need to perform the FLUSHING PRESERVATIVE/CLEANING SOLUTION procedures, continue with the MICRO-FILTRATION SYSTEM START-UP procedures listed below.

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MICRO-FILTRATION SYSTEM START-UP

NOTE

The following are common mistakes made during start-up:
- **MODE switch is put in the wrong position**
- **MF feed pump manually started or stopped at the wrong time**
- **MF feed tank runs out of water during initial startup or during a backwash**
- **Air Pressure Low alarm sounds during initial backwash**
- **RO feed tank runs out of water during initial startup or during a backwash**
- **RO Feed Pressure Low alarm sounds during initial startup or during a backwash**

If any of the above or similar errors occur, perform the following steps to re-initialize (or reset) the PLC.
- **Return the system mode switch the STANDBY**
- **Drain the RO feed tank**
- **Power down the system by opening the MAIN Circuit Breaker at the PDP (switch to OFF)**
- **Power up the system by closing the MAIN Circuit Breaker at the PDP (switch to ON)**
- **Wait for the air compressor to stop**
- **Proceed with a normal startup**

1. Ready the Micro-filter assembly as follows:
    a. Make sure Strainer S-2 Drain Valve V-109 is closed (see Figure 2 for valve location).
    b. Check to be sure that the SYSTEM MODE SWITCH is set to STANDBY
    c. Check the MF Trans-Membrane Pressure reading. If it is not 0.0, turn the MF Trans-Membrane Zero adjust dial until a reading of 0.0 is obtained.
2. If stopped, re-establish raw water flow and partially open the Raw Water Flow Control Valve V-107 (see Figure 4 for valve location).

NOTE

The PLC automatic control moves through the cycle steps and controls the MF feed pump as needed to fill and flush the MF modules. The time required is 45 seconds. The blinking STANDBY light indicates cycle completion. The MF feed pump will shut down.

After the MF feed pump comes on, check the MF filtrate flow indicator to make sure flow is indicated. If no flow, refer to troubleshooting, WP 0033.

3. Set the SYSTEM MODE SWITCH to MF FILL/HOLD. Adjust Raw Water Flow Control Valve V-107 as necessary to maintain the MF feed tank about 3/4 full.
4. When the Fill/Hold is complete (MF Feed Pump “START” button light goes off), set the SYSTEM MODE SWITCH to RUN.
5. After the RUN light comes on, start the MF feed pump.

NOTE

The pump will not start if the MF FILL/HOLD step has not been completed.

6. Be sure to close RO Feed Tank Drain Valve V-412. When the RO feed tank level reaches the high level setting, the MF feed pump will stop. Wait for this before continuing to RO System Start-Up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED – OPERATION UNDER USUAL CONDITIONS

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RO SYSTEM START-UP

1. At the antiscalant and hypochlorite chemical pumps, set the SPEED switches fully counter clockwise to OFF (see Figure 3). When starting with empty chemical buckets, the chemical pumps are switched OFF until the chemical buckets are setup.
2. Check to make sure that Main Pressure Control Valve HVC-401 and the Auxiliary Pressure Control Valve HCV-401A are fully open (see Figure 2 for valve location).
3. Toggle the ALARM switch to RESET to clear the RO Feed Tank Level Low Alarm.
4. Make sure the MF feed pump has stopped (the MF Pump indicator light should go off).
5. Make sure HP pump valve V-212 is open, then start the RO feed pump.
6. Wait until a steady RO Reject Flow rate greater than 10 gpm is indicated and the RO Feed Pressure is steady. If, while waiting, the RO Feed Tank level drops below 85%, start the MF Feed Pump.

NOTE

HP Pump P-5 starts first followed by Pump P-6 after a 10 second time delay. It is normal for a high product TDS alarm to sound after the high pressure pumps are started.

7. START the MF Feed Pump if not already on.
8. Immediately START the High Pressure Pumps.

CAUTION

The MF will not begin the automatic timing of the backwash interval until the first backwash is manually initiated. Failure to do this will lead to rapid fouling of the MF membrane, which will require chemical cleaning to restore.

9. Make sure the MF feed tank is at least ¾ full, then push the MF Backwash Start button to manually initiate the first backwash cycle. (The Backwash Start button green light will stay lit until the PLC detects that the air compressor is off and the RO tank level is at 100 to 105%. Then the PLC will start the backwash and establish the normal automatic backwash timing. The green light will flash on and off during the backwash then stay off when the backwash cycle is done.)

NOTE

Several HCV-401 valve adjustments will be required to obtain the correct product flow. Allow up to several minutes between valve adjustments for flow and pressure to stabilize. Normal product flow is 20.5 to 21 gpm on seawater and 25.5 to 26 gpm on freshwater and brackish water up to 20,000 mg/l TDS surface water or 2500 mg/l TDS ground water.

10. Set the Pressure Control valves to obtain the normal product flow rate as follows:
    a. For seawater: fully close Auxiliary Pressure Control Valve V-401A, then slowly CLOSE Main RO Pressure Control Valve HCV-401 until the normal product flow rate is obtained, or the RO feed pressure reaches 1200 psig, or the valve is closed.
    b. For fresh or brackish waters, set Auxiliary Pressure Control Valve V-401A to 50% closed, then slowly CLOSE Main RO Pressure Control Valve HCV-401 until the normal product flow rate is obtained. If HCV-401 is fully closed and the normal product flow is not obtained, open HCV-401, fully close HCV-401A and then adjust HCV-401.
11. Reset the high TDS alarm if on. If the alarm won't reset, refer to **RESPONDING TO NORMAL OPERATION ALARMS** in WP 0016.
12. Check the TQG voltage and adjust to 416 volts if needed (TQG TM 5-6115-545-12).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0014 00**
OPERATOR INSTRUCTIONS
INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED – OPERATION UNDER USUAL CONDITIONS

ANTISCALANT AND HYPOCHLORITE CHEMICAL SYSTEMS START-UP

1. Set the Antiscale/Chlorine switch on the OCP to ON.
2. Make sure that the SPEED dial on each pump is set to OFF (dial turned fully counterclockwise) (see Figure 3).
3. Make sure that the chemical buckets are properly located for operation in front of the chemical pumps in the Operator Station (see Figure 9). Make sure the color coded covers match the labels on the chemical buckets.
    a. Sodium Bisulfite bucket cover **BLUE**
    b. Antiscalant bucket cover **YELLOW**
    c. Calcium Hypochlorite bucket cover **RED**

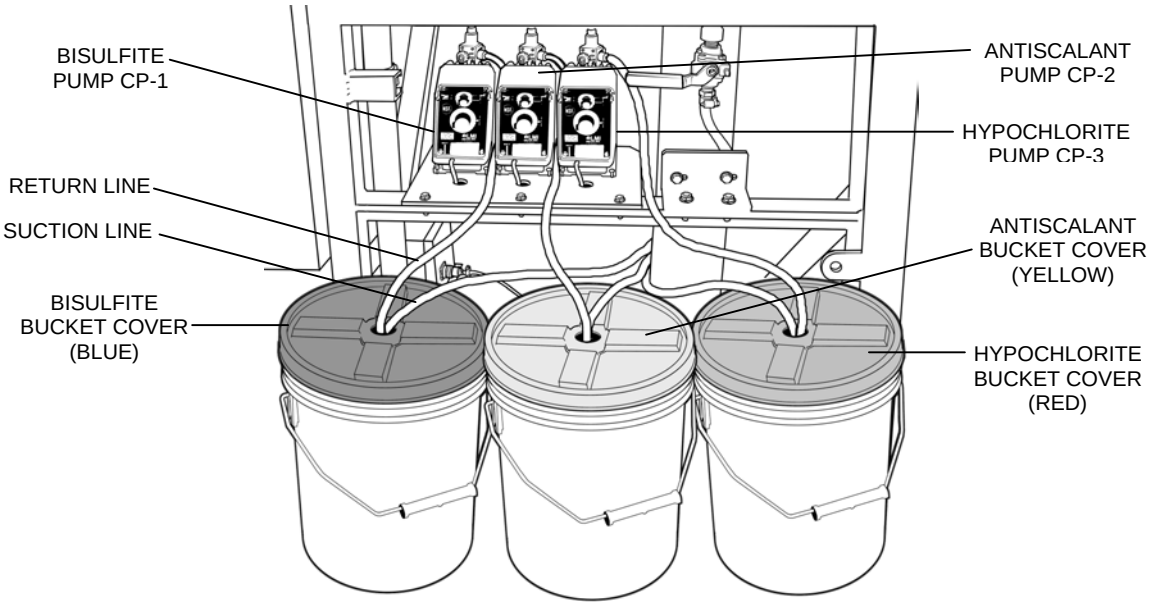

Figure 9. Chemical Buckets Located for Operation.

4. Set-up the Antiscalant System as follows:

WARNING

Irritant. Wear a protective face shield and chemical gloves when handling antiscalant chemical. Avoid inhaling chemical fumes. Failure to observe this warning may result in irritation of the nose, throat, eyes, and skin.

    a. With the product utility hose, fill the Antiscalant bucket with product water to the 5-gallon level.
    b. Rinse the mixing paddle with product water from the product utility hose.
    c. Fill the AC-110 measuring cup with AC-110 antiscalant to the 650 milliliter level. Slowly pour into the antiscalant chemical bucket and then mix with the paddle.

d. Place the chemical injection pump suction tube and return line hose through the cover hole and into the chemical bucket. Be sure the suction hose inlet rests near the bottom of the bucket, but not flat on the bottom.
e. Turn the speed dial on the chemical pump to 80, note that the pump has started, and then rotate the stroke dial to 80.
f. Rotate the black knob on the priming valve one-half turn.
g. Note that the chemical solution is drawing up the suction tube and entering the pump housing.
h. Rotate the black knob on the priming valve back to its original position when discharge is noted back to the tank and air is not noted in the suction tube or the pump head. The pump is now primed.
i. Set the speed dial to 70%.
j. Set the stroke dial to 60%.

5. Set-up the Hypochlorite System as follows:

WARNING

Hazardous chemical dust and/or fumes. Wear the protective face shield, chemical gloves, and dust mask when handling calcium hypochlorite. Avoid inhaling chemical dust or fumes. Hypochlorite will give off chlorine vapor, which will burn your nose, throat and lungs if breathed directly. Keep your head away from top of the bucket while filling. Inhalation of calcium hypochlorite dust may cause severe chemical burns. Direct contact with the eyes may cause severe eye damage.

NOTE

When operating on fresh water and brackish water that contains up to 20,000 mg/L TDS (total dissolved salts) surface water or 2500 mg/L TDS ground water, the product water flow can initially be assumed to be 25.5 to 26 gpm.

When operating on seawater or brackish water that contains over 20,000 mg/L TDS (total dissolved salts) surface water or over 2500 mg/L TDS ground water, the product water flow can initially be assumed to be 20.5 to 21 gpm

Refer to Table 2 for the required free chlorine concentration to be established in the product water with a product water flow of 25.5 or 21 gpm (depending on the source water and its TDS as described in the NOTE above). The calcium hypochlorite is mixed in four gallons of water in the hypochlorite bucket.

Refer to Table 3 through Table 5 at the end of this WP for additional information on the correct chemical injection pump stroke and speed settings for given product flow rates and free chlorine required.

Table 2. Free Chlorine Required, mg/L

Free Chlorine Required, mg/L	Four Ounce (Oz) Packets Required
0.05 – 1.5 mg/L	1 packet, 4oz each
2.0 – 3.0 mg/L	2 packets, 4oz each
5.0 mg/L	4 packets, 4oz each
10.0 mg/L	6 packets, 4oz each

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0014 00**
OPERATOR INSTRUCTIONS
INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED – OPERATION UNDER USUAL CONDITIONS

a. With the product utility hose, fill the Hypochlorite bucket with product water to the **4**-gallon level.
b. Rinse the mixing paddle with product water from the product utility hose.
c. Pour the required quantity of hypochlorite into the hypochlorite bucket and mix using the mixing paddle. Mix until the hypochlorite is dissolved.
d. Place the chemical injection pump suction tube and return line hose through the cover hole and into the chemical bucket. Be sure the suction hose inlet rests near the bottom of the bucket, but not flat on the bottom.
e. Turn the speed dial on the chemical pump to 80, note that the pump has started, and then rotate the stroke dial to 80.
f. Rotate the black knob on the priming valve one-half turn.
g. Note that the chemical solution is drawing up the suction tube and entering the pump housing.
h. Rotate the black knob on the priming valve back to its original position when discharge is noted back to the tank and air is not noted in the suction tube or the pump head. The pump is now primed.
i. Set the stroke and speed as listed in Table 3 through Table 5 for the expected product flow rate and the free chlorine concentration required.
j. Turn the Antiscale/Chlorine switch on the OCP to AUTO.

COMPLETING START-UP

1. If the product flow is less than the normal 20.5 to 21 gpm or 25.5 to 26 gpm and cannot be adjusted to the normal product flow rate, refer to Table 3 through Table 5 and change the hypochlorite pump speed (strokes/min) and stroke length settings as listed for the flow rate and required free chlorine concentration. If the flow is between two listed flows, use the higher flow setting.
2. Before connecting the product hose to the distribution tank, refer to **WATER QUALITY MEASUREMENT** in WP 0016 and verify the free chlorine residual in the product water using the Portable Chlorine Test Meter (MC-TWPS) or the WQAS-P chlorine test kit (A-TWPS).
3. Connect the product water hose (from the TWPS product water discharge) to the distribution tank.
4. Check the MF feed tank. Just before a backwash it should be approximately 3/4 full. If low, slightly open raw water flow Valve V-107.
5. Refer to WP 0016, Maintaining Normal Operation; complete the Operator's Data Log and check that all readings are within normal values.

Table 3. Hypochlorite System Setup

4 oz (1 packet) Hypochlorite Mixed in 4 Gallons

Product Flow, pm	Free Chlorine Required, mg/L								
	0.5			1.0			1.5		
	GPH	Stroke	Speed	GPH	Stroke	Speed	GPH	Stroke	Speed
12.0	0.069	30	23	0.137	40	34	0.206	50	41
12.5	0.071	30	24	0.143	40	36	0.214	50	43
13.0	0.074	30	25	0.149	40	37	0.223	50	45
13.5	0.077	30	26	0.154	40	39	0.231	50	46
14.0	0.080	30	27	0.160	40	40	0.240	50	48
14.5	0.083	30	28	0.166	40	41	0.249	50	50
15.0	0.086	30	29	0.171	40	43	0.257	50	51
15.5	0.089	30	30	0.177	40	44	0.266	50	53
16.0	0.091	30	30	0.183	40	46	0.274	50	55
16.5	0.094	30	31	0.189	40	47	0.283	50	57
17.0	0.097	30	32	0.194	40	49	0.291	50	58
17.5	0.100	30	33	0.200	40	50	0.300	50	60
18.0	0.103	30	34	0.206	40	51	0.309	50	62
18.5	0.106	30	35	0.211	40	53	0.317	50	63
19.0	0.109	30	36	0.217	40	54	0.326	50	65
19.5	0.111	30	37	0.223	40	56	0.334	50	67
20.0	0.114	30	38	0.229	40	57	0.343	50	69
20.5	0.117	30	39	0.234	40	59	0.351	50	70
21.0	0.120	30	40	0.240	40	60	0.360	50	72
21.5	0.123	30	41	0.246	40	61	0.369	50	74
22.0	0.126	30	42	0.251	40	63	0.377	50	75
22.5	0.129	30	43	0.257	40	64	0.386	50	77
23.0	0.131	30	44	0.263	40	66	0.394	50	79
23.5	0.134	30	45	0.269	40	67	0.403	50	81
24.0	0.137	30	46	0.274	40	69	0.411	50	82
24.5	0.140	30	47	0.280	40	70	0.420	50	84
25.0	0.143	30	48	0.286	40	71	0.429	50	86
25.5	0.146	30	49	0.291	40	73	0.437	50	87
26.0	0.149	30	50	0.297	40	74	0.446	50	89

Table 4. Hypochlorite System Setup

8 oz (2 packets) Hypochlorite Mixed in 4 Gallons

Product Flow, gpm	Free Chlorine Required, mg/L					
	2.0			3.0		
	GPH	Speed	Stroke	GPH	Speed	Stroke
12.0	0.137	34	40	0.206	41	50
12.5	0.143	36	40	0.214	43	50
13.0	0.149	37	40	0.223	45	50
13.5	0.154	39	40	0.231	46	50
14.0	0.160	40	40	0.240	48	50
14.5	0.166	41	40	0.249	50	50
15.0	0.171	43	40	0.257	51	50
15.5	0.177	44	40	0.266	53	50
16.0	0.183	46	40	0.274	55	50
16.5	0.189	47	40	0.283	57	50
17.0	0.194	49	40	0.291	58	50
17.5	0.200	50	40	0.300	60	50
18.0	0.206	51	40	0.309	62	50
18.5	0.211	53	40	0.317	63	50
19.0	0.217	54	40	0.326	65	50
19.5	0.223	56	40	0.334	67	50
20.0	0.229	57	40	0.343	69	50
20.5	0.234	59	40	0.351	70	50
21.0	0.240	60	40	0.360	72	50
21.5	0.246	61	40	0.369	74	50
22.0	0.251	63	40	0.377	75	50
22.5	0.257	64	40	0.386	77	50
23.0	0.263	66	40	0.394	79	50
23.5	0.269	67	40	0.403	81	50
24.0	0.274	69	40	0.411	82	50
24.5	0.280	70	40	0.420	84	50
25.0	0.286	71	40	0.429	86	50
25.5	0.291	73	40	0.437	87	50
26.0	0.297	74	40	0.446	89	50

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0014 00**
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INITIAL START-UP OR START-UP WITH THE SYSTEM FULLY DRAINED –
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Table 5. Hypochlorite System Setup.

16 oz (4 packets) or 24 oz (6 packets) Hypochlorite Mixed in 4 Gallons

Product Flow, gpm	16 oz (4 packets) Hypochlorite Mixed in 4 Gallons			24 oz (6 packets) Hypochlorite Mixed in 4 Gallons		
	Free Chlorine Required, mg/L			Free Chlorine Required, mg/L		
	5.0			10.0		
	GPH	Speed	Stroke	GPH	Speed	Stroke
12.0	0.171	34	50	0.229	46	50
12.5	0.179	36	50	0.238	48	50
13.0	0.186	37	50	0.248	50	50
13.5	0.193	39	50	0.257	51	50
14.0	0.200	40	50	0.267	53	50
14.5	0.207	41	50	0.276	55	50
15.0	0.214	43	50	0.286	57	50
15.5	0.221	44	50	0.295	59	50
16.0	0.229	46	50	0.305	61	50
16.5	0.236	47	50	0.314	63	50
17.0	0.243	49	50	0.324	65	50
17.5	0.250	50	50	0.333	67	50
18.0	0.257	51	50	0.343	69	50
18.5	0.264	53	50	0.352	70	50
19.0	0.271	54	50	0.362	72	50
19.5	0.279	56	50	0.371	74	50
20.0	0.286	57	50	0.381	76	50
20.5	0.293	59	50	0.390	78	50
21.0	0.300	60	50	0.400	80	50
21.5	0.307	61	50	0.410	82	50
22.0	0.314	63	50	0.419	84	50
22.5	0.321	64	50	0.429	86	50
23.0	0.329	66	50	0.438	88	50
23.5	0.336	67	50	0.448	90	50
24.0	0.343	69	50	0.457	90	51
24.5	0.350	70	50	0.467	90	52
25.0	0.357	71	50	0.476	90	53
25.5	0.364	73	50	0.486	90	54
26.0	0.371	74	50	0.495	90	55

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0015 00**
OPERATOR INSTRUCTIONS
START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

INITIAL SETUP

References:
A-TWPS: WQAS-P TM 10-6630-222-12&P
Personnel Required:
One Operator/Crew
Equipment Condition:
System fully set up.
MF feed tank is ¾ full.
Chemical systems are set up and ready to operate.
TWPS has been operated and a short term or standby shutdown without draining has been performed.

GENERAL

The procedures covered in this work package include:

- Initial Inspection, Checks and Adjustments
- Establishing Electrical Power (WP 0012)
- Establishing Raw Water Flow with Both Raw Water Pumps
- Establishing Raw Water Flow with Only the Electric Raw Water Pump
- Micro-Filtration System Start-Up
- RO System Start-Up
- Completing Start-Up

INITIAL INSPECTIONS, CHECKS AND ADJUSTMENTS

1. Using Table 1 and Figure 2 check that the valves are in the indicated start-up position.

NOTE

The Product RO Element 3-Way Valves are in the normal position when the middle pointer on the valve handle is pointing to the black product hose (see Figure 1). The handle itself may be pointing toward or away from the product pipe depending on the RO vessel.

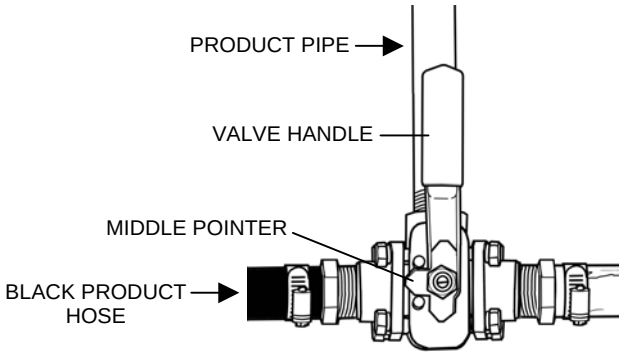

Figure 1. RO Element 3-Way Valve in the Normal Position.

2. Make sure that the product water hose is disconnected from the product water distribution tank.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0015 00**
OPERATOR INSTRUCTIONS
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Table 1. Valve Start-Up Position – Start-Up After Short Term or Standby Shutdown.

✓	VALVE NAME AND NUMBER	POSITION
	P-1 Diesel Pump Drain Valve V-103	Closed
	P-2 Electric Pump Drain Valve V-105	Closed
	P-3 Electric MF Feed Pump Drain Valve V-108	Closed
	MF Vent Valve V-114	Closed
	Product RO Element 3-Way Valves, left end, V-502, 503, 506, 507, 510	Normal
	RO Vessel Drain Valve V-408	Closed
	Main Pressure Control Valve HCV-401	Full Open
	Auxiliary Pressure Control Valve HCV-401A	Open
	RO Feed Tank Auxiliary Drain Valve V-210	Closed
	Turbocharger Reject Drain Valve V-410	Closed
	Turbocharger Feed Drain Valve V-303	Closed
	Feed Control Selector Valve V-914	Auto
	Strainer S-2 Vent /Sample Valve V-110	Closed
	Strainer S-2 Drain Valve V-109	Closed
	MF Cleaning Feed Valve V-704	Closed
	Clean Mixing Valve V-703	Closed
	RO Clean Feed Valve V-701	Closed
	Clean Return Valve V-702	Closed
	Product Utility Valve V-511	Closed
	Feed Piping Drain Valve V-304	Closed
	HP Pump Outlet Drain Valve V-302	Closed
	HP Pump Inlet Valve V-212	Open
	Strainer S-4 Drain Valve V-213	Closed
	RO Feed pump P-4 Drain Valve V-211	Closed
	Low Pressure Air Vent Valve V-915	Closed
	LP Air Shutoff Valve V-909	Open
	Low Press Air Vent Valve V-910	Closed
	High Press Air Vent Valve V-904	Closed
	Coalescer CO1 Drain Shutoff Valve V-902	Open
	HP Pumps Case Drain Valve V-215	Closed
	HP Pump P-5 and P-6 Inlet Drain Valve V-214	Closed
	HP Pump P-5 and P-6 Outlet Drain Valve V-301	Closed
	Air Compressor Intermediate Filter Drain Valve V-901	Open
	Product RO Element 3-Way Valves, right end, V-501, 504, 505, 508, 509	Normal
	Air Receiver Tank Valve V-907	Open
	RO Feed Tank Main Drain Valve V-412	Closed
	RO Air Purge Valve V-913	Closed
	MF Filtrate Sample/Drain Valve V-204	Closed
	MF Filtrate Drain Valve V-203	Closed
	MF Shell Drain Valve V-403	Closed
	P-7 Electric Pump Drain Valve V-520	Closed
	Auxiliary Hose Valve V-522 (If attached)	Closed
	Distribution Nozzles V-523 A&B	Closed
	P-8 Diesel Pump Drain Valve V-524	Closed
	Distribution Nozzles V-523 C&D	Closed

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0015 00**
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START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN
WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

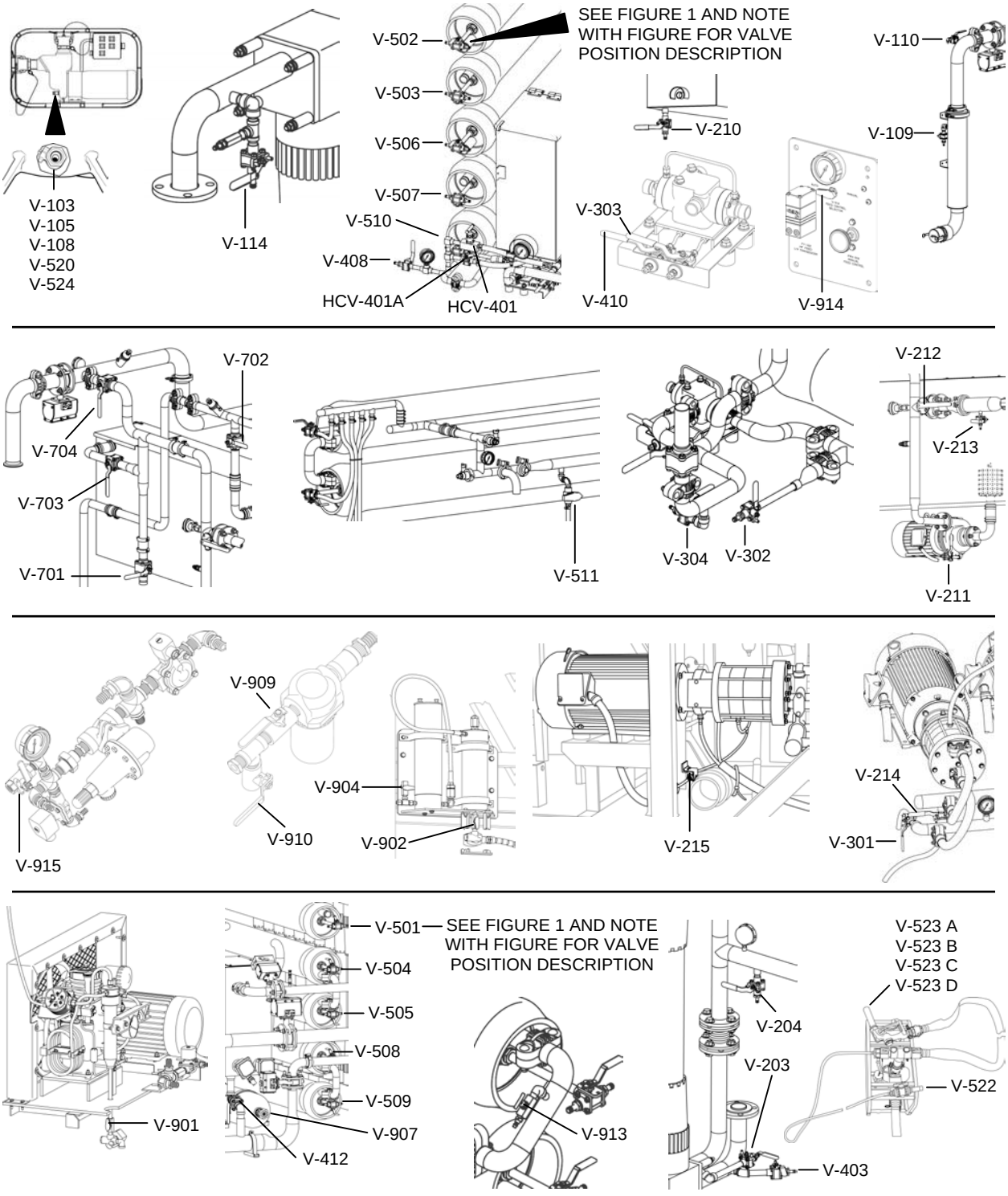

Figure 2. Location of Valves for Start-Up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0015 00**
OPERATOR INSTRUCTIONS
START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

ESTABLISHING ELECTRICAL POWER

Make sure that electrical power to the TWPS has been established as described in WP 0012, Establishing Electrical Power.

AIR COMPRESSOR START-UP

Start up the compressor as follows:

1. Check the oil level dipstick. If the oil level is below the add oil mark, add oil to the top of the mark.
2. Start the air compressor as follows:
    a. Make sure LP Air Vent Valve V-910 is closed.
    b. Make sure High Pressure Air Vent Valve V-904 is closed.
    c. Turn the AIR COMPRESSOR SWITCH on the OCP to AUTO.

ESTABLISHING RAW WATER FLOW WITH BOTH RAW WATER PUMPS

NOTE

If only the motor-driven raw water pump is deployed, see the procedures for "Establishing Raw Water Flow with Only the Motor-Driven Raw Water Pump" that immediately follow these procedures for "Establishing Raw Water Flow with Both Raw Water Pumps".

1. Set valve positions as follows (see Figure 3 for valve location):
    a. Partially OPEN Raw Water Flow Control Valve V-107 on Adaptor A-05.
    b. Fully OPEN Vent Valve V-102 on Adaptor A-02.
    c. Check that pump Drain Valve V-103 on the diesel-driven pump skid is closed.
2. If the pump has lost prime, disconnect the pump vent hose from the top of Adaptor A-02, use the priming pitcher to pour water through Vent Valve V-102 until the pump case is full, then reconnect the vent hose.
3. Disconnect the pump vent hose from the top of Adaptor A-02.

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START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN
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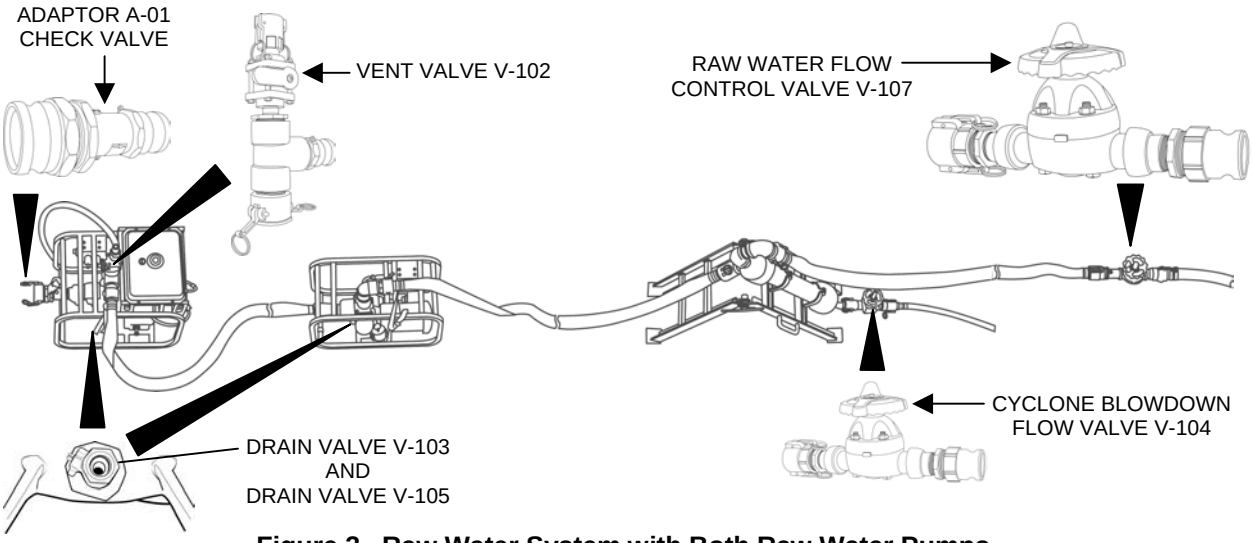

Figure 3. Raw Water System with Both Raw Water Pumps.

WARNING

Combustion hazard. Fuel the diesel engine in a well ventilated area with the engine stopped. Do not smoke or allow flames or sparks in the area where the engine is fueled or where the fuel is stored. Failure to observe this warning may result in fire and severe injury.

Combustion hazard. Do not overfill the fuel tank. Make sure the filler cap is securely closed after fueling. Be careful not to spill fuel when fueling. If any fuel is spilled, make sure the area is dry before starting the engine. Failure to observe this warning may result in fire and severe injury.

CAUTION

Potential for engine damage. The diesel engine may be damaged if operated with insufficient lube oil. It is also dangerous to supply too much lube oil to the engine because a sudden increase in engine rpm could be caused by its combustion. Failure to observe this caution may result in engine damage.

Potential for engine damage. Only use the correct diesel fuel. Use of the wrong fuel may cause engine damage.

When adding fuel to the fuel tank, be careful not to push the fuel screen filter into the tank.

4. Before starting the diesel-driven pump, the diesel fuel tank may be topped off. For short term shutdown, there is no need to check the oil level.
5. Start the diesel engine using the following procedure (see Figure 4).
    a. Set the fuel cock clockwise to the OPEN position.

b. Put the engine speed lever in the START position.
c. Slowly pull out the recoil-starting handle until you feel strong resistance, then return it to the initial position.
d. Push down the decompression lever. If the lever does not stay down by itself, it may be necessary to pull the recoil starting handle out a little more. The decompression lever will return to the up position automatically when the recoil starter is pulled all the way out to start the engine.
e. Pull out the recoil starting handle briskly with both hands to start the engine
f. If the engine fails to start; return to step c. (initial start of a new engine may require 6 or more pulls to clear the air from the fuel lines)
g. Reposition the engine speed lever to a middle position to reduce the engine speed to idle.

6. Warm up the engine at idle for about three 3 minutes. Then set the speed lever to START.
7. If the pump had lost its prime, it will draw the air out of the suction hose and pump it through the open Vent Valve V-102 and the vent hose. As the air is removed the water follows.
8. When pressurized water is observed discharging from the vent hose, the pump is primed. Close Vent Valve V-102.

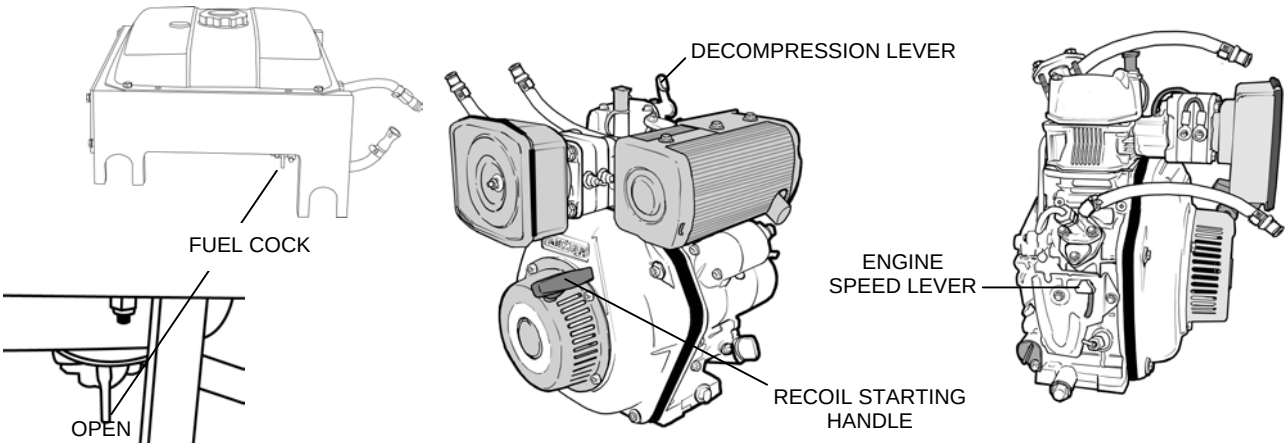

Figure 4. Diesel Engine Controls.

NOTE

The time required to prime the pump will depend on the elevation of the pump (suction lift), the length of hose out of the water, and how much water remained in the hose during the short term or standby shutdown. The listing below provides typical times to be expected with 30 ft. of hose out of water and with no water in the raw water hose.

Suction Lift (Ft)	Priming Time (Minutes)
5	3 to 5
10	5 to 10
15	10 to 15
20	15 to 20

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START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

CAUTION

Potential for overheating. While the pump is evacuating air from the suction hose, the priming water circulates in the pump. After a period of time, the water and pump may get hot. Check the pump regularly with your hand for heating. If the pump starts getting hot, remove the vent hose, add more water to the pump, then reinstall the vent hose. Repeat as needed to keep the pump cool until it begins pumping water. Failure to observe this caution may result in overheating and damage to t he pump.

9. If the expected time for priming is exceeded, stop the pump and check all of the hose couplings that are out of the water. Specifically check the gaskets to be certain that they are free of sand and dirt. Remove Check Valve Adapter (A-01) from the pump skid and make certain that the flapper seat is clean (see Figure 3). Install and fill the pump again and repeat. If after 20 minutes, the pump has not primed, refer to WP 0033, Troubleshooting.
10. When using both pumps, start the Motor-Driven Pump P-2 after the discharge hose from P-1 pump is pressurized. Start the P-2 pump by pushing the Raw Water Pump #2 START button.

CAUTION

Do not leave the pump running with V-107 closed without opening Vent Valve V-102. Failure to observe this caution will cause the pump to overheat and damage the shaft seal.

11. If the MF Feed Tank reaches 3/4 full and you are not ready to continue with start-up, close Raw Water Flow Control Valve V-107, stop Motor-Driven Raw Water Pump P-2 (if in use as the second pump), crack open Vent Valve V-102 and leave the Diesel-Driven Raw Water Pump P-1 running at idle.

ESTABLISHING RAW WATER FLOW WITH ONLY THE MOTOR-DRIVEN RAW WATER PUMP

1. Set valve positions as follows (see Figure 5 for valve location):
    a. Partially OPEN Raw Water Flow Control Valve V-107 on Adapter A-05.
    b. Fully OPEN Vent Valve V-102 on Adaptor A-02.
    c. Check that the pump Drain Valve V-105 on Motor-Driven Raw Water Pump P-2 is closed.
2. If the pump had lost its prime, perform the following:
    a. Disconnect the pump vent hose from the top of Adaptor A-02.
    b. Use the priming pitcher to pour water through Vent Valve V-102 until the pump case is full.
    c. Connect the vent hose after priming.
3. Start the P-2 pump by pushing the Raw Water Pump #2 START button on the OCP.
4. The pump will draw the air out of the suction hose and pump it through the open Vent Valve V-102 and the vent hose. As the air is removed the water follows.
5. When pressurized water is observed discharging from the vent hose, the pump is primed. Close Vent Valve V-102.

NOTE

The time required to prime the pump will depend on the elevation of the pump (suction lift), the length of hose out of the water, and how much water remained in the hose during the short term or standby shutdown. The listing below provides typical times to be expected with 30 ft. of hose out of water and with no water in the raw water hose.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0015 00**
OPERATOR INSTRUCTIONS
START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN
WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

Suction Lift (Ft)	Priming Time (Minutes)
5	3 to 5
10	5 to 10
15	10 to 15
20	15 to 20

CAUTION

Potential for overheating. While the pump is evacuating air from the suction hose, the priming water circulates in the pump. After a period of time, the water and pump may get hot. Check the pump regularly with your hand for heating. If the pump starts getting hot, remove the vent hose, add more water to the pump, then reinstall the vent hose. Repeat as needed to keep the pump cool until It begins pumping water. Failure to observe this caution may result in overheating and damage to t he pump.

6. If the expected time for priming is exceeded, stop the pump and check all of the hose couplings that are out of the water. Specifically check the gaskets to be certain that they are free of sand and dirt. Remove Check Valve Adaptor A-01 from the pump skid and make certain that the flapper seat is clean (see Figure 3 for valve location). Install and fill the pump again and repeat. If after 20 minutes, the pump has not primed, refer to WP 0033, Troubleshooting.

CAUTION

Do not leave the pump running with V-107 closed without opening Vent Valve V-102. Failure to observe this caution will cause the pump to overheat and damage the shaft seal.

7. If the MF Feed Tank reaches 3/4 full and you are not ready to continue with start-up, close raw water flow control valve V-107 and stop Motor-Driven Raw Water Pump P-2.

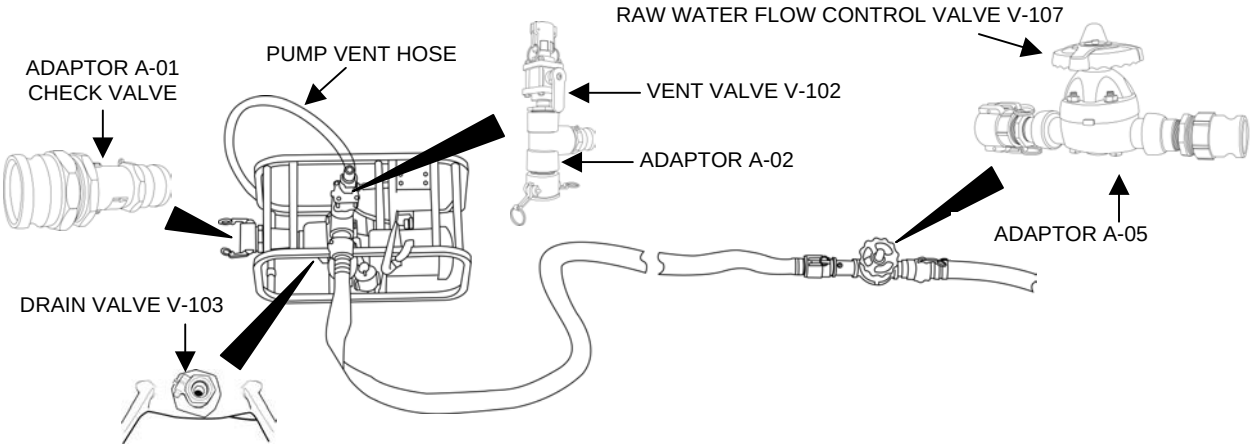

Figure 5. Raw Water System with Only the Motor-Driven Raw Water Pump.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0015 00**
OPERATOR INSTRUCTIONS
START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

MICRO-FILTRATION SYSTEM START-UP

NOTE

The following are common mistakes made during start-up:
- **MODE switch is put in the wrong position**
- **MF feed pump manually started or stopped at the wrong time**
- **MF feed tank runs out of water during initial startup or during a backwash**
- **Air Pressure Low alarm sounds during initial backwash**
- **RO feed tank runs out of water during initial startup or during a backwash**
- **RO Feed Pressure Low alarm sounds during initial startup or during a backwash**

If any of the above or similar errors occur, perform the following steps to re-initialize (or reset) the PLC.
- **Return the system mode switch the STANDBY**
- **Drain the RO feed tank**
- **Power down the system by opening the MAIN Circuit Breaker at the PDP (switch to OFF)**
- **Power up the system by closing the MAIN Circuit Breaker at the PDP (switch to ON)**
- **Wait for the air compressor to stop**
- **Proceed with a normal startup**

1. Ready the Micro-filter assembly as follows:
    a. Make sure Strainer S-2 Drain Valve V-109 is closed (see Figure 2 for valve location).
    b. Check the MF Trans-Membrane Pressure reading. If it is not 0.0, turn the MF Trans-Membrane Zero adjust dial until a reading of 0.0 is obtained.
    c. Check to be sure that the SYSTEM MODE SWITCH is set to STANDBY
2. If stopped, re-establish raw water flow and partially open the Raw Water Flow Control Valve V-107 (see Figure 3 for valve location).

NOTE

The PLC automatic control moves through the cycle steps and controls the MF feed pump as needed to fill and flush the MF modules. The time required is 45 seconds. The blinking STANDBY light indicates cycle completion. The MF feed pump will shut down.

After the MF feed pump comes on, check the MF filtrate flow indicator to make sure flow is indicated. If no flow, refer to troubleshooting, WP 0033.

3. Set the SYSTEM MODE SWITCH to MF FILL/HOLD. Adjust Raw Water Flow Control Valve V-107 as necessary to maintain the MF feed tank about 3/4 full.
4. When the Fill/Hold is complete (MF Feed Pump “START” button light goes off), set the SYSTEM MODE SWITCH to RUN.
5. After the RUN light comes on, start the MF feed pump.

NOTE

The pump will not start if the MF FILL/HOLD step has not been completed.

6. Be sure to close RO Feed Tank Drain Valve V-412 (see Figure 2 for valve location). When the RO feed tank level reaches the high level setting, the MF feed pump will stop. Wait for this before continuing to RO System Start-Up.

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START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

RO SYSTEM START-UP

1. Check to make sure that Main Pressure Control Valve HVC-401 is fully open (see Figure 2 for valve location).
2. Toggle the ALARM switch to RESET to clear the RO Feed Tank Level Low Alarm.
3. Make sure the MF feed pump has stopped (the MF Pump indicator light should go off) and that High Pressure Pump Valve V-212 is open, then start the RO feed pump.
4. Wait until a steady RO Reject Flow rate greater than 10 gpm is indicated on the OCP readout and the RO Feed pressure is steady. If, while waiting, the RO Feed Tank level drops below 85%, start the MF Feed Pump.

NOTE

HP Pump P-5 starts first followed by Pump P-6 after a 10 second time delay. It is normal for a high product TDS alarm to sound after the high pressure pumps are started.

5. START the MF Feed Pump if not already on.
6. Immediately START the High Pressure Pumps.

CAUTION

The MF will not begin the automatic timing of the backwash interval until the first backwash is manually initiated. Failure to do this will lead to rapid fouling of the MF membrane, which will require chemical cleaning to restore.

7. Make sure the MF feed tank is at least ¾ full, then push the MF Backwash Start button to manually initiate the first backwash cycle. (The Backwash Start button green light will stay lit until the PLC detects that the air compressor is off and the RO tank level is at 100 to 105%. Then the PLC will start the backwash and establish the normal automatic backwash timing. The green light will flash on and off during the backwash then stay off when the backwash cycle is done.)

NOTE

Several HCV-401 valve adjustments will be required to obtain the correct product flow. Allow up to several minutes between valve adjustments for flow and pressure to stabilize. Normal product flow is 20.5 to 21 gpm on seawater and 25.5 to 26 gpm on freshwater and brackish water up to 20,000 mg/l TDS surface water or 2500 mg/l TDS ground water.

8. Set the Pressure Control valves.
    a. For seawater: fully close Auxiliary Pressure Control Valve V-401A, then slowly CLOSE Main RO Pressure Control Valve HCV-401 until the normal product flow rate is obtained, or the RO feed pressure reaches 1200 psig, or the valve is closed.
    b. For fresh or brackish waters, set Auxiliary Pressure Control Valve V-401A to 50% closed, then slowly CLOSE Main RO Pressure Control Valve HCV-401 until the normal product flow rate is obtained. If HCV-401 is fully closed and the normal product flow is not obtained, open HCV-401, fully close HCV-401A and then adjust HCV-401.
9. Reset the high TDS alarm if on. If the alarm won't reset, refer to **RESPONDING TO NORMAL OPERATION ALARMS** in WP 0016.
10. Check the TQG voltage and adjust to 416 volts if needed (TQG TM 5-6115-545-12).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0015 00**
OPERATOR INSTRUCTIONS
START-UP AFTER A SHORT TERM OR STANDBY SHUTDOWN WITHOUT DRAINING – OPERATION UNDER USUAL CONDITIONS

COMPLETING START-UP

1. Check that the chemical pumps are pumping properly by turning each black priming valve knob ½ turn. Flow should be observed discharging through the return line hose in the chemical solution bucket. Return the black priming valve knob to normal position. Note the chemical tank levels and approximate time when they will require filling.
2. Connect the product water hose (from the TWPS product water discharge) to the distribution tank.
3. Check the MF Feed Tank. Just before a backwash the level in the tank should be approximately 3/4 full. If low, slightly open raw water flow valve V-107. If the level is too high, slightly close Raw Water Flow Valve V-107.
4. Refer to WP 0016, Maintaining Normal Operations; complete the Operator's Data Log and check that all readings are within normal values.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

INITIAL SETUP:

References
A-TWPS only: WQAS-P TM 10-6630-222-12&P
Personnel
One operator/crew
Equipment Condition
Unit is fully operational and making product water at the required production rate. Product water is being discharged to the distribution tanks.

GENERAL

This work package describes how to maintain the TWPS during normal operation once the unit is up and running. The TWPS is capable of sustained operation without routine shut down. However, the TQG that powers the TWPS requires routine PMCS shut down. Therefore, it is to shut down the TPWS as required to support the generator PMCS schedule. It is also necessary to shut down the TWPS if it becomes necessary to interchange chemical pumps or raw water and distribution pumps.

The procedures covered in this work package include:

- Performing Routine Schedule Services
    - Schedule of Routine Crew Operational Services
    - Maintaining Product Flow
    - Product Distribution
    - Making Entries in the Operating Data Log
    - Water Quality Measurement
    - Checking and Refilling the Antiscalant Chemical System
    - Checking and Refilling the Hypochlorite Chemical System
    - Checking and Refilling the Bisulfite Chemical System
    - Evaluating RO% Clean and RO% Salt Rejection
    - Determining RO Cleaning Requirements
    - MF Pressure Integrity and Sonic Tests
    - RO Element Product Flow and Conductivity Tests
    - Manual Flow Control
- Responding to Normal Operation Alarms
- Normal Instrument Readings and Response to Changes
- Interchanging Chemical Pumps
- Interchanging Raw Water and Distribution Pumps

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

PERFORMING ROUTINE SCHEDULE SERVICES

Table 1. Schedule of Routine Crew Operational Services.

Operational Service	Reference	Frequency or Alert
Check TQG voltage and adjust to 416 volts as needed.	TM 5-6115-545-12	Hourly.
Operating Data Log entries	WP0080	Hourly.
Check instrument readings	Table 6	Hourly.
Feed water TDS measurement	WP0016	Hourly for operating log
Adjust OCP Feed Water TDS Set for new reading	WP0016	Hourly before taking operating log data.
Check and record product water chlorine level	WP0016	Hourly when taking operating data
Calculate RO% Clean	WP0083	Daily
Check Product Water Flow. Change pressure as needed to maintain proper flow: - 20.5 to 21 gpm on seawater, or brackish surface water over 20,000 mg/l, or brackish ground water over 2500 mg/l - 25.5 to 26 gpm on fresh and brackish surface water up to 20,000 mg/l or ground water up to 2500 mg/l.	WP0014	Hourly before taking data for Operating Data Log.
Check chemical tank levels to assure that chemical is being pumped and to determine if refill is needed. Check chemical pump flow rate.	WP0016	Hourly when taking data for the Operating Data Log. Refill when the remaining level is between the 1/2 and 1-gallon marks on the pail. Troubleshoot chemical pump if level does not drop from one hour to the next.
Check cyclone separator underflow rate.	WP 0014	Hourly. More frequently if the cyclone is clogging with sand more quickly.
Replace air system filters	WP 0081 WP 0042 WP 0042 WP 0042 WP 0081	Note filter log and current Operating Time Meter reading. Intake air filter, AF-1: rotate every 300 hours. Intake air filter, AF-1: replace every 900 hours. AF-2 Purifier Filter Cartridge, replace every 300 hours. Record filter maintenance in the filter log
Replace pump diesel engine filters	WP 0081 WP 0081	Note maintenance log and current Operating Time Meter reading. Replace air filter every 500 hours. Notify Unit Maintenance to: ▪ Replace lube oil and fuel filters every 1000 hours. Record in the maintenance log
Change pump diesel engine oil	WP 0081 WP 0081	Note maintenance log and current Operating Time Meter reading. Notify Unit Maintenance to change oil every 100 hours of operation. Record in the maintenance log
Clean MF	WP 0021	Schedule within 40 hours of MF TMP High Alarm. Typically 300 hours or more between cleanings.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

Table 1. Schedule of Routine Crew Operational Services – Continued.

Operational Service	Reference	Frequency or Alert
Determine and record RO % Clean	WP 0083	Daily
Clean RO	WP 0022 WP 0023	When indicated by performance.
Remove and clean MF Feed Tank Bag Strainer S-1	WP 0040	Check daily. Each 100 hours of operation at a minimum during normal PMCS shutdown
Distribute Product water	WP0016	As needed.
Check MF Integrity (MF Integrity Test)	WP0016	At the first PMCS shutdown for the TQG. After every 300 hours of operation.

MAINTAINING PRODUCT FLOW

NOTE

To assure the mission water production requirements are met, the flow should be adjusted 0.5 to 1 gpm higher than the normal flow rate. Do not set the water flow more than 1 gpm higher than the normal flow listed. The high TDS concentration in the reject may result in scaling of the RO elements, which will require acid cleaning to remove.

1. If the product flow rate is less than that shown in Table 2, increase the RO Feed pressure by slowly closing Main Pressure Control Valve HCV-401 until the flow is obtained, the RO Feed Pressure reaches 1200 psig, or the valve is closed.
2. Adjustments will not be frequent but will be needed if the water temperature changes or wind and tide change the TDS of the raw water source.

NOTE

Below 500F, the full 1200 gph water production on a seawater source may not be reached at 1200 psig, especially with older RO elements.

Do not exceed 15 gpm when operating on seawater over 50,000 mg/l, even if a higher flow can be obtained.

Table 2. Normal Product Flow Rates.

WATER SOURCE	NORMAL PRODUCT FLOW	TEMPERATURE RANGE
Surface water to 20,000 mg/l	25 gpm, 1500 gph	32 to 95^{0}F
Ground (well) water to 2500 mg/l	25 gpm, 1500 gph	32 to 95^{0}F
Surface water over 20,000 mg/l Ground water over 2500 mg/l	20 gpm, 1200 gph	32 to 95^{0}F
Normal seawater at 35,000 mg/l	20 gpm, 1200 gph	32 to 95^{0}F
Seawater at 45,000 mg/l (See note 1 above)	20 gpm, 1200 gph 17 gpm, 1020 gph	50 to 95^{0}F 32 to 50^{0}F
Seawater at 60,000 mg/l (See note 2 above)	15 gpm, 960 gph	77 to 95^{0}F

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

PRODUCT DISTRIBUTION

Complete the chlorine and TDS measurement checks described under **WATER QUALITY MEASUREMENT** before distributing product water after initial startup. To distribute water, start the Distribution Pump P-7 and use the distribution hoses and nozzles to dispense the water. The water level in the tanks must be at least 12 inches above the outlet to deliver the full flow rate through the nozzles. For the A-TWPS, fill the standard 6000-gallon distribution system at least half full before beginning to fill the 9000-gallon system. If supply demands allow, wait until the 6000-gallon system is full before filling the 9000-gallon system.

MAKING ENTRIES IN THE OPERATING DATA LOG

Complete the data entries in the Operating Data Log once each hour. Refer to WP 0080.

WATER QUALITY MEASUREMENT

General

The raw feed water TDS, the product water TDS and the product water free chlorine level are measured hourly and the results are entered into the Operating Data Log (WP 0080).

1. After measuring the raw feed water TDS, use the Feed Water TDS Set adjustment on the OCP to set the Feed Water TDS display to the value measured for the raw feed water.
2. Open the instrument/solenoid panel and make sure the conductivity transmitter ON/OFF switch is at the ON position (see Figure 1).

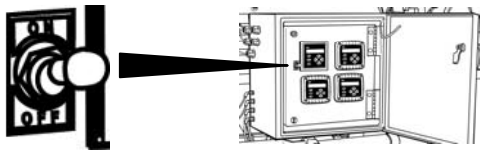

Figure 1. Instrument / Solenoid Panel.

3. Compare the measured product water TDS with the value displayed by the OCP.
    a. If significantly different, calibrate the TWPS conductivity transmitter CT-501 during the PMCS shutdown.
    b. The % Salt Rejection based on the measured value can be estimated as follows:
        100 – (100 – OCP %Salt Rejection) x (Measured TDS/OCP TDS)
4. If the mission requires low EMI emissions, move the conductivity transmitter ON/OFF switch on the instrument/solenoid panel to the OFF position.
5. Compare the measured free chlorine level with the requirement established for the mission. Adjust the hypochlorite pump if needed by changing the speed setting as follows:
        CM = measured chlorine level
        CR = required chlorine level
        S1 = pump speed dial setting
        S2 = new pump speed dial setting required
        S2 = S1 x CR/CM

A-TWPS Water Quality Measurement

Water quality measurements are conducted using the WQAS-P. Refer to TM 10-6630-222-12&P.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

MC-TWPS TDS Measurement

1. Remove the Portable TDS meter with its case from the pack-out box (see Figure 2).

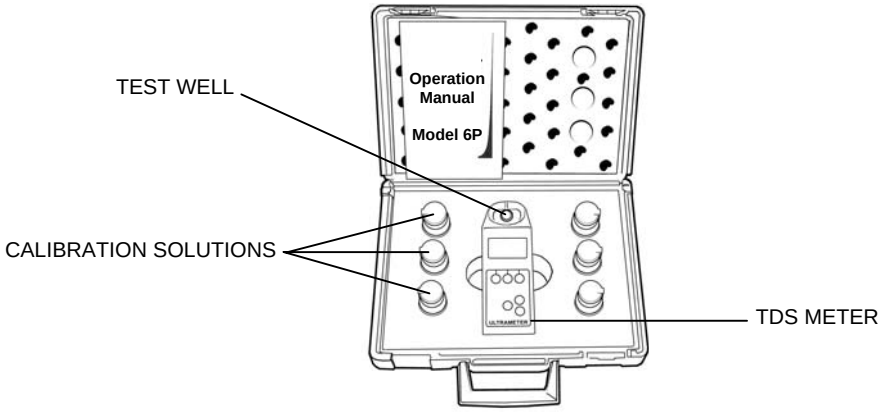

Figure 2. MC-TWPS Portable TDS Meter Kit.

2. Check / calibrate the Portable TDS Meter (if not calibrated within the last 30 days) as follows:
    a. Remove the calibration solutions marked KCl-70 and KCl-18000.
    b. Rinse the test well 3 times with product water from the Product Utility Hose.
    c. Blow the excess water out of the cup.
    d. Rinse the test well three times with the KCl-70 calibration solution.
    e. Then fill the well to the top with calibration solution.
    f. Press COND, then press CAL.
    g. Use UP – DOWN arrows to adjust the value to agree with the calibration solution.
        1) KCl-70 should read 70 us/cm
        2) KCl-18000 should read 18 ms/cm
    h. Press CAL again.
    i. Repeat using the KCl-18000 solution
3. Always measure the product TDS before measuring the raw water TDS.
4. Sample the product using the product utility hose located on the TWPS. Open the valve and let the water flow for a short time. Rinse the TDS meter test well 3 times, then fill the well.
    a. If the TDS reference (far left of display) is set to “NaCl”, press “TDS” and record the reading.
    b. If the TDS reference (far left of display) is not set to “NaCl”, press “TDS” and then press and hold CAL until the “SEL”. Is displayed.
    c. Use the up/down arrows to change the TDS reference to “NaCl”
    d. Press CAL again. Press TDS and record the reading.
5. Sample the raw water from the MF Feed Strainer drain or the in-line strainer drain. Open the valve and let the water flow for a short time. Rinse the meter test well 3 times, then fill the well.
    a. If the raw water is seawater or brackish water expected to be over 5000 mg/L, use the NaCl TDS reference setting. Press TDS and record the reading.
    b. If the raw water is expected to less than 5000 mg/L, set the TDS reference to “442”
        1) Press “TDS” and then press and hold CAL until the “SEL”. Is displayed.
        2) Use the up/down arrows to change the TDS reference to “442”
        3) Press CAL again. Press TDS and record the reading.

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MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

MC-TWPS pH Measurement

1. Remove the Portable TDS meter with its case from the pack-out box (see Figure 3).

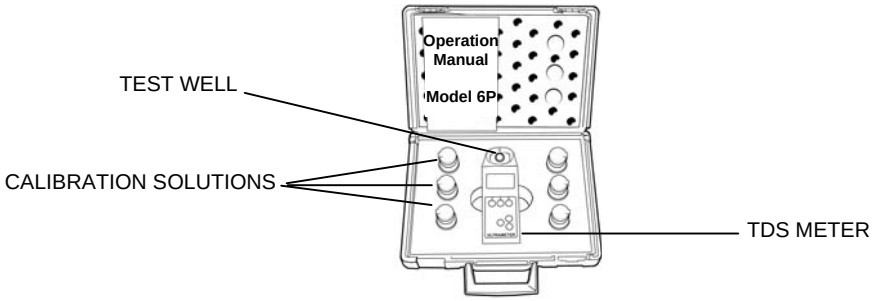

Figure 3. MC-TWPS Portable TDS Meter Kit.

NOTE

Use of the meter to monitor the pH of product water and to neutralize the cleaning waste only requires that the pH 7.0 be checked for calibration.

2. Check the pH calibration of the meter as follows:
    a. Remove the protective cap from the test well by squeezing the sides and pulling up.
    b. Rinse the test well 3 times with pH 7 buffer solution.
    c. Fill the well with pH 7 buffer solution.
    d. Press the “pH” button on the meter.
    e. If the display reads “7.0”, calibration is not required.
    f. If the display reads above “8” the pH cell is defective and the meter will need to be replaced. Make sure the pH 7 buffer was used for the pH calibration check before replacing the meter.
    g. If the display does not read 7.0 (but is less than 8), calibrate the meter for pH 7 as follows:
        1) Press the “CAL/MCLR” button.
        2) Press the Up arrow button or the down arrow button as needed to adjust the reading to 7.0.
        3) Press the “CAL.MCLR” button again to accept the calibration and exit the calibration mode.
3. Measure pH as follows:
    a. Remove the protective cap from the test well by squeezing the sides and pulling up.
    b. Rinse the test well 3 times with the sample to be tested.
    c. Fill the well with the sample.
    d. Press the “pH’ button.
    e. Record the reading.

CAUTION

Failure to keep the test well wet will lead to failure of the sensor.

    f. After use, fill the test well with the sensor storage solution of a pH 4 buffer solution.
    g. Reinstall the protective cap on the test well.

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MC-TWPS Free Chlorine Measurement

The measurement range is 0.05 to 6.0 mg/l free chlorine. The EPA certified range is 0.1 to 4.0 mg/l. If the product water is being chlorinated to a level greater than 5 mg/l, dilute the water taken from the distribution system by a factor of 2. Use the raw water priming pitcher. Rinse with product water. Fill to 1000 ml with un-chlorinated product water from the product utility hose on the TWPS. Then fill to the 2000 ml mark with chlorinated water from the distribution system.

1. Remove the Chlorine Analyzer with its case from the pack-out box (see Figure 4).
2. Fill a clean, dry cuvette to the mark with product water from the distribution system or with diluted water if chlorinated to a level greater than 5 mg/l (see above).
3. Install the cap and dry the outside of the cuvette if wet.
4. Turn on the analyzer by pressing the POWER key.
5. Press the MODE key until “Cl” appears on the display.
6. Place the cuvette in the analyzer and align the arrows,
7. Press the ZERO/TEST key.

NOTE

Do not use DPD No. 3 tablets for free chlorine measurement. The Chlorine Analyzer kit comes with a box of both DPD No. 1 and No. 3 tablets. Using the DPD No. 3 tablets will give inaccurate readings.

8. Remove the cuvette, remove the cap and add one tablet marked DPD No. 1. Crush and stir with the mixing rod. Be sure it is completely dissolved.
9. Install the cap and dry the outside of the cuvette if wet.
10. Place the cuvette in the analyzer and align the arrows,
11. Press the ZERO/TEST key.
12. The “Cl” symbol flashes for about 3 seconds and then the result is displayed as mg/l free chlorine.
13. An error message may be displayed.
    a. EOI: The lens is dirty. Clean with a soft cloth.
    b. +Err: The free chlorine level exceeds 6 mg/l (if not diluted) or 12 mg/l (if diluted)
    c. –Err: The free chlorine level is less than 0.05 mg/l
14. When complete, rinse the cuvette with product water, dry and return to the case.

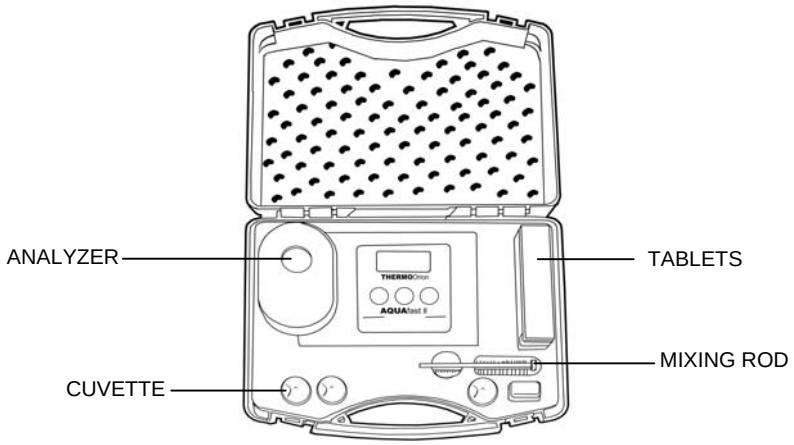

Figure 4. MC-TWPS Chlorine Analyzer.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

CHECKING AND REFILLING THE ANTISCALANT CHEMICAL SYSTEM

WARNING

Irritant. Wear a protective face shield and chemical gloves when handling antiscalant chemical. Avoid inhaling chemical fumes. Failure to observe this warning may result in irritation of the nose, throat, eyes, and skin.

1. Check:
    a. The chemical pump is set to pump 4.2 to 5 gallons during a 10-hour operating shift.
    b. The chemical level in the bucket should be observed to make sure that it drops a little less than 1/2 gallon per hour. If this is not observed, refer to troubleshooting in WP 0033.
2. Refill:
    a. Refill when the remaining level is between the 1/2 and 1-gallon marks on the bucket.
    b. Fill the AC-110 measuring cup with AC-110 antiscalant to the 650 milliliter level.
    c. Using the product utility hose, open valve V-511 to slowly fill to the bucket to the 5-gallon level. At the same time, slowly add the antiscalant.
    d. Rinse the paddle with water from the product utility hose. Stir the water in the bucket with the mixing paddle to thoroughly mix in the antiscalant. Be careful not to damage the suction strainer. Rinse the paddle again when finished.
3. Pump Settings: The pump settings are the same for all conditions.
    a. Speed 70

CAUTION

The stroke length should only be adjusted when the pump is running.

    b. Stroke 60
4. Check the pump prime:
    a. Check that the pump return line hose is directed into the tank.
    b. Rotate the black knob on the priming valve counter-clockwise one half turn and check that the chemical is discharging through the pump return line hose. If not observed, refer to troubleshooting in WP 0033.
    c. Return the black knob on the priming valve to its normal position.

CHECKING AND REFILLING THE HYPOCHLORITE CHEMICAL SYSTEM

WARNING

Hazardous chemical dust and/or fumes. Wear the protective face shield, chemical gloves, and dust mask when handling calcium hypochlorite. Avoid inhaling chemical dust or fumes. Hypochlorite will give off chlorine vapor, which will burn your nose, throat and lungs if breathed directly. Keep your head away from top of the bucket while filling. Inhalation of calcium hypochlorite dust may cause severe chemical burns. Direct contact with the eyes may cause severe eye damage.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

NOTE

At very low pump flows, it may require two hours to clearly observe a drop in hypochlorite level in the chemical bucket.

1. Check:
    a. The pump flow rate is set based on the product flow rate and the amount of free chlorine required as listed in Tables 3 through 5 in WP 0014, Initial Start-Up or Start-Up with the System Fully Drained.
    b. The drop in hypochlorite level in the bucket varies, but should always be clearly observed to drop from one hour to the next.
    c. If a drop is not observed, refer to troubleshooting in WP 0033.
2. Refill:
    a. Refill when the remaining level is between the 1/2 and 1-gallon marks inside the bucket.
    b. Using the product utility hose, open valve V-511 to slowly fill to the bucket to the 5-gallon level.
    c. Slowly add the number of packets of hypochlorite required for the desired free chlorine level and product flow rate as indicated in Tables 3 through 5 in WP 0014.
    d. Rinse the paddle with water from the product utility hose. Stir the water in the bucket with the mixing paddle to thoroughly mix in the hypochlorite. Be careful not to damage the suction strainer. Rinse the paddle again when finished.
3. Pump Settings vary with the product water flow and the free chlorine required as indicated in Tables 3 through 5 in WP 0014.
4. Check the Prime:
    a. Check that the pump return line hose is directed into the bucket.
    b. Rotate the black knob on the priming valve counter-clockwise one half turn and check that the chemical is discharging through the pump return line hose. If not observed, refer to troubleshooting in WP 0033.
    c. Return the black knob on the priming valve to its normal position.

CHECKING AND REFILLING THE BISULFITE CHEMICAL SYSTEM

WARNING

Chemical dust. Wear the protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to use bisulfite when operating on a chlorinated water source will lead to destructive failure of the MF and RO membranes.

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NOTE

The Bisulfite System is only used when the raw water source is chlorinated, as is always the case with municipal water. When in use, the Bisulfite Pump Switch is set to AUTO.

1. Check:
    a. The chemical pump is set to pump 4.2 to 5 gallons during a 10-hour operating shift
    b. The chemical level in the bucket should be observed to make sure that it drops a little less than 1/2 gallon per hour. If this is not observed, refer to troubleshooting in WP 0033
2. Refill:
    a. Refill when the remaining level is between the 1/2 and 1-gallon marks on the bucket.
    b. Using the product utility hose, open valve V-511 to slowly fill to the bucket to the 5-gallon level. At the same time slowly add one 12 oz packet of bisulfite.
    c. Rinse the paddle with water from the product utility hose. Stir the water in the bucket with the mixing paddle to thoroughly mix in the bisulfite. Be careful not to damage the suction strainer. Rinse the paddle again when finished.
3. Pump Settings are the same for all conditions:
    a. Speed 70

CAUTION

The stroke length should only be adjusted when the pump is running.

    b. Stroke 60
5. Check the Prime:
    a. Check that the pump return line hose is directed into the tank.
    b. Rotate the black knob on the priming valve counter-clockwise one half turn and check that the chemical is discharging through the pump return line hose. If not observed, refer to troubleshooting in WP 0033.
    c. Return the black knob on the priming valve to its normal position.

EVALUATING RO % CLEAN AND RO % SALT REJECTION

The evaluation of the RO clean and salt rejection percentages indicates the condition of the RO membranes and the need to clean or replace the RO elements.

1. RO % Clean:
    a. The RO % Clean is obtained from the operating data using the procedure provided by WP 0083.
    b. RO % Clean shows the openness (permeability) of the RO membranes to water flow as a percentage of the new membrane openness.
    c. As the RO% Clean value decreases (as the membranes become fouled), the pressure required to produce the same water flow increases.
    d. RO % Clean decreases as the RO elements age, especially when operated at high pressures with warm source waters.

e. RO % Clean also decreases if salt scale, dirt or biological growth build up on the membrane surface.
f. A decrease of 10% or more in RO % Clean during operation indicates that the RO needs to be cleaned.
g. Water production listed in Table 2 can be obtained with RO % Clean values which equal or exceed the values listed below.

Fresh water and brackish water to 5000 mg/l	50%
Normal seawater (35,000 mg/l)	70%
45,000 mg/l sea water	79%
60,000 mg/l sea water	79%

h. With lower RO% Clean values, the maximum operating pressure will be reached before reaching the listed water production.

2. % Salt Rejection
   a. The % Salt Rejection value is displayed on the OCP. It shows the percentage of salt that is rejected from the feed water as the water passes through the membrane to become product water. This value is calculated by the PLC using the feed water TDS entered by the operator, the product measured TDS, the feed water temperature and the product flow rate.
   b. The % salt rejection decreases with increasing temperature.
   c. The % Salt Rejection decreases as the RO membrane ages and if salt scale builds on the membrane surface during operation.
   d. Compare the % Salt Rejection readings with the values listed in Table 3. If a reading is close to the minimum and dropping, schedule the checks and corrective action listed in Table 5 under "Product TDS High" Alarm. When % Salt rejection falls below the minimum, the alarm will come on. The alarm also comes on if the measured TDS is greater than 1000 mg/l.

Table 3. Expected Salt Rejection Readings.

Raw Water	Expected	Minimum
Seawater and other sources over 20,000 mg/l	99.2% or higher	98.5%
Brackish water 5000 to 20,000 mg/l	99.2% or higher	98%
Fresh water and brackish water to 5000 mg/l	99.2% or higher	95%

3. RO Cleaning Indication:
   a. The need to schedule cleaning of the RO, and the type of cleaning required, is indicated by changes in the RO% Clean and % Salt Rejection values. Refer to Table 4.
   b. If the % Salt rejection is close to the minimum value, refer to Table 5, under the heading "Product TDS High".

DETERMINING RO CLEANING REQUIREMENTS

NOTE

If you are not certain which RO cleaning procedure is needed, complete both the low pH acid and high pH detergent cleaning.

Table 4. RO Cleaning Schedule.

RO % Clean	% Salt Rejection	Problem Indicated	Cleaning Required
Less than 90% and a decrease of 10% or more since beginning the mission or last cleaning	Unchanged	Silt fouling, or biological film growth from inadequate preservation	RO Detergent Cleaning (High pH cleaner AC-310 Detergent)
Less than 90% and a decrease of 10% or more since beginning the mission or last cleaning	Decreased	Scale	RO Acid Cleaning (Low pH cleaner AC-210 Citric Acid)

Refer to WP 0020, Cleaning and Preservation Introduction, for cleaning procedures.

MF PRESSURE INTEGRITY AND SONIC TESTS

MF Pressure Integrity Test:

This is an automated self-test. From STANDBY with the MF full of water, the filtrate is drained and purged with air. An air pressure of approximately 15 psig is then applied to the MF modules and shut off. Broken membrane fibers will leak air out the open ends of the fibers into the feed water (shell) side of the modules. As the air leaks out, the air pressure will decrease. The PLC notes the air pressure after 2 minutes and again after 2 additional minutes. The PLC compares the pressures to determine if the leakage is excessive. If MF Filtrate Pressure Transmitter PT-102 is not functioning properly (TMP cannot be zeroed), the automatic test will give a fail indication. In this event, the MF Pressure Integrity can be checked manually using readings from MF Filtrate Pressure Gauge PI-201.

NOTE

New MF membranes will not be fully wetted until they have been operated for 50 - 200 hours. Without full wetting, they will not pass the integrity test. This does not indicate a problem.

Perform the automatic MF Pressure Integrity Test as follows:

1. Shutdown the TWPS to STANDBY.
2. Set the MF Test Switch to PRESSURE.
    a. The test automatically sequences.
    b. The MF Integrity Test indicator light is on during the test.
3. At the end of the test the same indicator light indicates pass/fail.
    a. Light off – Pass.
    b. Light flashing – Fail.
4. If the test indicates failure, continue with the Sonic Test.

Perform the MF Pressure Integrity Test manually using MF Filtrate Pressure Gauge PI-201 as follows:

1. Shutdown the TWPS to STANDBY.
2. Set the MF Test Switch to PRESSURE.
3. Wait 2½ minutes, then record the reading from MF Filtrate Pressure Gauge PI-201. A reading of less than 10 psig indicates failure.
4. If the reading is 10 psig or higher, wait an additional 2 minutes, then record the reading again.
5. Subtract the second reading from the first reading. A result greater than 6 psig indicates failure.

MF Sonic Test:

The sonic test holds the air pressure by leaving the air valve open. Leakage may be a result of leaking filtrate valve V202 or O-rings as well as broken fibers.

Perform the MF Sonic Test as follows:

1. Set the System Mode Switch to Fill/Hold.
2. When the Fill/Hold cycle is completed, set the System Mode Switch back to Standby.
3. Set the MF Test Switch to SONIC.
4. Listen for the sound of air bubbling through water as follows (see Figure 5):
    a. Remove the Mechanic's Stethoscope from the toolbox.
    b. Place the end on the body of the Filtrate Flow Control Valve V-202. Leakage is noted by noise heard with the stethoscope.
    c. If the leak is at V-202, notify unit maintenance and continue operation. There is no problem with the MF elements.
    d. If the leakage is not at V-202, continue and listen to each MF module starting at the top collar and moving down to the bottom collar.

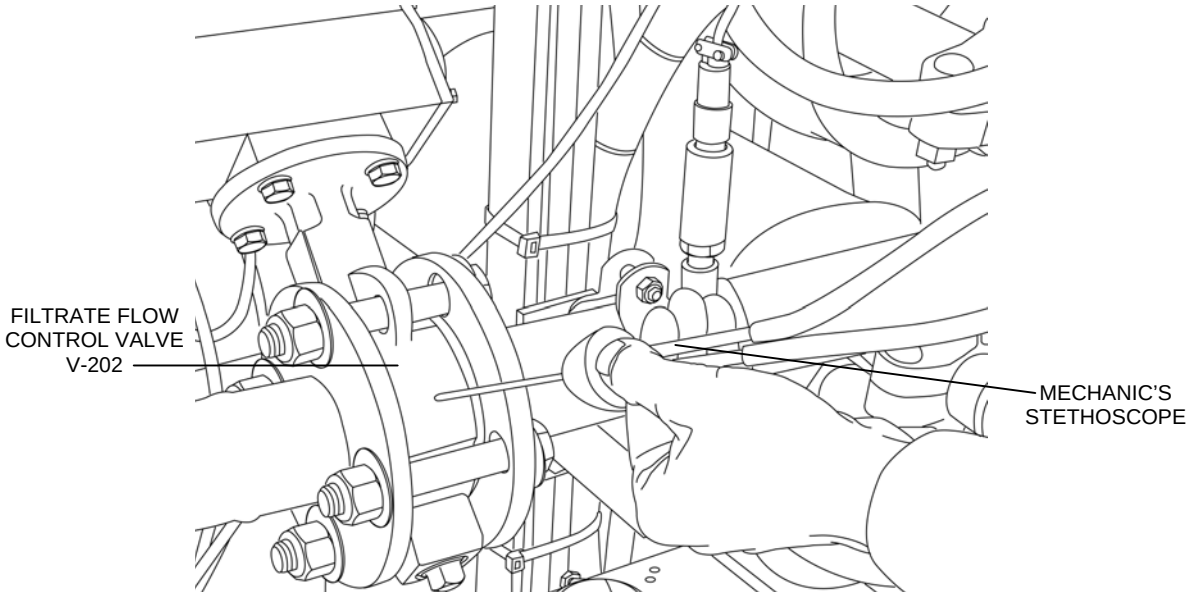

Figure 5. Performing the MF Sonic Test.

5. If the leak is limited to one or two MF modules, isolate the modules by turning both their top and bottom filtrate valves off as follows (see Figure 6):
    a. Remove the MF Valve Tool from the toolbox.
    b. Press in the Tee handle to open the jaws of the tool. The jaws fit over the valve stem.
    c. Push the tool up through the hole in the TWPS frame below the module to be isolated.
    d. Engage the valve stem with the valve tool jaws.
    e. Turn the valve stem ¼ turn clockwise.
    f. Pull the valve outwards, then turn the valve ¼ turn counter-clockwise.
    g. Repeat for the valve at the top of the module.

6. Note the position of the module for identification.
    a. If more than two are leaking, isolate the two with the most noise.
    b. Continue operation. Notify unit maintenance to replace the damaged MF elements or O-rings.
        1) If the leakage noise is only at the top or bottom of a module, the problem is most likely a damaged O-ring.
        2) If the leakage is observed along the column, the MF element probably requires replacement.
    c. Set the MF Test Switch to OFF after completing the sonic test and isolating the damaged MF modules.

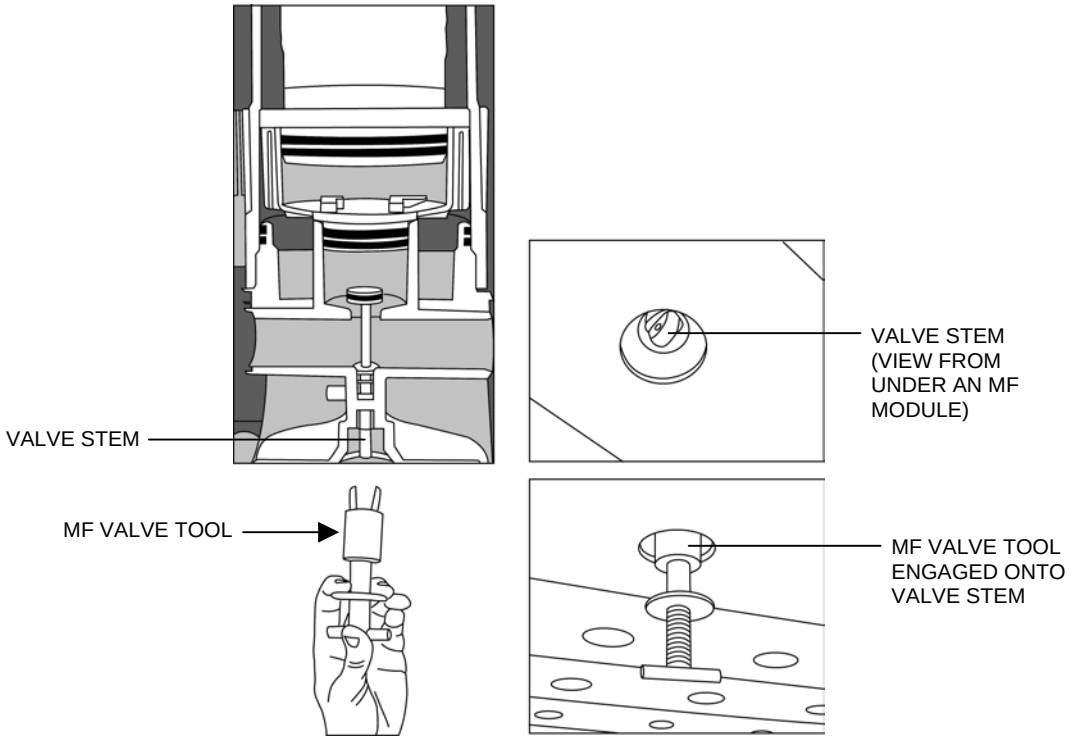

Figure 6. Isolating an MF Module.

RO ELEMENT PRODUCT FLOW AND CONDUCTIVITY TESTS

A product TDS high alarm at startup and a TDS reading that does not drop below 1000 mg/L after a few minutes of operation is an indication of a damaged RO vessel O-ring or RO element failure. If you get a high TDS alarm, perform a conductivity test and correct as indicated.

RO product water flow and conductivity tests are also performed at the beginning of deployment and after 500 hours of operation. Product water flow tests and conductivity tests are typically performed at the same time. The product water flow test is performed for a given element first and is immediately followed with the conductivity test for the element.

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The RO vessels are designed so that the product water from each element is discharged separately to the Product Manifold through a 3-way valve (see Figure 7). The 3-way valve can be positioned one of the following three ways:

Position Name	Physical Positioning	Direction of Water Flow
Normal Position	Middle pointer points toward black product hose.	From RO vessel to distribution system.
Drain Position	Middle pointer points toward RO Vessel.	From RO vessel and black product hose (and product manifold) to clear drain hose.
Sample Position	Middle pointer points toward clear drain hose.	To clear drain hose.

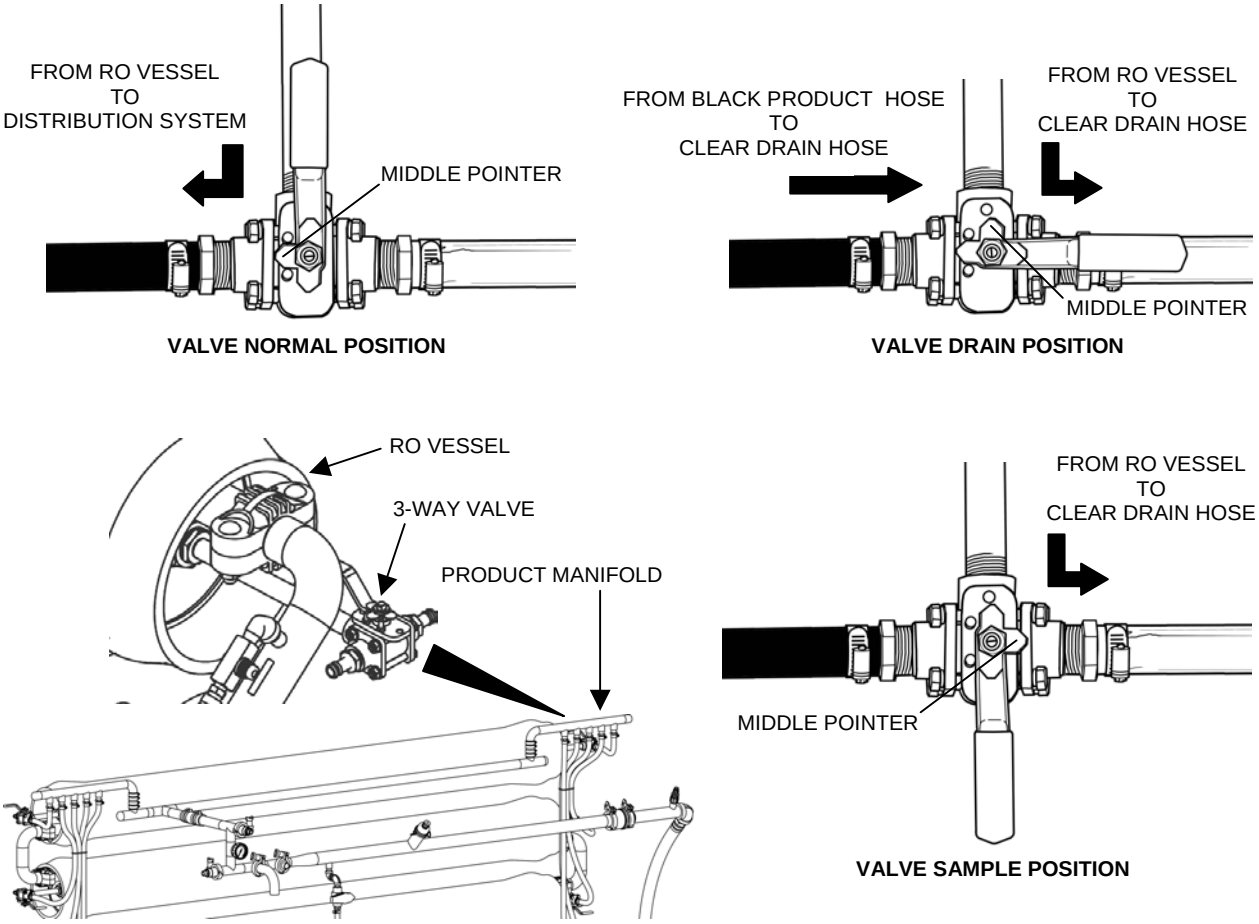

Figure 7. RO Vessel 3-Way Valve Positions.

Perform the RO element product flow and conductivity tests as follows:

1. Collect the following items:
    a. RO Element Product Flow Tester
    b. (MC-TWPS) Portable TDS Meter Kit with TDS Meter and Calibration Solutions
    c. (A-TWPS) WQAS-P with TDS Meter and Calibration Solutions

2. For the A-TWPS, check / calibrate the Portable TDS Meter (if not calibrated within the last 30 days) as described in the WQAS-P TM 10-6630-222-12&P.
3. For MC-TWPS, check / calibrate the Portable TDS Meter (if not calibrated within the last 30 days) as follows:
    a. Remove the calibration solutions marked KCl-70 and KCl-18000.
    b. Rinse the conductivity cell cup 3 times with product water from the Product Utility Hose.
    c. Blow the excess water out of the cup.
    d. Rinse the conductivity cell cup three times with the KCl-70 calibration solution.
    e. Then fill the cup to the top with calibration solution.
    f. Press COND, then press CAL.
    g. Use UP – DOWN arrows to adjust the value to agree with the calibration solution.
        1) KCl-70 should read 70 us/cm
        2) KCl-18000 should read 18 ms/cm
    h. Press CAL again.
    i. Repeat using the KCl-18000 solution
4. Test RO element product flow as follows (see Figure 8):
    a. Connect the RO Element Product Flow Tester to the end of the drain/sample tube for the RO element to be tested. Direct the free end away from the unit.
    b. Turn the 3-way RO valve to direct product flow to sample (see Figure 7).

NOTE
The flow tester turns off automatically.

    c. Push and release the DISPLAY button on the flow tester until FLOWRATE appears in the lower left of the display. Wait until the reading stabilizes and record in the RO Element Performance Log (WP 0082, GPM column).

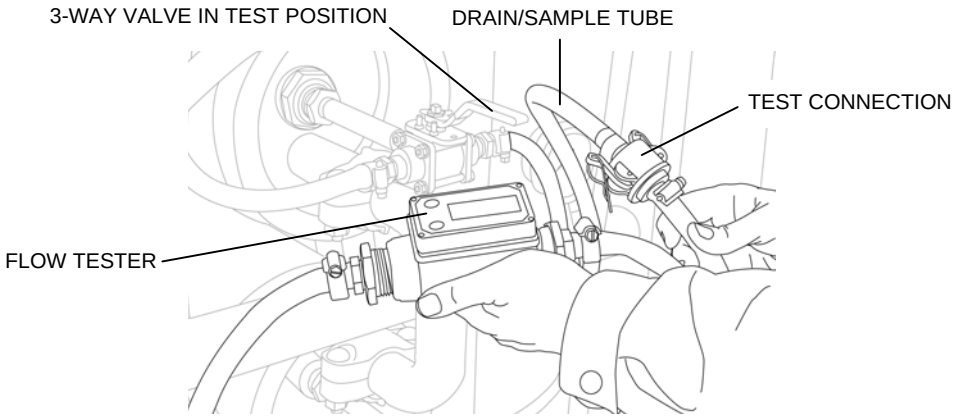

Figure 8. RO Element Product Water Flow Test Setup.

5. Test RO element conductivity as follows (see Figure 9):
    a. Rinse the TDS Meter cup 3 times with water from the end of the sample tube, then fill.
    c. If the TDS reference (far left of display) is set to “NaCl”, press “TDS” and record the reading in the RO Element Performance Log (WP 0082, TDS column).

d. If the TDS reference (far left of display) is not set to “NaCl”, press “TDS” and then press and hold CAL until the “SEL”. Is displayed.
e. Use the up/down arrows to change the TDS reference to “NaCl”
f. Press CAL again. Press TDS and record the reading.
b. Press TDS to measure the Total Dissolved Solids. The reading will be in Parts Per Million (PPM), which is equivalent to milligram per liter (mg/l).
c. Record the reading in the RO Element Performance Log (WP 0082, TDS column).

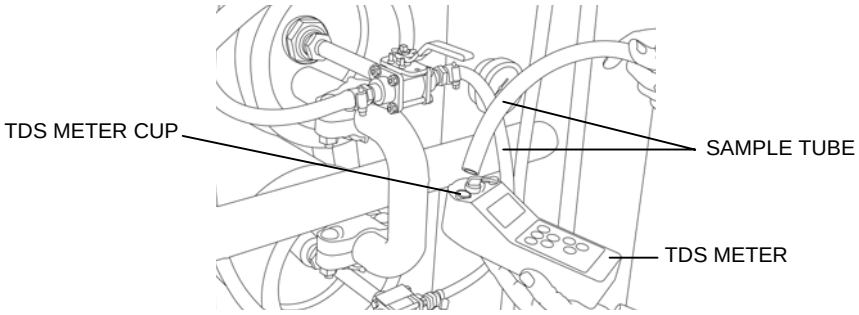

Figure 9. RO Element Product Water Conductivity Test Setup.

6. Repeat the product flow and conductivity tests for each of the RO elements.

MANUAL FLOW CONTROL

Manual flow control is used as a backup control procedure if the automatic control fails to properly fill the RO Feed Tank or if the automatic control overflows the tank.

1. At the Feed Flow Control Panel, turn the Feed Control Selector handle from the Auto position to the Manual position.
2. Use the Manual Feed Control to adjust the MF Feed Flow. Turning the control dial clockwise will decrease the flow. Turning the control counter-clockwise will increase the flow.
3. If the RO Feed Tank Level display is not working, open the RO Feed Tank cover to observe the level.
4. While operating, set the flow to approximately 65 gpm until the level is within 4 inches of the top. The tank must be refilled before the backwash begins. Then reduce the flow to approximately 55 gpm or as needed to hold the level at or above 4 inches from the top without overflowing until the backwash begins.
5. As soon as the backwash is complete, increase the flow to fill the tank again.

RESPONDING TO NORMAL OPERATION ALARMS

NOTE

When an alarm sounds and a red alarm light comes on, unless the unit automatically shuts itself down, continue operation and follow the applicable instructions in Table 5.

1. When an alarm sounds, turn the Alarm Switch to SILENCE.
2. After correcting the cause of the alarm, or after shutdown to standby to correct the cause of the alarm, turn the Alarm Switch to RESET.
3. For alarms during normal operation, refer to Table 5 to determine the corrective action to take.
4. For alarms during startup and cleaning, refer to the specific startup or cleaning procedures.

Table 5. Normal Alarms and Alarm Responses.

Alarm	Immediate Response	Problem	Test or Inspection	Corrective Actions
Check MF Integrity				Note: This alarm is not connected, but is available for future product improvement.
MF Backwash Cycle Fail	- Return System Mode to Standby. - Drain the RO feed tank. - Power down the system by opening the MAIN circuit breaker at the PDP (OFF position) - Then power up the system, thus resetting the PLC, by closing the MAIN circuit breaker at the PDP (ON position) - Troubleshoot.	(1) One or more automatic valve has failed to cycle as required during backwash.	(1) Step through the BIT self-tests to identify if an automatic valve fails to cycle (see WP 0013).	1) If a valve fails to operate, notify Unit Maintenance. Do not continue operation.
		(2) Solenoid valve XV-901 has failed to operate	(2) Step through the BIT self-tests to identify if XV-901 fails to energize (see WP 0013).	(2) If XV-901 fails to energize, replace the coil with the spare coil from the BII. Repeat the BIT test. If XV-901 again fails to energize, notify Unit Maintenance. Do not continue operation
		(3) Pressure transmitter PT-102 failure	(3) Continue operation. Observe pressure gage PI-201. If the pressure during the backwash pressurization step is at least 80 psig, pressure transmitter PT-102 has failed.	(3) If PT-102 has failed, continue operation. Notify Unit Maintenance
		(4) Other causes		Notify Unit Maintenance
Air Pressure Low (compressor is on when backwash is initiated).	Backwash continues. Reset the alarm. When backwash ends, perform the following: - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Start the compressor. - Wait until air pressure is 900 psig, then restart the TWPS. - When the compressor stops, push Backwash Start. (If compressor does not stop before the pressure reaches 1025 psig, see Cause #2.) If the alarm repeats during a later backwash, troubleshoot during the next PMCS shutdown.	(1) Air leakage	(1) Stop the generator and listen for air leaks. (WP0033 Table 9)	(1) WP0033 Table 9
		(2) Pressure switch PSL/PSH-901 out of adjustment or failed	(2) Start the compressor. If the compressor does not stop before the pressure reaches 1025 psig, the pressure switch is out of adjustment or has failed.	(2) Continue operation. Notify Unit Maintenance to adjust or replace PSL/PSH-901.
		(3) Worn compressor valves or piston rings	(3) Open the LP Air Vent valve (V-910) until air flow stops. Close the valve and start the compressor. Note the time required to reach full pressure and stop. If longer than 30 minutes, the compressor valves or rings are worn.	(3) Continue operation. Notify Unit Maintenance.

Table 5. Normal Alarms and Alarm Responses – Continued.

Alarm	Immediate Response	Problem	Test or Inspection	Corrective Actions
Clean Strainer (210 to 190 gpm backwash flow)	- Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Follow normal startup procedures - Troubleshoot if alarm re-occurs.	(1) MF Feed Strainer S-2 fouled. (2) Debris in MF Feed Pump. (3) MF Feed Pump worn.	(1) Check strainer basket. (2) Remove the hoses and adaptor. Check for debris in the pump inlet or outlet.	(1) Clean. (2) Remove any debris found. (3) Continue operation. Notify Unit Maintenance.
MF Backwash Flow Low (Backwash flow less than 190 gpm)	- Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Follow normal startup procedures - Troubleshoot if alarm re-occurs.	(1) MF Feed tank out of water (2) Automatic valve failure. (3) Flow measurement loop failure. (4) Severely fouled strainer S-2 or MF Feed Pump	(1) Check MF Feed Tank Level. Should not be less than 25% full at end of backwash. (2) Step through the BIT self-tests to identify if an automatic valve fails to cycle or fails to cycle fully (see WP 0013). (3) Resume operation. Note the backwash flow. If it is less than 190 gpm, the flow measurement loop may have failed. (4) See Clean Strainer (1) and (2)	(1) Open flow control valve. (2) If a valve fails to operate or cycle fully, notify Unit Maintenance. Do not continue operation. (3) Continue operation. Notify Unit Maintenance. (4) See Clean Strainer (1) and (2). Check MF Feed Tank Strainer S-1 for breaks.
MF TMP High	Continue operation. Note operating hour reading on hour meter.	(1) Pressure transmitter PT-102 failure (2) MF TMP Zero out of adjustment. (3) MF fouled and ready for routine cleaning.	(1) Compare TMP with Operating Data Log entries. If it is much higher than previous entries, PT-102 may have failed. Compare the difference between pressure gages PI-101 and PI-102 with the TMP display. If the pressure gages show a lower TMP, this also confirms PT-102 failure. (2) Check TMP for zero at next PMCS shutdown. (3) Schedule routine cleaning within 40 hours. Do not exceed maximum pressures listed for various temperatures in Table 6. Clean sooner if required.	(1) Continue operation. Use pressure gages PI-101 and PI-201 to determine the TMP. Notify Unit maintenance. (2) Adjust Zero if needed. (3) Clean MF (WP 0021).

Table 5. Normal Alarms and Alarm Responses – Continued.

Alarm	Immediate Response	Problem	Test or Inspection	Corrective Actions
RO Feed Tank Level Low	HP pumps stop automatically. - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Follow normal startup procedures - Troubleshoot if alarm re-occurs.	1) MF Feed Tank almost empty. (2) Level measurement loop failure (3) MF Filtrate Flow control failure	(1) Check level in MF Feed Tank. It should never be less than one-third full. (2) Open the RO Feed Tank cover. If the actual level is not almost empty, the level measure loop has failed. (3) Restart. After the first backwash, the level should be back between 95% and 105% when the next backwash begins.	(1) Troubleshoot raw water system. (WP0033 Table 1) (2) Notify Unit Maintenance. (3) If the level is not reached and the alarm repeats, switch to manual flow control and continue operation. Notify Unit maintenance. If the flow cannot be controlled in manual, shutdown until the problem is corrected.
RO Temp High	Cleaning only. Heaters shut off automatically.	Cleaning solution over 110°F.		Turn Tank Heater Switch to OFF.
RO Feed Pressure Low (during normal operation)	HP Pumps stop automatically (or will not start). RO Feed Pump remains on. If the system was in backwash and the RO tank level is low, see response for RO feed tank low level alarm. - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Follow normal startup procedures. - Watch HP Pump Feed Pressure gage PI-202. - Troubleshoot if alarm re-occurs.	 (1) Pressure transmitter PT-201 failure (2) PT-201 measurement loop electrical failure	**Pressure gage PI-202 does not drop below 35 psig and alarm repeats.** (1) See corrective action (2) After replacing PT-201 continue operation. If the alarm repeats, the failure is in the measurement loop electrical system.	Perform steps 1 and 2. (1) Replace PT-201 with the spare located in the BII. Continue operation. (2) Notify Unit Maintenance.

Table 5. Normal Alarms and Alarm Responses – Continued.

Alarm	Immediate Response	Problem	Test or Inspection	Corrective Actions
RO Feed Pressure Low (during normal operation continued)			**Pressure gage PI-202 drops below 35 psig .**	Perform steps 3, 4, and 5.
		(3) In-line Strainer S-4 plugged.	(3) Remove and inspect In-line strainer S-4.	(3) Clean if dirty
		(4) RO Feed Tank Strainer S-3 plugged.	(4) Remove / inspect RO Feed Tank Strainer S-3.	(4) Clean if dirty
		(5) RO feed pump worn.	(5) Previous inspections	(5) Notify Unit Maintenance.
RO Operating Pressure High (while in operation)	HP Pumps automatically stop. - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Follow normal startup procedures. - Watch RO feed pressure gage PI-304. - Troubleshoot if alarm re-occurs.	(1) Pressure control valve HCV-401 out of adjustment.	(1) Fully open valve, start HP Pumps and adjust valve. Observe pressure at panel display. Do not exceed 1200 psig.	(1) Do not let pressure drift above 1200 psig.
		(2) Pressure transmitter PT-301 failure.	(2) Observe pressure gage PI-304 to make sure it is the same as the panel display.	(2) Disconnect electrical connector at the transmitter. Continue operation using PI-304 as the indication for RO feed pressure. Notify Unit Maintenance.
Product TDS High	Set product hose to discharge back to the water source and troubleshoot.	(1) Conductivity sensor or transmitter failure.	(1) Check conductivity using portable TDS Meter.	(1) If portable TDS meter reads a significantly lower TDS than the OCP display, notify unit maintenance and continue operation.
		(2) Feed Water TDS not correctly set	(2) Check feed water TDS using portable TDS meter.	(2) Be sure that OCP display has been adjusted with the TDS Set dial to agree with the measurement.
		(3) Leaking O-ring or damaged membrane.	(3) Check individual RO element performance (see RO Element Product Flow Test procedure in this WP).	(3) If one or two elements show significantly higher conductivity product water, replace O-rings and re-install. Replace element if conductivity remains high.

Table 5. Normal Alarms and Alarm Responses – Continued.

Alarm	Immediate Response	Problem	Test or Inspection	Corrective Actions
	Cleaning or element replacement can be delayed by setting the 3-way valve V-510 for element #10 to the sample position. This will divert the highest TDS water. If the product water TDS alarm will not reset, set 3-way valve V-509 for element #9 to the sample position to divert this water also. Adjust HCV-401 to maintain the required product flow.	(4) RO membrane scaled. (5) Old membranes.	(4) Restored performance after cleaning. (5) Acid cleaning fails to improve % Salt rejection.	(Note: This action may be deferred to the next PMCS shutdown by setting the 3-way valve V-510 and possibly V-509 to the Sample position to divert the product from the problem elements) (4) AC-210 Low pH acid cleaning. Extend recirculation period to 4 hours. If the % Salt rejection is improved after cleaning, but still close to the minimum, repeat the cleaning. (5) Replace all RO elements.
Pump red stop button is on.	Pump stops. Set System Mode Switch to Standby.	(1) Circuit breaker has tripped (2) Contactor thermal overload has tripped.	See WP 0033 See WP 0033	See WP 0033 See WP 0033
Air compressor switch is red	Compressor stops. Set System Mode Switch to Standby	(1) Circuit breaker has tripped (2) Contactor thermal overload has tripped. (3) Air compressor has over heated.	See WP 0033 See WP 0033 See WP 0033	See WP 0033 See WP 0033 See WP 0033

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NORMAL INSTRUMENT READINGS AND RESPONSE TO CHANGES

Table 6 provides the normal readings to be expected from the OCP displays and the operator response to changes in the readings.

Table 6: Normal Instrument Readings and Response to Changes.

<table>
<tr><th>Normal Reading</th><th>Reading Changes</th><th>Response to Changes</th></tr>
<tr><td><u>Feed Water TDS</u>

Steady reading as input by the operator through the Feed Water TDS Set adjustment.</td><td>Change in reading without operator adjustment.</td><td>Notify Unit Maintenance. Note that the % Salt Rejection display will not be correct and that the Product TDS High alarm may come on without actual high TDS (or % Salt Rejection).</td></tr>
<tr><td><u>MF Flow</u>

210 to 225 gpm during MF Fill/Hold.</td><td>Decreasing flow during mission.</td><td>Inspect and clean the MF Feed Strainer S-2 at the next PMCS shutdown.</td></tr>
<tr><td>Over 210 gpm during shell sweep step of backwash.</td><td>Decreasing flow during mission.</td><td>Inspect and clean the MF Feed Strainer S-2 at the next PMCS shutdown. (MF Backwash Flow Low Alarm will come on at 200 gpm).</td></tr>
<tr><td>60 to 70 gpm filling the RO Feed Tank, 50 to 60 gpm after reaching 95 to 105% level.</td><td>Much higher flow and the RO Feed Tank overflows.</td><td>Switch to Manual Flow Control and continue operation. If manual flow control does not work, shut down and notify Unit Maintenance.</td></tr>
<tr><td><u>MF Trans-Membrane Pressure</u>

3 to 5 psi at 50 to 60 gpm MF Feed Flow after cleaning. The alarm setting and the maximum allowable pressure (psi) depend on the water temperature (^{0}F).

<table>
<tr><th>Temp</th><th>Alarm psi</th><th>Max psi</th></tr>
<tr><td>32</td><td>28</td><td>30</td></tr>
<tr><td>45</td><td>25</td><td>28</td></tr>
<tr><td>55</td><td>21</td><td>25</td></tr>
<tr><td>65</td><td>18</td><td>22</td></tr>
<tr><td>75</td><td>16</td><td>20</td></tr>
<tr><td>85</td><td>14</td><td>18</td></tr>
<tr><td>95</td><td>13</td><td>16</td></tr>
</table>
</td><td>Sudden increase and MF Trans-Membrane Pressure High alarm is on.</td><td>See alarm response.</td></tr>
<tr><td><u>RO Feed Flow</u>

52 to 58 gpm after startup and stabilization. 54 to 56 gpm most usual range.</td><td>Operating data shows a noticeable decrease over and extended period of time.

Reading is very low or all zeros.</td><td>HP pumps are wearing. Notify Unit Maintenance to repair pumps at next opportunity within mission requirements.

Notify Unit Maintenance. Refer to troubleshooting WP0035.</td></tr>
</table>

Table 6. Normal Instrument Readings and Response to Changes – Continued.

<table>
<tr><th>Normal Reading</th><th>Reading Changes</th><th>Response to Changes</th></tr>
<tr><td><u>RO Feed Pressure</u>

This changes with the water TDS and the water temperature.</td><td>Wind and tide may change the TDS of seawater and brackish water sources which will require a change in operation pressure.

Any increase in pressure which is associated with RO element fouling will be noted by the RO %Clean calculation.</td><td></td></tr>
<tr><td><u>RO Reject Flow</u>

12 to 20 gpm at start up before starting the HP pumps.

At 20 gpm product flow
▪ 32 to 38 gpm range
▪ 34 to 36 gpm normal
At 25 gpm product flow
▪ 27 to 33 gpm range
▪ 29 to 31 gpm normal</td><td></td><td></td></tr>
<tr><td><u>RO Feed Tank Level %</u>

15% or higher at the end of each backwash.

95 to 105% for several minutes before the start of a backwash.</td><td>If near 0%, the RO Feed Tank Level Low alarm will come on.

At 115%, the RO Feed tank overflows.</td><td>Notify Unit Maintenance. Refer to Troubleshooting WP0035.

Switch to Manual Flow Control and continue operation. If manual flow control does not work, shut down and notify Unit Maintenance.</td></tr>
<tr><td><u>RO %Salt Rejection</u>

99% or higher.</td><td>The minimum value which initiates the Product TDS High alarm is listed in the table below.

<table><tr><td>Seawater and other sources over 20,000 mg/l</td><td>98.5%</td></tr><tr><td>Brackish water 5000 to 20,000 mg/l</td><td>98%</td></tr><tr><td>Fresh water and brackish water to 5000 mg/l</td><td>95%</td></tr></table>
Operating data log shows a continuing decrease over time.</td><td>Schedule RO cleaning before the minimum %Salt Rejection value is reached.</td></tr>
</table>

Table 6. Normal Instrument Readings and Response to Changes – Continued.

<table>
<tr><th>Normal Reading</th><th>Reading Changes</th><th>Response to Changes</th></tr>
<tr><td><u>Product Flow</u>

See Table 2.</td><td>Increase to more than 1 gpm over normal.

Decrease to less than 0.5 gpm over normal.</td><td>Slowly open the Main Pressure Control Valve V-401 to decrease the flow.

Slowly close the Main Pressure Control Valve V-401 to increase the flow</td></tr>
<tr><td><u>Product TDS</u>

The product TDS changes with the raw water TDS. Normal ranges are as listed.

<table><tr><th>Raw Water</th><th>Prod mg/l</th></tr><tr><td>Fresh water</td><td>1 to 2</td></tr><tr><td>Brackish water</td><td>50 to 300</td></tr><tr><td>Normal seawater</td><td>400 to 600</td></tr><tr><td>High TDS Seawater</td><td>600 to 900</td></tr></table></td><td></td><td>The %Salt Rejection display provides the information for operator response to adverse changes in the product TDS.

For Product TDS High alarm, refer to Table 5.</td></tr>
<tr><td><u>Total Product Water</u>

120,000 to 126,000 gallons on high brackish and seawater sources over 100 hour (5 day) mission.

150,000 to 156,000 gallons on low brackish and freshwater sources over 100 hour (5 day) mission.</td><td></td><td>Run TWPS to assure that the minimum 100-hour mission product total is produced.</td></tr>
<tr><td><u>High Pressure Air PI-902</u>

Nominal air pressure of 100 psig.</td><td>Acceptable pressure range of 90-110 psig.</td><td>Adjust PRV-901 if the pressure reading is outside of the acceptable range. Refer to WP 0042.</td></tr>
<tr><td><u>Low Pressure Air PI-903</u>

Nominal air pressure of 15 psig.</td><td>Acceptable pressure range of 14-16 psig.</td><td>Adjust PRV-902 if the pressure reading is outside of the acceptable range. Refer to WP 0042.</td></tr>
</table>

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

INTERCHANGING CHEMICAL PUMPS

The antiscalant and the hypochlorite chemical pumps are used routinely for all TWPS deployments. The bisulfite pump is only used when the raw water is taken from a chlorinated source. If the bisulfite chemical pump is not being used, it is available as a spare in the event that one of the other two pumps fails.

Interchange chemical pumps as follows:

1. Perform a **Standby Shutdown without Draining Down**. Refer to WP 0017.
2. Do not shut off the TQG.
3. Do not shut off the air compressor.

WARNING

Irritant. Wear a protective face shield and chemical gloves when handling antiscalant chemical. Avoid inhaling chemical fumes. Failure to observe this warning may result in irritation of the nose, throat, eyes, and skin.

Hazardous chemical dust and/or fumes. Wear the protective face shield, chemical gloves, and dust mask when handling calcium hypochlorite. Avoid inhaling chemical dust or fumes. Hypochlorite will give off chlorine vapor, which will burn your nose, throat and lungs if breathed directly. Inhalation of calcium hypochlorite dust may cause severe chemical burns. Direct contact with the eyes may cause severe eye damage.

4. Flush the replacement chemical pump to remove any chemical residue that may remain from previous use as follows:
    a. Rinse the priming pitcher with product water from the distribution auxiliary hose then fill the pitcher with product water.
    b. Set the pitcher down in the operator station area in front of the bisulfite pump.
    c. Place the chemical pump suction tube into the pitcher of water. Be sure the suction tube inlet rests near the bottom of the pitcher.
    d. Direct the return tube so that it drains to the ground. Do not place it in the pitcher.
    e. Make sure that the chemical pump SPEED control dial is set to OFF (turned fully counterclockwise; see Figure 10).
    f. Set the Bisulfite Pump switch on the OCP to ON.
    g. Prime the Bisulfite pump as follows:
        1) Turn the speed dial to 80.
        2) Note that the Bisulfite pump has started, then turn the stroke dial to 80.
        3) Rotate the black knob on the priming valve one-half turn. Note that the chemical solution is drawing up the suction tube, entering the pump housing and flowing out the return tube.
    h. Operate the Bisulfite pump in the priming mode for an additional two minutes after the pump is primed.
    i. After two minutes, turn the priming knob to its original position, turn the stroke dial to zero, and turn the speed dial to zero.
    j. Set the Bisulfite Pump switch on the OCP to OFF.

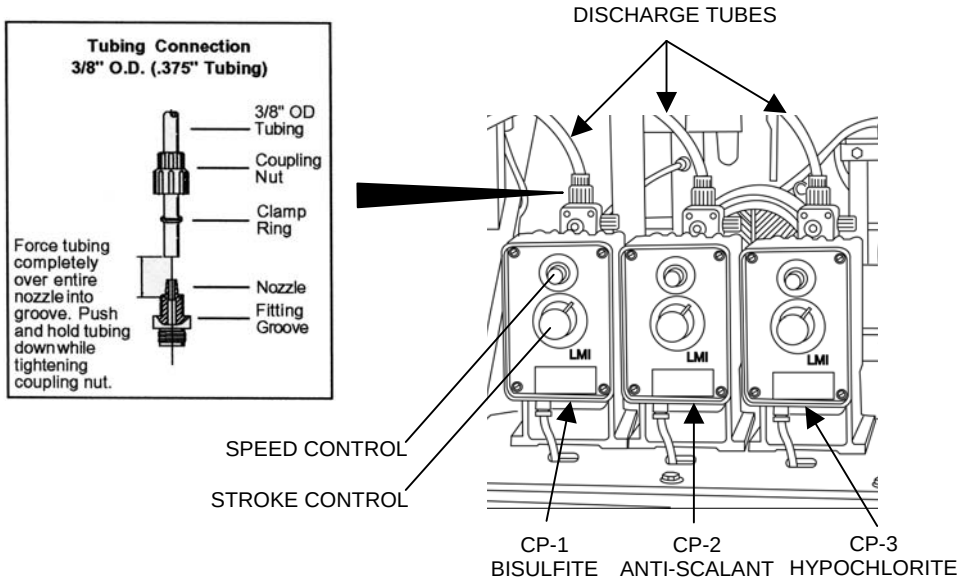

Figure 10. Chemical Pumps.

5. Switch the Bisulfite pump with the chemical pump to be replaced as follows (see Figure 10):
   a. Disconnect the discharge tube from both the Bisulfite pump and the pump to be changed out.
   b. Connect the discharge tube for the pump being changed out to the discharge outlet of the Bisulfite pump.
   c. Set the speed switch on the pump being changed out to the OFF position.

NOTE

The Bisulfite pump does not start and stop with the HP Pumps. Therefore, the operator will need to set the Bisulfite switch to ON immediately after starting the HP pumps and to OFF immediately after setting the Mode Switch to Standby. If the HP pumps stop due to an alarm shutdown, the operator must also set the Bisulfite switch to OFF as soon as possible.

6. Set the Bisulfite switch to ON. Prime the replacement chemical pump following the procedure in WP0014. Refer to **ANTISCALANT AND HYPOCHLORITE CHEMICAL SYSTEMS START-UP** in WP 0014 for the proper settings for the Speed and Stroke after the pump is primed.
7. Tape a note on the Bisulfite pump stating it's current use (antiscalant or hypochlorite). Tape a similar note on the OCP near the Bisulfite pump switch.
8. Start up the TWPS. Refer to WP 0015. Remember to set the Bisulfite switch to ON after starting the HP pumps.

INTERCHANGING RAW WATER AND DISTRIBUTION PUMPS

If a raw water or distribution pump is not required for a given deployment, it is available as a spare in the event that one of the raw water or distribution pumps becomes inoperable.
Interchange raw water and/or distribution pumps as follows:

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1. Perform a **Standby Shutdown without Draining Down**. Refer to WP 0017.
2. Shut down the raw water diesel engine if it is to be changed out. Refer to **Raw Water Diesel Engine Shutdown** in WP 0017.
3. If the pump to be replaced is a motor-driven pump, or if cold weather heating blankets or pump heaters are used, perform the following steps in order before removing the pump:
    a. STOP the air compressor by turning the OCP (operator control panel) Air Compressor switch to OFF.
    b. Switch the OCP Hose/Pump Heaters switch to OFF.

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. Pump skid electrical power cables must be removed in a specific order. FIRST, the Main Breaker on the PDP is switched to OFF. NEXT, the pump skid power cable is disconnected from the PDP power outlet. LAST, the pump skid power cable is disconnected from the pump skid junction box. Failure to observe this warning may result in serious injury or death from electrocution.

    c. Switch the Main Circuit Breaker on the power distribution panel (PDP) to OFF.
    d. Disconnect the pump skid power cable from its PDP outlet.
    e. Disconnect the pump skid power cable from the junction box on the pump skid.
4. If removing a distribution pump, close the valve on Adaptor A-07 (see Figure 11).

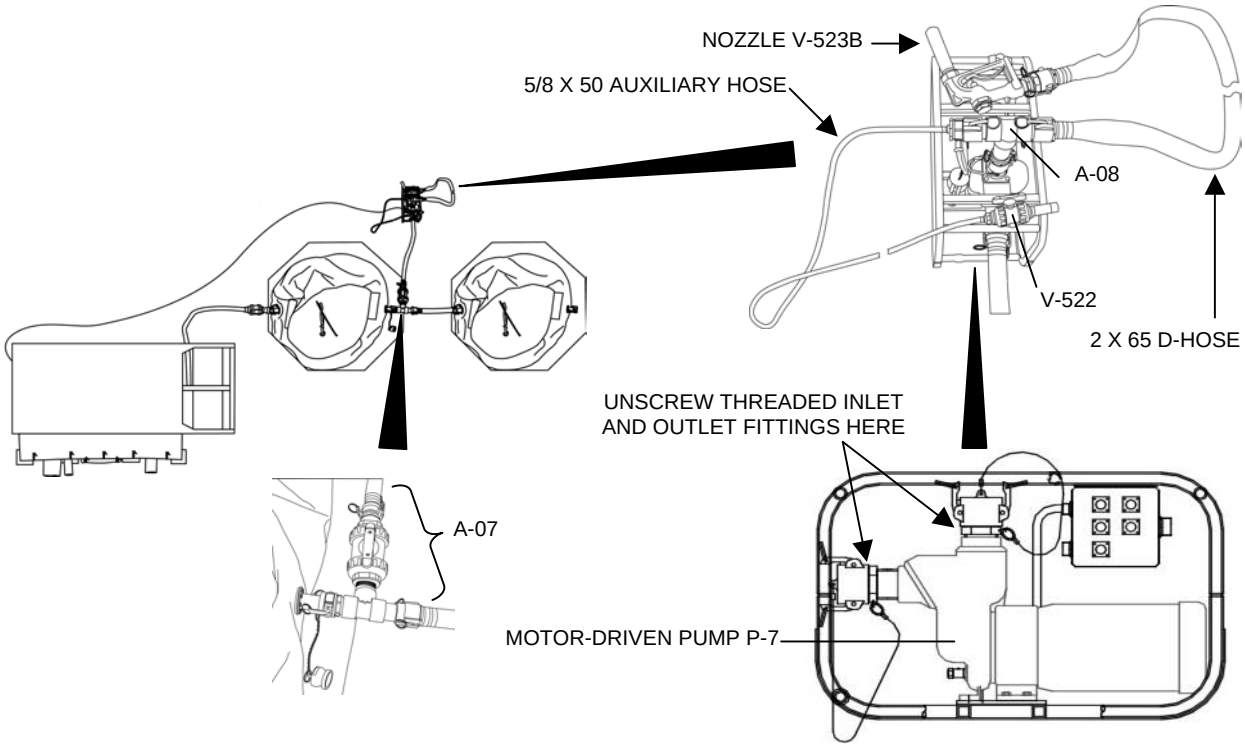

Figure 11. Distribution System.

5. Remove the pump to be replaced from the system.
6. Remove the threaded inlet and outlet fittings from the replacement pump.
7. Remove the threaded inlet and outlet fittings from the inoperable pump and install them on the replacement pump.
8. Connect the system hoses and adaptor to the pump inlet and outlet.

WARNING

Electrical hazard. The TWPS operates on 416 volts AC. Pump skid electrical power cables must be connected in a specific order. FIRST connect the pump skid power cable to its pump skid junction box. NEXT, make sure the Main Breaker on the PDP is switched to OFF. LAST, connect the pump skid power cable to its PDP power outlet. Failure to observe this warning may result in serious injury or death from electrocution.

NOTE

Use the pump power cable appropriate for the function that the replacement pump is serving. For example, if the P-7 distribution pump is being used in place of the P-2 pump for raw water, use the power cable ordinarily used for the P-2 pump and plug the cable into the P-2 terminal at the PDP. This ensures that the pump can be operated using the Raw Water Pump button on the control panel.

If the heating blankets are used, the replacement pump/motor assembly must be removed from its skid and installed on the skid for the pump being replaced. This is necessary because only the junction box on the original pump skid has the proper number of connectors for the heating blankets used at its location. For example, the P-7 pump skid junction box does not have the number of heater connectors that the P-2 pump skid junction box has. The P-8 pump does not have the same number of heater connectors as the P-1 pump.

9. Connect the pump skid power cable to the junction box on the pump skid. Use the power cable for the proper service.
10. Make sure the Main Breaker on the PDP is switched to OFF.
11. Connect the pump skid power cable to its PDP outlet.
12. Sanitize the raw water pump as follows if using it as a replacement for a distribution pump (see Figure 10):
    a. Install Adaptor A-08 on the pump discharge.
    b. Disconnect and cap the distribution hoses from the adaptor.
    c. Install the auxiliary hose and Valve V-522 assembly to one side of Adaptor A-08 and cap the other side of the adaptor.
    d. Open Valve V-522 and the valve on Adaptor A-07.
    e. Switch the Main Circuit Breaker on the PDP to ON.
    f. Start the pump and flush it with product water for 5 minutes.
    g. Stop the pump.
    h. Close the valve on Adaptor A-07.
    i. Remove Adaptor A-08 from the pump discharge.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0016 00**
OPERATOR INSTRUCTIONS
MAINTAINING NORMAL OPERATION UNDER USUAL CONDITIONS

WARNING

Hazardous chemical and/or fumes. Wear the protective face shield and chemical gloves when handling calcium hypochlorite solution. Avoid inhaling chemical fumes. Hypochlorite will give off chlorine vapor, which will burn your nose, throat and lungs if breathed directly. Direct contact with the eyes may cause severe eye damage.

j. Drain the pump.
k. Take solution from the hypochlorite bucket and pour it into the pump discharge until the pump is filled.
l. Reinstall Adaptor A-08 on the pump discharge.
m. Allow the pump to sit for 30 minutes.
n. Open the valve on Adaptor A-07.
o. Start the pump and flush it with product water for about one minute.
p. Stop the pump.
q. Close the valve on Adaptor A-07.
r. Install the distribution hoses and nozzles on Adaptor A-08.

13. Start up the TWPS. Refer to WP 0015.

WARNING

Health hazard. If a distribution pump is used in the raw water system, it must be sanitized according to the sanitizing step above before it can used in the distribution system. Failure to observe this warning could result in illness from contamination of the product water.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS

0017 00

INITIAL SETUP:

Reference:
TM 5-6115-545-12
Personnel Required:
One Operator/Crew
Equipment Condition:
TWPS is fully operational and making product water at the required production rate.
Product water is filling the product distribution tanks.
Cold weather system may or may not be deployed.

GENERAL:

There are several types of shutdowns for the TWPS that are defined by the duration of the shutdown and the purpose of the shutdown. The shutdown types include: standby, short-term, extended, and long-term.

Standby shutdown applies when the shutdown period is not expected to exceed 4 hours.

Short-term shutdown applies when the shutdown period is expected to be greater than 4 hours but no more than 54 hours.

Extended shutdown applies when the shutdown is expected to last longer than 54 hours during deployment. An extended shutdown includes preservation of the RO and MF membranes. Extended shutdown procedures are described in WP 0018, Extended Shutdown During Deployment.

Long-term shutdown applies when the shutdown is performed in preparation for storage. A long-term shutdown requires cleaning and preservation of the RO and MF membranes. Long-term shutdown procedures are described in WP 0031, Preparation for Storage – Army Unit, and in WP 0032, Preparation for Storage – Marine Corps Unit.

This work package describes the procedures for standby and short-term shutdown during both normal and cold weather operation. ("Cold weather" is defined in WP 0009, Cold Weather Set-Up, under the heading **GENERAL**.)

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS

0017 00

Table 1 provides a summary of standby and short-term shutdown requirements.

Table 1. Summary of Standby and Short-Term Shutdown Requirement.

Shutdown Type	Operating Conditions	Shutdown Duration	Shutdown Requirements
Standby shutdown	Normal Operation	Four hours or less	Shutdown without drain down or with drain down as required.
	Cold Weather	30 minutes or less with TQG in operation	Shutdown without drain down. TQG, heat blankets, pump heat collars and diesel fuel fired space heater remain on.
		15 minutes or less with TQG secured	Shutdown without drain down.
Short term shutdown	Normal operation	54 hours or less	Double product water backwash of the MF and product water flush of the RO.
	Cold weather	30 minutes to 54 hours and whenever TQG is secured for more than 15 minutes .	Shutdown with complete drain down including multiple drain of MF and air purge drain of the RO. Flushing is not required.

The standby and short-term shutdown procedures covered in this work package include:

- Standby Shutdown without Draining Down
- Standby Shutdown - Cold Weather Operation
- Standby Shutdown with Drain-Down
- Short Term Shutdown - Normal Operation
- Short Term Shutdown - Cold Weather Operation
- Raw Water Diesel Engine Shutdown

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0017 00**
OPERATOR INSTRUCTIONS
STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS

STANDBY SHUTDOWN WITHOUT DRAINING DOWN

This procedure applies to routine shutdown during a mission for periods not exceeding four (4) hours for normal operations and 30 minutes for cold weather operation. The system is not drained, but remains ready for operation. For cold weather operations proceed to **Standby Shutdown – Cold Weather Operation** in this work package.

The procedures for standby shutdown without draining down are as follows:

1. Fully OPEN Main Pressure Control Valve HCV-401 and then Auxiliary Pressure Control Valve HCV-401A (see Figure 1 for valve location).
2. Turn the SYSTEM MODE SWITCH to STANDBY. The PLC automatically performs the following actions:
    a. HP pumps are stopped.
    b. MF feed pump is stopped.
    c. Automatic valves are cycled to the standby position.
    d. RO feed pump remains ON to flush the RO membranes until the RO feed tank empties. The low level alarm will sound when the tank is empty and the pump will stop.
3. Stop Motor-Driven Raw Water Pump P-2 if in use.
4. Close raw water Flow Control Valve V-107 (see Figure 1 for valve location).
5. If Diesel Engine-Driven Pump P-1 is used, it may remain running for short shutdowns.
    a. Reduce the engine speed to idle
    b. Crack open Vent Valve V-102 on Adaptor A-02 at the pump discharge and leave the pump running for short shutdowns (see Figure 1 for valve location). (If the cyclone separator is in use, the vent valve need not be opened. The cyclone drain provides the needed flow discharge.)

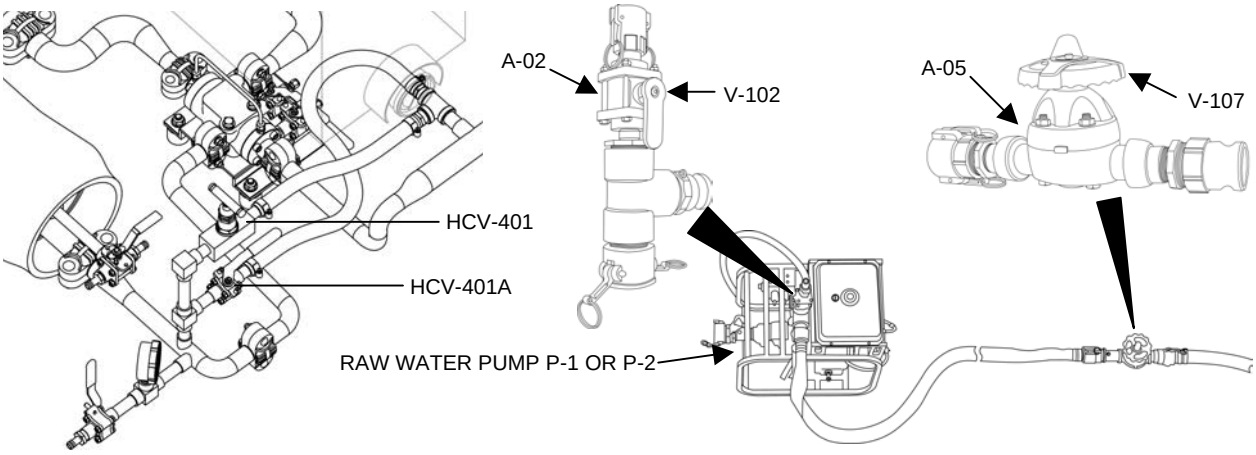

Figure 1. Valves to Operate for Standby Shutdown without Draining Down.

6. If it is necessary to stop Diesel Engine-Driven Raw Water Pump P-1, proceed to **Raw Water Diesel Engine Shutdown** at the end of this work package.
7. If the TQG (diesel tactical quiet generator) is to be shut down, perform the following steps in order:
    a. STOP the air compressor by turning the Air Compressor switch to OFF.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0017 00**
OPERATOR INSTRUCTIONS
STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS

b. Switch the Main Circuit Breaker on the power distribution panel (PDP) to OFF.
c. A-TWPS only. Shut down the TQG as described in TM 5-6115-545-12.

STANDBY SHUTDOWN – COLD WEATHER OPERATION

Use this procedure during cold weather deployment under the following conditions:

- The TWPS is to be shut down for less than 30 minutes, the TQG is to remain running, and the diesel-fired heater remains on.
- Or, the TWPS and the TQG are both to be shut down for no more than 15 minutes.

1. Fully OPEN Main Pressure Control Valve HCV-401 and then Auxiliary Pressure Control Valve HCV-401A (see Figure 1 for valve location).
2. Turn the SYSTEM MODE SWITCH to STANDBY. The PLC automatically performs the following actions:
    a. HP pumps are stopped.
    b. The MF feed pump is stopped.
    c. Automatic valves are cycled to the standby position.
    d. The RO feed pump remains ON to flush the RO membranes until the RO feed tank empties. The low level alarm will sound when the tank is empty and the pump will stop.
3. Stop Motor-Driven Raw Water Pump P-2 if in use.
4. Close Raw Water Flow Control Valve V-107 (see Figure 1 for valve location).
5. If Diesel Engine-Driven Raw Water Pump P-1 is used, reduce the speed to idle, leave Vent Valve V-102 on Adaptor A-02 at the pump discharge closed and leave the pump running for short shutdowns not exceeding 30 minutes (see Figure 1 for valve location).
6. If it is necessary to stop Diesel Engine-Driven Raw Water Pump P-1, proceed to **Raw Water Diesel Engine Shutdown** at the end of this work package then drain the raw water system to prevent freezing.
7. Leave the hose heating blankets and pump heating collars installed and the Hose/Pump Heater Switch set to ON.

STANDBY SHUTDOWN WITH DRAIN-DOWN

Follow this procedure when an operational situation requires a system drain-down. For Cold Weather applications proceed to **Short Term Shutdown – Cold Weather Operation** in this work package.

1. Complete the procedure for **Standby Shutdown without Drain Down**. Leave the TQG in operation.
2. Set The SYSTEM MODE SWITCH to MF Drain.
    a. The PLC automatic control purges the water from the MF using air.
    b. The automatic valves return to Standby positions at completion.
3. After one minute return the SYSTEM MODE SWITCH to STANDBY.
4. Move the drain and vent valves to the position listed in Table 2 (refer to Table 2 for valve position and Figure 3 to locate the valves).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0017 00**
OPERATOR INSTRUCTIONS
STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS

Table 2. Drain and Vent Valve Position for Drain-Down.

✓	VALVE NAME AND NUMBER	POSITION
	MF Vent Valve V-114	Open
	Product RO Element 3-Way Valves, left end, V-502, 503, 506, 507, 510	Drain
	RO Vessel Drain Valve V-408	Open
	Main Pressure Control Valve HCV-401	Full Open
	Auxiliary Pressure Control Valve HCV-401A	Open
	RO Feed Tank Auxiliary Drain Valve V-210	Open
	Turbocharger Reject Drain Valve V-410	Open
	Turbocharger Feed Drain Valve V-303	Open
	Strainer S-2 Vent /Sample Valve V-110	Open
	Strainer S-2 Drain Valve V-109	Open
	MF Cleaning Feed Valve V-704	Open
	Clean Mixing Valve V-703	Open
	RO Clean Feed Valve V-701	Open
	Clean Return Valve V-702	Open
	Product Utility Valve V-511	Open
	Feed Piping Drain Valve V-304	Open
	HP Pump Outlet Drain Valve V-302	Open
	Strainer S-4 Drain Valve V-213	Open
	RO Feed pump P-4 Drain Valve V-211	Open
	HP Pumps Case Drain Valve V-215	Open
	HP Pump P-5 and P-6 Inlet Drain Valve V-214	Open
	HP Pump P-5 and P-6 Outlet Drain Valve V-301	Open
	Product RO Element 3-Way Valves, right end, V-501, 504, 505, 508, 509	Drain
	RO Feed Tank Main Drain Valve V-412	Open
	MF Filtrate Sample/Drain Valve V-204	Open
	MF Filtrate Drain Valve V-203	Open
	MF Shell Drain Valve V-403	Open

NOTE

The Product RO Element 3-Way Valves are in the drain position when the middle pointer on the valve handle is pointing toward the RO Vessel (see Figure 2).

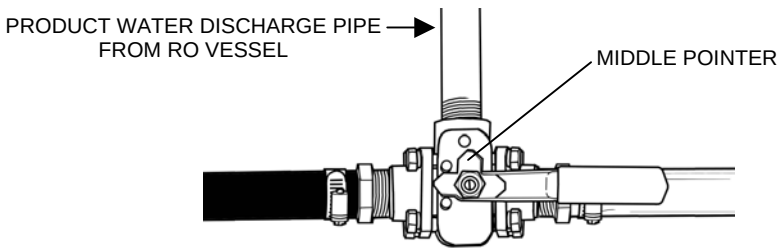

Figure 2. RO Element 3-Way Valve in the Drain Position.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0017 00**
OPERATOR INSTRUCTIONS
STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS

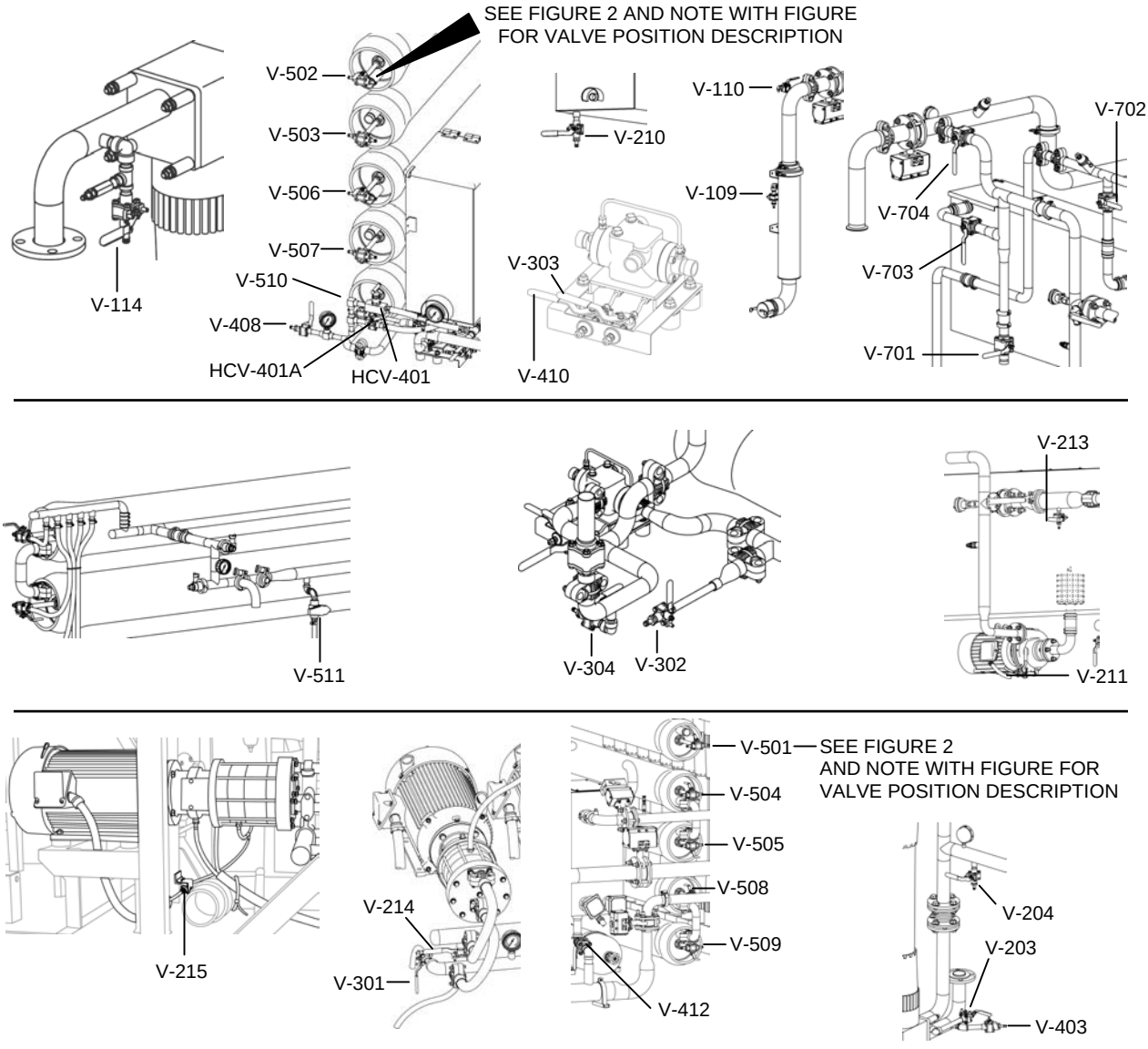

Figure 3. Location of Valves for Drain-Down.

5. Continue with the draining of the Raw Water and Distribution Systems as required.
6. If the TQG (diesel tactical quiet generator) is to be shut down, perform the following steps in order:
    a. STOP the air compressor by turning the Air Compressor switch to OFF.
    b. Switch the Main Circuit Breaker on the power distribution panel (PDP) to OFF.
    c. A-TWPS only. Shut down the TQG as described in TM 5-6115-545-12.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS **0017 00**

SHORT TERM SHUTDOWN - NORMAL OPERATION

This procedure applies to any shutdown anticipated to be over 4 hours but less than 54 hours.

1. Shutdown to Standby as follows:
    a. Fully OPEN Main Pressure Control Valve HCV-401 and then Auxiliary Pressure Control Valve HCV-401A (see Figure 1 for valve location).
    b. Turn the SYSTEM MODE SWITCH to STANDBY. The PLC automatically performs the following actions:
        1) HP pumps are stopped.
        2) MF feed pump is stopped.
        3) Automatic valves are cycled to the standby position.
        4) RO feed pump remains ON to flush the RO membranes until the RO feed tank empties. The low level alarm will sound when the tank is empty and the pump will stop.
    c. Stop Motor-Driven Raw Water Pump P-2 if in use.
    d. Close Raw Water Flow Control Valve V-107 (see Figure 1 for valve location).
    e. Open RO Feed Tank Drain Valve V-412 after the RO feed pump shuts off (see Figure 4 for valve location). Close the valve when the tank is drained.
    f. Stop Diesel Engine-Driven Raw Water Pump P-1 if in use as described in **Raw Water Diesel Engine Shutdown** at then end of this work package.

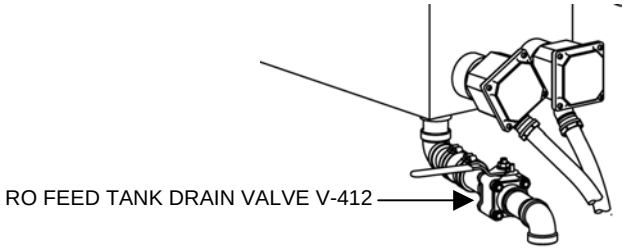

Figure 4. RO Feed Tank Drain Valve V-412.

2. Backwash the MF with product water as follows:
    a. Drain the MF Feed Tank. Disconnect the MF feed pump suction hose from the tank and lift the MF feed tank to drain as much remaining water as possible.
    b. Reconnect the MF feed pump suction hose to the tank.

WARNING

Chemical dust. Wear the protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

Failure to add sodium bisulfite to the chlorinated product water that is used for flushing will result in MF membrane failure.

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NOTE

Open one of the 12oz sodium bisulfite packets and pour it into the bottle provided in the BII. The bisulfite powder will be used to neutralize the chlorine in the product water when product water is required for flushing or cleaning.

c. Fill the MF feed tank with product water from the product water distribution system by connecting the end of a blue-banded product distribution hose to raw water Adapter A-05 and opening V-107.
d. Using the bottle of bisulfite, fill the bottle cap with bisulfite twice and empty it into the MF feed tank while it is filling with product water.
e. When ready, set the SYSTEM MODE SWITCH to MF Fill/Hold.
f. When the Standby Light comes on again, set the SYSTEM MODE SWITCH to Run.
g. When the air compressor stops (or if already stopped), start the MF feed pump.
h. Wait a few seconds and then push MF Backwash Start to manually initiate a backwash using product water from the MF feed tank.
i. When the back wash is complete, STOP the MF feed pump.
j. Set the SYSTEM MODE SWITCH back to Standby.

NOTE

Make sure the RO Feed Tank level is at or below 50% before continuing. If it is not, open RO feed tank main drain valve V-412 and drain water from the tank until the level drops to 50%. If you proceed to the second backwash with a high RO feed tank level, the RO tank will overflow during the second backwash.

3. Backwash the MF with product water a second time and fill the RO feed tank as follows:
    a. When the air compressor stops again, set the SYSTEM MODE SWITCH to MF Fill/Hold.
    b. When the Standby Light comes on again, set the SYSTEM MODE SWITCH to Run
    c. Start the MF Feed Pump, wait a few seconds and push MF Backwash Start to manually initiate a second backwash.
    d. When the second backwash is complete, leave the MF feed pump on. It will stop automatically when the RO feed tank is filled.
4. Flush the RO with potable water as follows:
    a. Reset any alarms and then start the RO feed pump
    b. Turn the SYSTEM MODE SWITCH to STANDBY. The PLC automatically performs the following actions:
        1) The automatic valves are cycled to the standby position.
        2) The RO feed pump remains ON to flush the membranes until the RO feed tank empties. The low level alarm will sound when the tank is empty and the pump will stop.
5. Complete the drain-down after the RO feed pump turns off as follows:
    a. Set SYSTEM MODE SWITCH to MF DRAIN.
        1) The PLC automatic control purges the water from the MF using air.
        2) The automatic valves return to Standby position at completion.
    b. After one minute return the SYSTEM MODE SWITCH to STANDBY.
    c. Move the drain and vent valves the position listed in Table 2 (refer to Table 2 for valve position and Figure 3 to locate the valves).
    d. Continue with the draining of the Raw Water and Distribution Systems as required.

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6. If the TQG (tactical quiet generator) is to be shut down, perform the following steps in order:
    a. STOP the air compressor by turning the Air Compressor switch to OFF.
    b. Switch the Main Circuit Breaker on the power distribution panel (PDP) to OFF.
    c. A-TWPS only. Shut down the TQG as described in TM 5-6115-545-12.

SHORT TERM SHUTDOWN - COLD WEATHER OPERATION

The following procedure should be followed if the TWPS is to be shut down for more than 30 minutes but less than 54 hours, or if the TQG is to be shut down.

1. Follow the standby shut down procedures in “Standby Shutdown - Cold Weather Operation.
2. Complete MF Drain as follows:
    a. From Standby, set the SYSTEM MODE SWITCH to MF DRAIN. (The drain cycle lasts 90 seconds.)
    b. When complete, set the SYSTEM MODE SWITCH to STANDBY
    c. Wait 10 seconds, then set the SYSTEM MODE SWITCH back to MF DRAIN to initiate the second drain. Repeat for a total of 4 drains.
    d. When complete, set the SYSTEM MODE SWITCH to STANDBY again.
    e. Open the following valves (see Figure 5 for valve location):
        1) MF Vent Valve V-114. Use the priming pitcher to catch the small amount of water that will flow from this valve.
        2) MF Cleaning Valve V-704
        3) Clean Mixing valve V-703
        4) MF Filtrate Drain Valve V-203
        5) MF Shell Drain Valve V-403

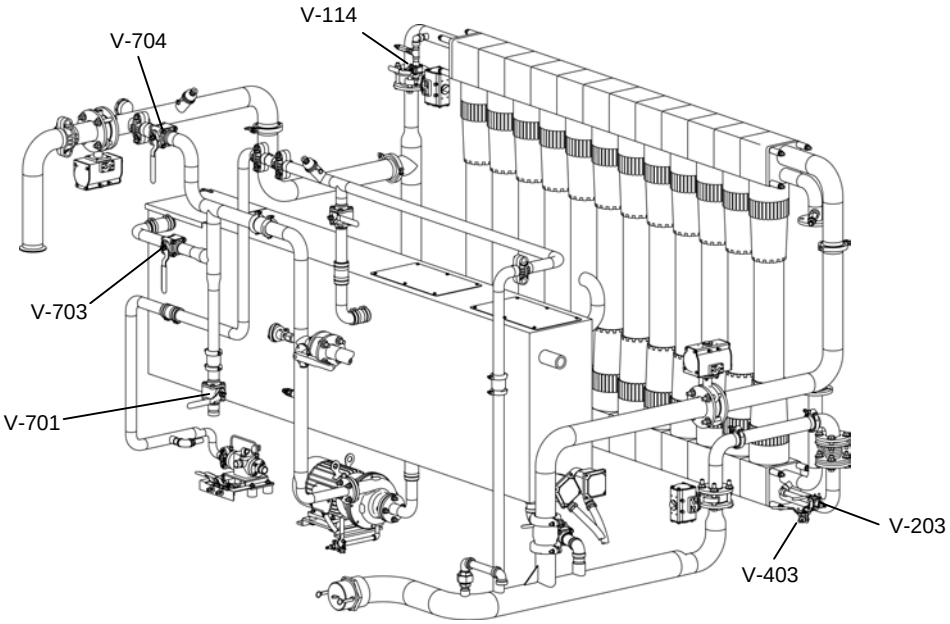

Figure 5. Valves to Operate MF Drain – Cold Weather Operations.

f. Drain into buckets if required to prevent freezing at the hose ends or the hose ends from becoming frozen to the ground. (Use the heat gun to thaw any hose end that becomes blocked with ice. Note that the heat gun must be plugged into the generator 110-volt outlet and not the TWPS PDP 110-volt outlet.)

3. Leave the diesel-fired space heater on if not moving, or as long as possible if moving.
4. Leave the TQG running until all draining has been completed.
5. Open RO Feed Tank Drains V-412 and V-210 (see Figure 3 and Figure 4 for valve locations).

CAUTION

Do not disconnect the hose heater blanket and pump heater collar electrical power cables at this time.

6. Drain the MF Tank and strainer as follows:
   a. Open the Strainer S-2 Drain Valve V-109 and the Vent Valve V-110 (see Figure 6 for valve location).
   b. Disconnect the 3 in. x 3 ft hose from the P-3 MF feed pump suction.
   c. Remove the 2 in. x 10 ft., green-banded raw water suction hose from the MF feed tank and disconnect it from Adaptor A-05.
   d. Disconnect the 2 in. x 50 ft., green-banded raw water discharge hose from Adapter A-05.

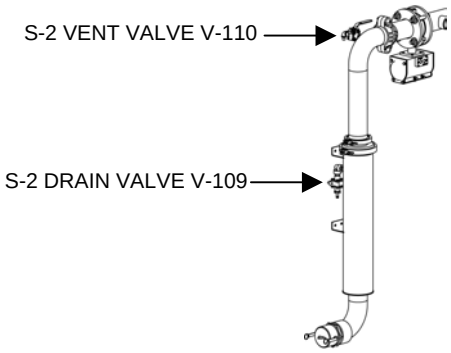

Figure 6. Strainer S-2 Drain Valve V-109 and Vent Valve V-110.

   e. Disconnect the green-banded, 3 in. x 3 ft. suction hose from the MF feed tank outlet. Lift the MF feed tank on the side opposite the tank discharge connection to drain as much water out of the tank as possible.
   f. Remove the hoses from the MF feed pump and drain.
   g. Open the MF feed pump drain.
7. Drain the raw water system as soon as possible after draining the MF feed tank as follows:
   a. Remove the discharge hose at the first raw water pump, then at the suction of the second pump. Drain the hose.
   b. Leave the hose heater blanket and pump heater collar electrical power cables connected.
   c. Remove the discharge hose from the second pump and drain.
   d. Do not disconnect the hose heater blanket and pump heater collar electrical power cables.

e. If not yet shut down, stop the P-1 diesel driven pump as described in **Raw Water Diesel Engine Shutdown** at the end of this work package. Open the pump drain valve.
f. If in use, open the Raw Water Pump P-2 drain valve.
g. Remove the suction hose at the suction inlet of the first raw water pump.
h. Pull the hose out of the water source and drain it. Disconnect the ice hole strainer.
i. Remove Adaptor A-01.
j. Do not disconnect the hose heater blanket and pump heater collar electrical power cables.

8. Drain the RO System as follows:
   a. Open RO Vessel Drain Valve V-408. Direct the hose off the skid and into a bucket to avoid freezing of the hose end.
   b. Force-air drain the RO elements and feed/reject piping as follows (see Figure 7):
      1) Connect one end of the auxiliary air hose (from BII) to the quick-disconnect fitting above the compressor and opposite Pressure Gauge PI-902.
      2) Connect the other end of the auxiliary air hose to the quick-disconnect fitting at the RO Air Purge Valve V-913 in the feed inlet to RO vessel #1.
      3) Partially open Air Purge Valve V-913.

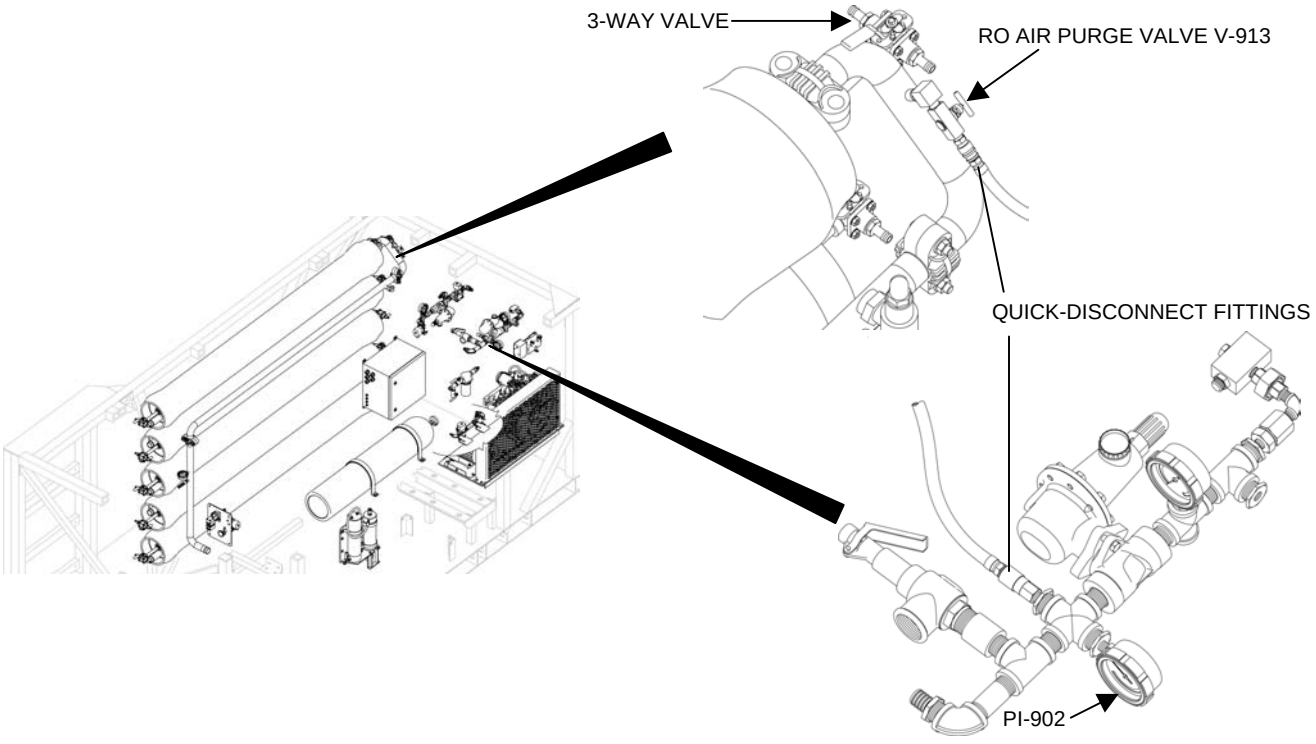

Figure 7. Auxiliary Air Hose Quick Disconnect Connections.

   c. Set the Product RO Element 3-way Valves V-501 through V-510 to the drain position while force air draining the RO elements. (Position each 3-way valve handle so that the middle pointer points toward the RO Vessel. See Figure 8.)

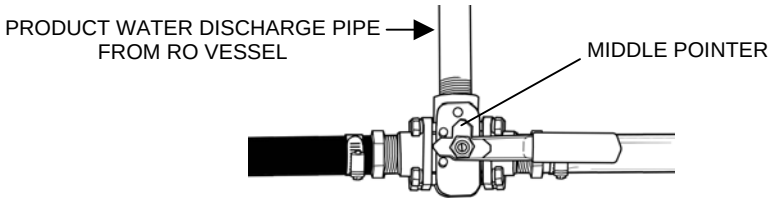

Figure 8. RO Element Three Way Valve in the Drain Position.

d. While purging, open RO drain valves V-302, 303, 304 and 410 until air is noted. Then close until the purge is completed.
e. Close RO Air Purge Valve V-913 when only a trickle of water is draining out the RO Vessel Drain Valve V-408.
f. Disconnect the auxiliary air hose at the V-913 end and connect the air gun (from the Tool Box) to the air hose.
g. Blow the water out of the HP pumps as follows (see Figure 9):
    1) Open valve V-215 under the HP Pumps.
    2) Disconnect the HP Pump cooling water return tubes from the RO Feed Tank.
    3) Connect one end of the auxiliary air hose to the quick-disconnect fitting above the compressor opposite Pressure Gauge PI-902.
    4) Connect the auxiliary air gun to the other end of the auxiliary air hose.
    5) Using the air gun, blow air into each of the cooling water return tubes to push water out of the pumps and out the tube at valve V-215.
    6) Reconnect the HP Pump cooling water return tubes after the pumps are drained.

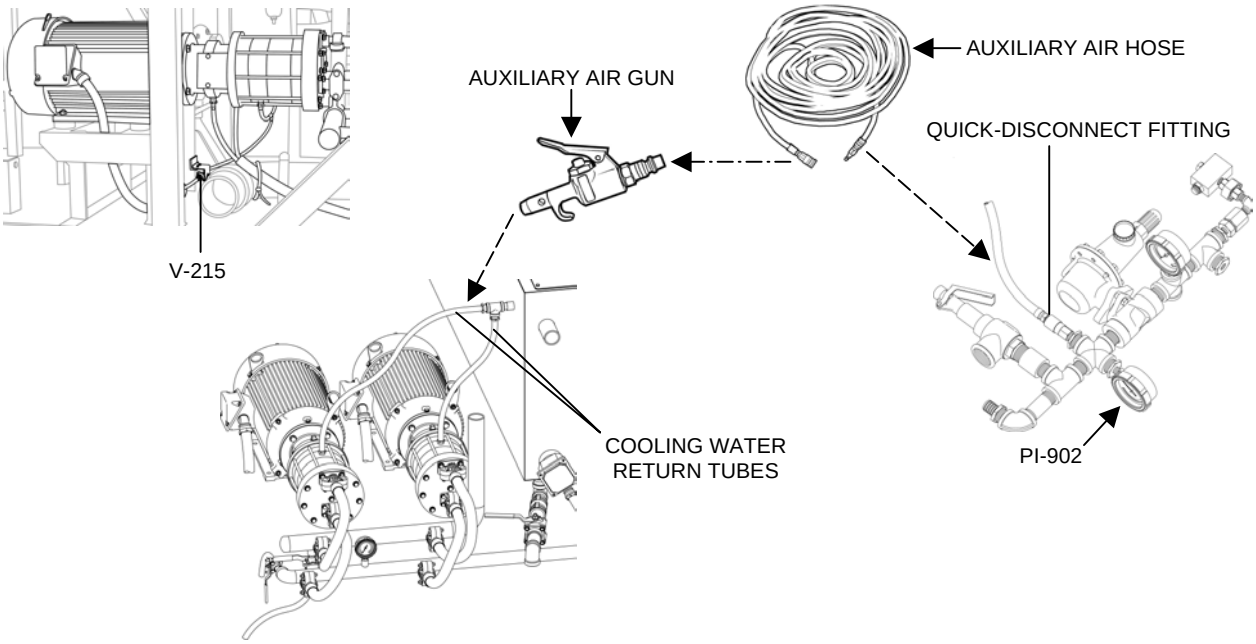

Figure 9. High Pressure Pump Drain Valve and Cooling Water Return Tubes.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS STANDBY OR SHORT-TERM SHUTDOWN – OPERATION UNDER USUAL CONDITIONS **0017 00**

NOTE

Before opening a drain valve, if the temperature is cold enough to freeze water, set the end of the drain hose into a bucket so that water isn't drained onto the ground around the TWPS where it can freeze into ice and create a hazard.

Use the heat gun to thaw any drain tube end that becomes blocked with ice. Note that the heat gun must be plugged into the generator 110-volt outlet and not the TWPS PDP 110-volt outlet.

h. Set all valves to the Drain-Down position as listed in Table 2 and shown in Figure 2 and Figure 3. Be sure to open valves V-302, 303, 304 and 410 that were closed in step d.
i. When water stops draining from a drain tube, disconnect the tube from its valve and hold the end up to drain the residual water from the tube. Then reconnect the tube to its valve. (It is not necessary to perform this step for a drain tube that is secured to its valve with a hose clamp.)

9. Drain the chemical system as follows:
   a. Disconnect the chemical pump discharge tubes at both ends and drain. Use the air hose if needed to blow them dry.
   b. Disconnect the chemical pump suction tubes from the pump and from the foot valves. Be sure that they drain. Use the air hose if needed to blow them dry.
   c. With the tubes removed, turn the black knob on the 4-function valves to the prime position.
   d. Set the Bisulfite and Antiscalant/Chlorine switches to ON to pump the solutions from the pump heads back into the chemical buckets.
   e. Turn the pumps OFF when no more water is coming out of the pumps.
   f. Disconnect the air hose at the PI-902 end and store.
10. Drain the product water distribution system (and the extended distribution system as applicable) as follows:
   a. Remove the distribution nozzles from the distribution hoses.
   b. Pump the distribution tanks out through the distribution hoses.
   c. Lift each distribution tank on the side opposite the tank discharge connection to allow the distribution pump to pump as much water out of the tanks as possible.
   d. Stop the distribution pump.
   e. Disconnect and drain the distribution hoses from the distribution pump and from the distribution tanks.
   f. Do not disconnect the hose heater blanket and pump heater collar electrical power cables.
   g. Open the distribution pump drain.
   h. Finish emptying the distribution tanks.

WARNING

Electrical hazard. To prevent an electrical hazard, do not disconnect the hose heater blanket and pump heater collar electrical power cables until the Hose/Pump Heater switch has been turned OFF and the Main Breaker has been switched to the OFF position. Failure to observe this warning may result in injury or death from electrocution.

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11. Drain the hoses as follows:
    a. Open up all of the hose heating blankets. **Do not disconnect the electrical connectors**.
    b. Without delay, walk the raw water and distribution hoses to complete the draining (lift the hose at one end and walk along the length of the hose, raising the hose as you go along to cause all the water to drain out of the hose). Roll the hose up if the unit is to be packed. Continue until all hoses have been drained and, if required, rolled up.
    c. If not packing up, and if the hoses have not been rolled up, close the blankets over the hoses.
    d. Remove all adapters and place inside the TWPS.
12. Secure electrical power as follows:
    a. Wait until the TWPS skid drains have stopped flowing.
    b. Switch the diesel fueled heater switch to OFF.
    c. Turn the Hose/Pump Heat Switch OFF.
    d. Stop the air compressor by turning the Air Compressor switch to OFF.
    e. Switch the Main Breaker to the OFF position.
    f. A-TWPS only. Shut down the TQG (tactical quiet generator) as described in TM 5-6115-545-12.

RAW WATER DIESEL ENGINE SHUTDOWN

Shut down the Raw Water pump as follows:
1. Before stopping the engine, move the engine speed lever to the idle mark and run the engine for about 3 minutes.
2. Move the engine speed lever to the STOP position. The engine should turn off. (If it does not, the engine will stop when the next step is performed).
3. (Except for a standby shutdown) turn the fuel cock lever counter clockwise to the closed position.
4. (Except for a standby shutdown) slowly pull out the recoil handle until pressure is felt and leave the handle in this position. This step sets the engine so that the intake and exhaust valves are closed and helps prevent rust from forming while the engine is not in use.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS EXTENDED SHUT-DOWN DURING DEPLOYMENT – OPERATION UNDER USUAL CONDITIONS

0018 00

INITIAL SETUP

Materials/Parts:
AC-120 Bisulfite Bucket, 10 lb.
Measuring Bottle for Bisulfite (Box #4)
Chemical scoop (Box #4)
AC-350 Caustic, (2) 1 Gallon Containers (Box #5)
Three 2-in. x 10 ft. Cleaning Waste Hoses
Adaptor A-10 (Box #1)
Adaptor A-12 (Box #1)
Cleaning Waste Storage Module if used

- One 1500 gallon cleaning waste storage tank
- Two Adaptors A-16 (A-TWPS, Box #1)

One 2 in. x 50 ft., green-banded raw water discharge hose if cleaning waste storage module not used
Personal protective gear (Box #1)

- Two chemical aprons
- One face shield
- Two chemical gloves
- One dust mask

Personnel Required:
Two Operator/Crew

GENERAL

During deployment, if the TWPS needs to be shut down for longer than 54 hours, an extended shut-down is performed. An extended shut down includes the following steps:

- The TWPS is shut down.
- The RO elements and the MF modules are flushed with product water.
- The RO elements are preserved by flushing them once with a sodium bisulfite solution.
- The MF modules are preserved by flushing them once with a caustic solution.

Preservation is necessary to ensure that biological growth does not become established on the RO membrane and MF fiber surfaces during the shutdown period. If they are not preserved and a biological film grows on the membranes and fibers, the TWPS will not meet performance requirements when placed back in operation. If the biological growth is severe enough, the RO elements and MF modules will require extensive cleaning/soaking and may need to be replaced.

NOTE

If the daily high temperatures are lower than 40 degrees F and the TWPS is shaded from direct sun exposure, biological growth is unlikely to occur. Under these conditions, it would not be necessary to preserve the RO membranes and MF fibers during an extended shut-down.

If the TWPS is to be shut down during deployment for longer than 54 hours, and it is not certain how long the TWPS will be shut down before it is started up again, a long-term shutdown should be performed. Long-term shut down procedures are described in WP 0031, Preparation for Storage – Army Unit or WP 0032, Preparation for Storage - Marine Corps Unit.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0018 00**
OPERATOR INSTRUCTIONS
EXTENDED SHUT-DOWN DURING DEPLOYMENT – OPERATION UNDER USUAL CONDITIONS

EXTENDED SHUTDOWN PROCEDURE

Perform an extended shutdown as follows:

1. Shutdown the TWPS following the **Short Term Shutdown** procedure described in WP 0017.
2. After the draining is completed, using Table 1 and Figure 2, return all valves to the indicated start-up position.

NOTE

The Product RO Element 3-Way Valves are in the normal position when the middle pointer on the valve handle is pointing to the black product hose (see Figure 1). The handle itself may be pointing toward or away from the product pipe depending on the RO vessel.

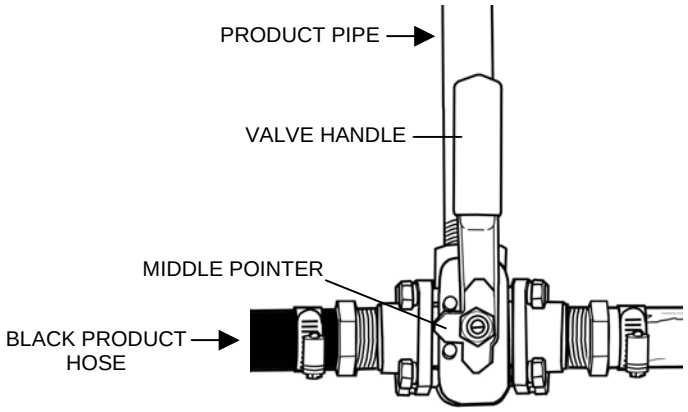

Figure 1. RO Element 3-Way Valve in the Normal Position.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0018 00**
OPERATOR INSTRUCTIONS
EXTENDED SHUT-DOWN DURING DEPLOYMENT – OPERATION UNDER USUAL CONDITIONS

Table 1. Valve Start-Up Position – Initial Startup or Fully Drained.

✓	VALVE NAME AND NUMBER	POSITION
	P-1 Diesel Pump Drain Valve V-103	Closed
	P-2 Electric Pump Drain Valve V-105	Closed
	P-3 Electric MF Feed Pump Drain Valve V-108	Closed
	MF Vent Valve V-114	Closed
	Product RO Element 3-Way Valves, left end, V-502, 503, 506, 507, 510	Normal
	RO Vessel Drain Valve V-408	Closed
	Main Pressure Control Valve HCV-401	Full Open
	Auxiliary Pressure Control Valve HCV-401A	Open
	RO Feed Tank Auxiliary Drain Valve V-210	Closed
	Turbocharger Reject Drain Valve V-410	Closed
	Turbocharger Feed Drain Valve V-303	Closed
	Feed Control Selector Valve V-914	Auto
	Strainer S-2 Vent /Sample Valve V-110	Closed
	Strainer S-2 Drain Valve V-109	Closed
	MF Cleaning Feed Valve V-704	Closed
	Clean Mixing Valve V-703	Closed
	RO Clean Feed Valve V-701	Closed
	Clean Return Valve V-702	Closed
	Product Utility Valve V-511	Closed
	Feed Piping Drain Valve V-304	Closed
	HP Pump Outlet Drain Valve V-302	Closed
	HP Pump Inlet Valve V-212	Open
	Strainer S-4 Drain Valve V-213	Closed
	RO Feed pump P-4 Drain Valve V-211	Closed
	Low Pressure Air Vent Valve V-915	Closed
	LP Air Shutoff Valve V-909	Open
	Low Press Air Vent Valve V-910	Closed
	High Press Air Vent Valve V-904	Closed
	Coalescer CO1 Drain Shutoff Valve V-902	Open
	HP Pumps Case Drain Valve V-215	Closed
	HP Pump P-5 and P-6 Inlet Drain Valve V-214	Closed
	HP Pump P-5 and P-6 Outlet Drain Valve V-301	Closed
	Air Compressor Intermediate Filter Drain Valve V-901	Open
	Product RO Element 3-Way Valves, right end, V-501, 504, 505, 508, 509	Normal
	Air Receiver Tank Valve V-907	Open
	RO Feed Tank Main Drain Valve V-412	Closed
	RO Air Purge Valve V-913	Closed
	MF Filtrate Sample/Drain Valve V-204	Closed
	MF Filtrate Drain Valve V-203	Closed
	MF Shell Drain Valve V-403	Closed
	P-7 Electric Pump Drain Valve V-520	Closed
	Auxiliary Hose Valve V-522 (If attached)	Closed
	Distribution Nozzles V-523 A&B	Closed
	P-8 Diesel Pump Drain Valve V-524	Closed
	Distribution Nozzles V-523 C&D	Closed

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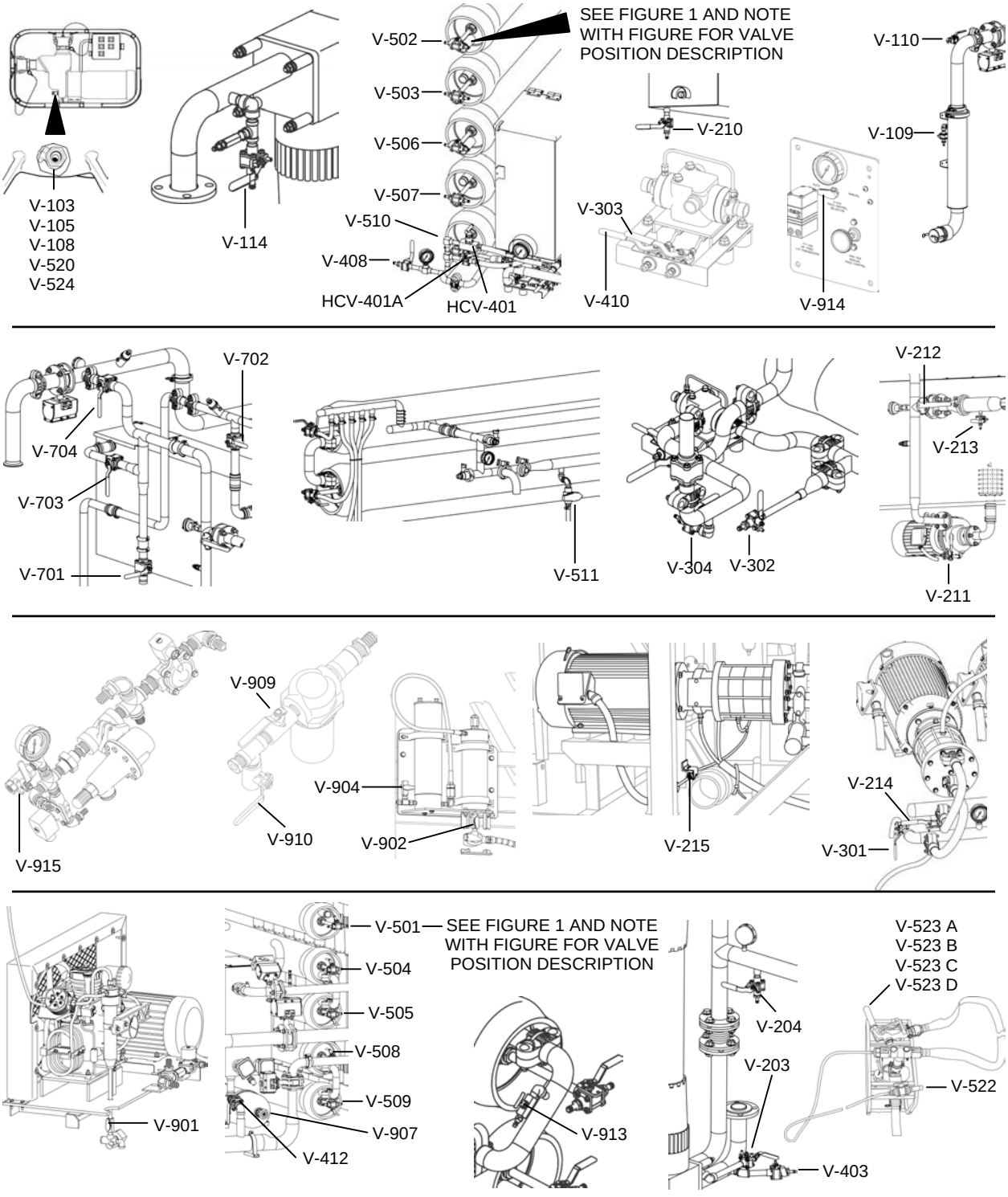

Figure 2. Location of Valves for Start-Up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0018 00**
OPERATOR INSTRUCTIONS
EXTENDED SHUT-DOWN DURING DEPLOYMENT – OPERATION UNDER USUAL CONDITIONS

3. Clean the MF Feed Strainer S-2 (refer to WP 0040).
4. Perform the **RO Preservation Flush for Extended Shutdown** procedures described in WP 0025, RO Preservation.
5. Using Table 1 and Figure 2, return all valves to the indicated start-up position.
6. Perform the **MF Preservation Flush for Extended Shutdown** procedures described in WP 0026, MF Preservation.

NOTE

Before opening a drain valve, if the temperature is cold enough to freeze water, set the end of the drain hose into a bucket so that water isn't drained onto the ground around the TWPS where it can freeze into ice and create a hazard.

Use the heat gun to thaw any drain tube end that becomes blocked with ice. Note that the heat gun must be plugged into the generator 110-volt outlet and not the TWPS PDP 110-volt outlet.

7. Using Table 2 and Figure 4, move the valves to the indicated ending position for Extended Shut-Down. The valves are listed starting from the Operator Control Station moving counter-clockwise around the TWPS skid. (The illustrations in Figure 4 are included to help you locate the valves. The valves are not necessarily shown in their ending position for Extended Shut-Down).
8. When water stops draining from a drain tube, disconnect the tube from its valve and hold the end up to drain the residual water from the tube. Then reconnect the tube to its valve. (It is not necessary to perform this step for a drain tube that is secured to its valve with a hose clamp.)

NOTE

The Product RO Element 3-Way Valves are in the drain position when the middle pointer on the valve handle is pointing toward the RO Vessel (see Figure 3).

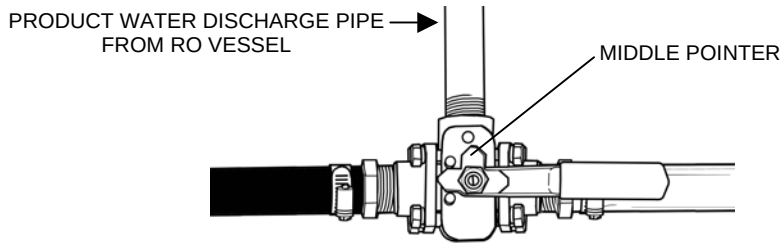

Figure 3. RO Element 3-Way Valve in the Drain Position.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0018 00**
OPERATOR INSTRUCTIONS
EXTENDED SHUT-DOWN DURING DEPLOYMENT – OPERATION UNDER USUAL CONDITIONS

Table 2. Valve Ending Position – Extended Shut-Down.

✓	VALVE NAME AND NUMBER	POSITION
	P-1 Diesel Pump Drain Valve V-103	Open
	P-2 Electric Pump Drain Valve V-105	Open
	P-3 Electric MF Feed Pump Drain Valve V-108	Open
	MF Vent Valve V-114	Open
	Product RO Element 3-Way Valves, left end, V-502, 503, 506, 507, 510	Drain
	RO Vessel Drain Valve V-408	Open
	Main Pressure Control Valve HCV-401	Full Open
	Auxiliary Pressure Control Valve HCV-401A	Open
	RO Feed Tank Auxiliary Drain Valve V-210	Open
	Turbocharger Reject Drain Valve V-410	Open
	Turbocharger Feed Drain Valve V-303	Open
	Feed Control Selector Valve V-914	Auto
	Strainer S-2 Vent /Sample Valve V-110	Open
	Strainer S-2 Drain Valve V-109	Open
	MF Cleaning Feed Valve V-704	Open
	Clean Mixing Valve V-703	Open
	RO Clean Feed Valve V-701	Open
	Clean Return Valve V-702	Open
	Product Utility Valve V-511	Open
	Feed Piping Drain Valve V-304	Open
	HP Pump Outlet Drain Valve V-302	Open
	HP Pump Inlet Valve V-212	Open
	Strainer S-4 Drain Valve V-213	Open
	RO Feed pump P-4 Drain Valve V-211	Open
	Low Pressure Air Vent Valve V-915	Closed
	LP Air Shutoff Valve V-909	Open
	Low Press Air Vent Valve V-910	Open
	High Press Air Vent Valve V-904	Open
	Coalescer CO1 Drain Shutoff Valve V-902	Open
	HP Pumps Case Drain Valve V-215	Open
	HP Pump P-5 and P-6 Inlet Drain Valve V-214	Open
	HP Pump P-5 and P-6 Outlet Drain Valve V-301	Open
	Air Compressor Intermediate Filter Drain Valve V-901	Open
	Product RO Element 3-Way Valves, right end, V-501, 504, 505, 508, 509	Drain
	Air Receiver Tank Valve V-907	Open
	RO Feed Tank Main Drain Valve V-412	Open
	RO Air Purge Valve V-913	Closed
	MF Filtrate Sample/Drain Valve V-204	Open
	MF Filtrate Drain Valve V-203	Open
	MF Shell Drain Valve V-403	Open
	P-7 Electric Pump Drain Valve V-520	Open
	P-8 Diesel Pump Drain Valve V-524	Open

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0018 00**
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EXTENDED SHUT-DOWN DURING DEPLOYMENT – OPERATION UNDER USUAL CONDITIONS

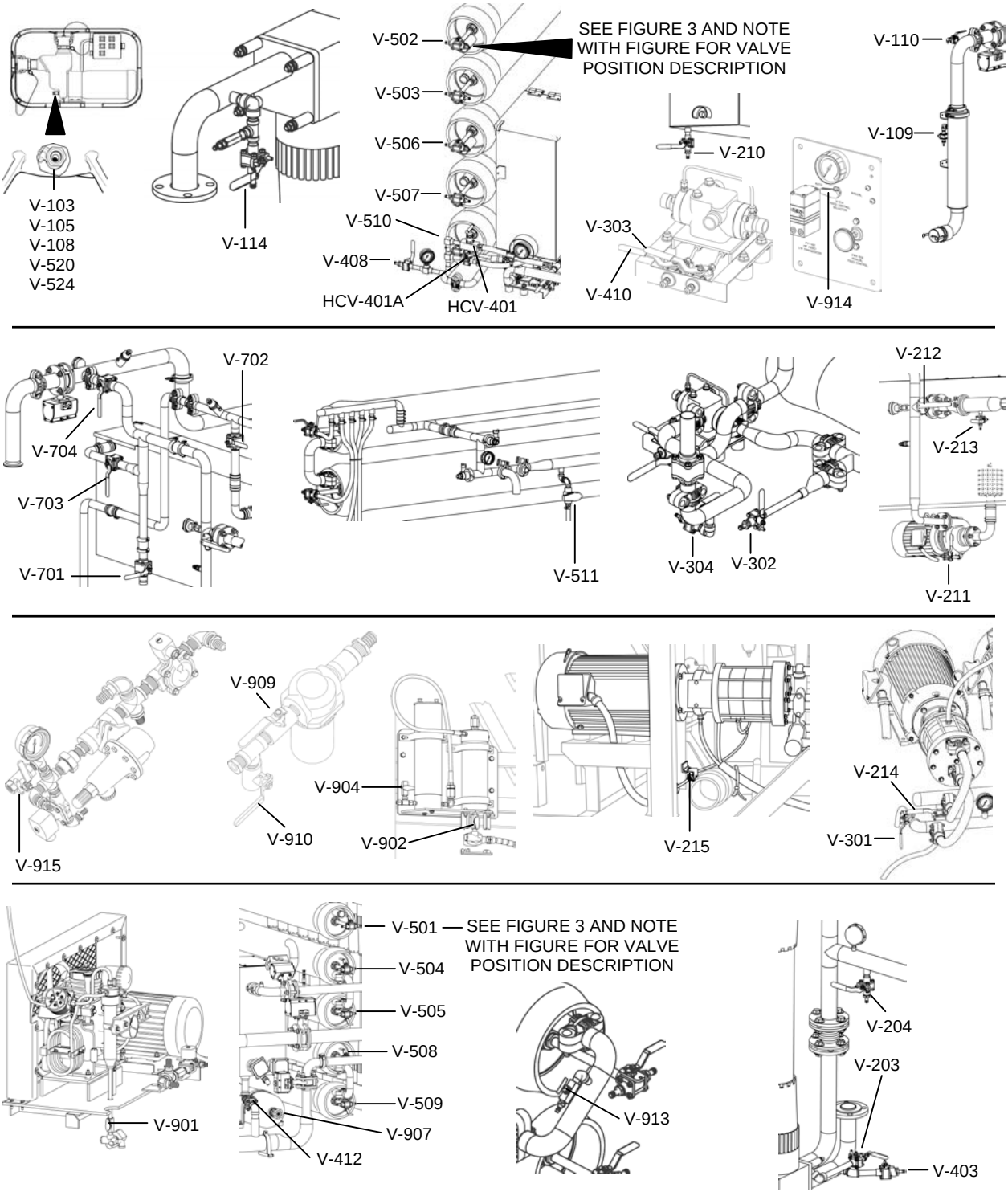

Figure 4. Location of Valves for Extended Shut-Down.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS EXTENDED SHUT-DOWN DURING DEPLOYMENT – OPERATION UNDER USUAL CONDITIONS **0018 00**

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS EMERGENCY SHUT-DOWN

0019 00

INITIAL SETUP

Personnel:
One Operator/Crew
Equipment Condition
The emergency stop can be used at any phase of TWPS operation.

GENERAL

During mission operation of the TWPS, emergency conditions can arise which will call for immediate shut-down of the TWPS.

The following procedure describes how to perform a TWPS emergency shut-down (see Figure 1).

1. Push in the EMERGENCY STOP button.
    a. All electrical devices are electrically disconnected when the button is pushed in.
    b. The OCP is de-energized when the button is pushed in.
2. If Diesel-Driven Raw Water Pump P-1 is used, it may remain running for short shut-downs.
    a. Reduce the engine speed to idle.
    b. Crack open Vent Valve V-102 on Adaptor A-02 at the pump discharge and leave the pump running for short shutdowns. (If the cyclone separator is in use, the vent valve need not be opened. The cyclone drain provides the needed flow discharge.)
3. If Diesel-Driven Raw Water Pump P-1 is used and shut down will not be for a short time, shut down the P-1 pump as follows:
    a. Move the engine speed lever to the idle mark and run the engine for about 3 minutes.
    b. Move the engine speed lever to the STOP position. The engine should turn off. (If it does not, the engine will stop when the next step is performed).
    c. Set the fuel cock lever to the closed position (horizontal).
    d. Slowly pull out the recoil handle until pressure is felt and leave the handle in this position. This step sets the engine so that the intake and exhaust valves are closed and helps prevent rust from forming while the engine is not in use.
4. Close Raw Water Flow Control Valve V-107 at the inlet to the MF feed tank.
5. Open Main Pressure Control Valve HCV-401 and the Auxiliary Pressure Control Valve HCV-0401A.
6. After the emergency condition has been corrected, the TWPS may be restarted following the procedures in Work Package 0015, Start-Up After A Short Term Or Standby Shutdown Without Draining.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0019 00**
OPERATOR INSTRUCTIONS
EMERGENCY SHUT-DOWN

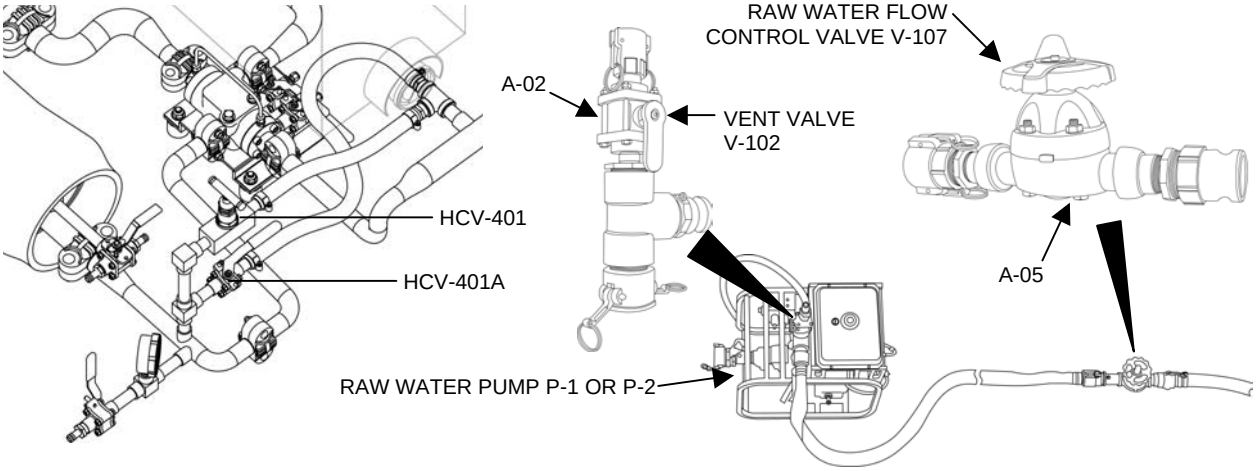

Figure 1. Emergency Shut-Down Controls.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0020 00**
OPERATOR INSTRUCTIONS
CLEANING, PRESERVATION, AND CLEANING WASTE
NEUTRALIZATION AND PUMP-OUT

GENERAL

The MF modules and the RO elements are cleaned and/or preserved at specific times for specific reasons. The cleaning and preservation procedures vary depending on the purpose of the procedure. The types of cleaning and preservation that are performed on the MF and RO are as follows:

- MF Cleaning
- RO Acid Cleaning
- RO Detergent Cleaning
- MF Cleaning with RO Acid Cleaning
- RO Preservation
- MF Preservation

This work package briefly describes the purpose and basic principle of each type of cleaning and preservation procedure. The specific steps for each procedure are described in work packages WP 0021 through WP 0026.

This work package also provides the procedures for neutralizing and pumping out the cleaning wastes when using the Cleaning Waste Storage Tank.

MF CLEANING

The MF fibers filter suspended solids (dirt) and microorganisms out of the raw water. The dirt and microorganism materials collect on the outside of the MF fibers. The fibers are automatically backwashed at 15 minute intervals during normal TWPS operation to remove most of the material. However, backwash alone is not sufficient to remove all of the material that collects on the fibers. Some of the material sticks on the fibers or gets trapped inside the pores of the fibers. Over a period of time the fiber pores become clogged and need to be cleaned.

MF cleaning, then, is a fairly routine procedure. The time interval between cleanings depends on the water source characteristics. Typically, the interval between cleanings will be at least 300 hours of operation and could be as long as 1000 hours. The need for routine cleaning is indicated by an MF Trans-Membrane Pressure (TMP) High alarm. MF cleaning should be performed within 40 hours after the alarm first indicates a high TMP. (Refer to Table 6 in WP 0016, Maintaining Normal Operation, for a TMP chart that correlates TMP High alarms with varying temperatures.)

MF cleaning consists of two cleaning stages. In the first stage the MF fibers are cleaned with a low pH, acid solution. AC-210 citric acid is used for the acid cleaning. In the second stage the MF fibers are cleaned with a high pH, caustic detergent solution. AC-310 detergent plus AC-350 caustic are used together for the caustic detergent cleaning. Both cleaning stages are required to properly clean the MF fibers.

Extended cleaning is required if the operator has chosen to wait 40 hours after the first transmembrane pressure (TMP) alarm, the maximum TMP has been exceeded (refer to WP 0021), the water temperature does not reach at least 100° F during the cleaning cycle, or the TMP is higher than the normal reading after cleaning (3 to 5 psi at 50 to 60 gpm MF Feed Flow). The extended cleaning steps are included in the regular MF Cleaning procedures and would be performed at the next cleaning. MF cleaning procedures are described in WP 0021, MF System Cleaning and in WP 24, MF Cleaning with Reverse Osmosis System Acid Cleaning.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0020 00**
OPERATOR INSTRUCTIONS
CLEANING, PRESERVATION, AND CLEANING WASTE
NEUTRALIZATION AND PUMP-OUT

RO ACID CLEANING

The filtered water, or filtrate, from the MF modules is pumped under pressure through the RO vessels. The RO element membranes reject dissolved solids (salts) in the filtrate. Antiscalant is injected into the filtrate during normal TWPS operation to prevent salt scale from forming on the RO membranes. If the antiscalant is not properly injected, or if the source water is well or seawater in Middle Eastern countries, the RO membranes can gradually become clogged with salt scale. If the RO is not properly preserved, the membranes can become clogged with a biological film. If some of the MF fibers are damaged or broken, silt or dirt can pass through and clog the RO membranes.

When the TWPS is operated properly, scaling, biological growth, and silt accumulation in the RO element membranes are very unlikely. Therefore, acid cleaning of the RO is seldom required. If cleaning does become necessary, the need for RO acid cleaning is indicated by the % Clean calculation and the % Salt Rejection display on the OCP. Table 1 identifies the % Clean and % Salt Rejection criteria that indicates that RO acid cleaning is needed. RO % Clean and RO % Salt Rejection are described in more detail in WP 0016, Maintaining Normal Operation. If you are unsure whether your % Clean and % Salt Rejection data indicates scaling or silt or biological fouling, an RO acid cleaning should be performed followed by an RO detergent cleaning.

Table 1. RO Acid Cleaning Schedule.

RO % Clean	% Salt Rejection	Problem Indicated	Cleaning Required
Less than 90% and a decrease of 10% or more since beginning the mission or last cleaning.	Decreased	Scale	RO Acid Cleaning (Low pH cleaner AC-210 Citric Acid)

AC-210 citric acid is used for the RO acid cleaning. RO Acid Cleaning procedures are described in WP 0022, RO System Acid Cleaning.

RO DETERGENT CLEANING

Like RO Acid Cleaning, RO Detergent Cleaning is seldom required. The excellent RO feed water provided by the MF avoids most of the RO fouling typically associated with dirt and biological material.

If cleaning does become necessary, the need for RO detergent cleaning is indicated by the % Clean calculation and the % Salt Rejection display on the OCP. Table 2 identifies the % Clean and % Salt Rejection criteria that indicates that RO detergent cleaning is needed. RO % Clean and RO % Salt Rejection are described in more detail in WP 0016, Maintaining Normal Operation. If you are unsure whether your % Clean and % Salt Rejection data indicates scaling or silt or biological fouling, an RO acid cleaning should be performed followed by an RO detergent cleaning.

Table 2. RO Detergent Cleaning Schedule.

RO % Clean	% Salt Rejection	Problem Indicated	Cleaning Required
Less than 90% and a decrease of 10% or more since beginning the mission or last cleaning.	Unchanged	Silt or biological fouling	RO Detergent Cleaning (High pH cleaner AC-310 Detergent)

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0020 00**
OPERATOR INSTRUCTIONS
CLEANING, PRESERVATION, AND CLEANING WASTE
NEUTRALIZATION AND PUMP-OUT

AC-310 detergent is used without the caustic for RO detergent cleaning. (Use of caustic for this cleaning will destroy the RO membranes.) RO Detergent Cleaning procedures are described in WP 0023, RO System Detergent Cleaning. If the RO %Clean is less than 60% when first operating after a long shutdown period, extend the detergent cleaning time to 4 hours to try to restore the RO elements. They are probably severely fouled due to improper preservation.

MF CLEANING WITH RO ACID CLEANING

MF Cleaning with RO Acid Cleaning is performed whenever the TWPS is placed in a long-term term shut-down in preparation for storage. It should also be performed if the TWPS is to be shut down during deployment for longer than 54 hours and it is not certain how long the TWPS will be shut down before it is started up again. Cleaning in preparation for storage is performed regardless of the TMP, RO % Clean, and RO % Salt Rejection values. The purpose of cleaning in preparation for storage is to preserve and extend the useful life of the MF modules and RO elements.

MF cleaning with RO acid cleaning combines the MF cleaning and RO acid cleaning procedures in the following order:

- MF Backwash (with product water)
- Acid Cleaning Solution Preparation
- MF Drain
- RO Acid Cleaning
- MF Acid Cleaning
- MF Caustic Detergent Cleaning

The MF Cleaning with RO Acid Cleaning procedures are described in WP 0024, MF System Cleaning and RO System Acid Cleaning.

RO PRESERVATION

The purpose of RO preservation is to prevent biological growth on the RO element membranes when the TWPS is not being used. If the RO membranes are not preserved, biological growth will clog the membranes and the TWPS will not meet performance requirements when it is placed back in service.

RO preservation is performed for an extended shut-down during deployment (shut-down greater than 54 hours) and at the end of deployment in preparation for long term storage. The RO membranes are preserved with AC-120 sodium bisulfite.

RO preservation for an extended shut-down during deployment involves flushing the RO membranes once with the bisulfite solution.

RO preservation in preparation for long term storage is performed after the MF Cleaning and RO Acid Cleaning procedures are performed. RO preservation involves recirculation of the bisulfite solution through the RO for an hour, then draining the RO system.

The RO Preservation procedures are described in WP 0025, RO System Preservation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0020 00**
OPERATOR INSTRUCTIONS
CLEANING, PRESERVATION, AND CLEANING WASTE NEUTRALIZATION AND PUMP-OUT

MF PRESERVATION

The purpose of MF preservation is to prevent biological growth on the MF module fibers when the TWPS is not being used. If the MF fibers are not preserved, biological growth will clog the fibers and the TWPS will not meet performance requirements when it is placed back in service.

MF preservation is performed for an extended shut-down during deployment (shut-down greater than 54 hours) and at the end of deployment in preparation for long term storage.

MF preservation for an extended shut-down during deployment involves flushing the MF module fibers once with a dilute caustic solution. The MF Preservation procedures for extended shut-down during deployment are described in WP 0026, MF System Preservation.

MF preservation in preparation for long term storage is performed as part of the MF Cleaning with RO Acid Cleaning procedure described in WP0024. The caustic detergent solution used in the procedure is not rinsed from the MF system.

CLEANING WASTE NEUTRALIZATION AND PUMP-OUT

This procedure applies whenever the cleaning waste storage tank is used. Table 1 lists the various cleanings and the approximate neutralization chemical usage.

Table 3. Neutralization Chemicals Required per Cleaning Type.

Cleaning Type	WP	Cleaning Waste Storage tank initial charge	Additional Amount for Neutralization *	Final pH
Flushing Preservative/ Cleaning Solution from MF at start-up after extended shutdown	0014	2 lb citric acid (AC-210)	0 lb Citric acid (AC-210) 1 lb Citric acid (AC-210)	pH 9.0 pH 7.0
MF Cleaning	0021	20 lb citric acid (AC-210)	0 lb Citric acid (AC-210) 8 lb Citric acid (AC-210)	pH 9.0 pH 7.0
Reverse Osmosis System Acid cleaning	0022	None	0 lb Sodium carbonate 25 lb Sodium carbonate	pH 4.3 pH 7.0
Reverse Osmosis System Detergent Cleaning	0023	None	0 lb Citric acid (AC-210) 5 lb Citric acid (AC-210)	PH 10.0 PH 7.0
Micro-Filtration System Cleaning with Reverse Osmosis System Cleaning	0024	20 lb citric acid (AC-210)	0 lb Citric acid (AC-210) 8 lb Citric acid (AC-210)	pH 9.0 pH 7.0
Reverse Osmosis System Preservation	0025	Always combined with micro-filtration system preservation		
Micro-Filtration System Preservation	0026	10 lb citric acid (AC-210)	0 lb Citric acid (AC-210) 4 lb Citric acid (AC-210)	pH 9.0 pH 7.0

* If using the 3 L priming pitcher to measure out citric acid, 1 lb of citric acid is equivalent to 300 mL.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS CLEANING, PRESERVATION, AND CLEANING WASTE NEUTRALIZATION AND PUMP-OUT

0020 00

When using the cleaning waste storage tank to handle the wastes from Flushing Preservative/Cleaning Solution (WP 0014), MF Cleaning (WP 0021), MF Cleaning with RO Acid Cleaning (WP 0024) or MF Preservation (WP 0026), citric acid is poured into the tank as an initial charge when the tank is set up. The procedure for adding the citric acid is given by the referenced work packages. After the cleaning wastes have been discharged into the tank, further neutralization may be accomplished as described. This section provides the procedures to complete the waste neutralization and for pumping the cleaning wastewater out of the tank for disposal.

Material:
AC-210 Citric Acid, (1) 20 lb. bucket
(For RO Acid Cleaning waste only) Sodium carbonate, 50 lb. container, (refer to WP 0079, item 40)
Personal protective gear (Box #1)

- Chemical apron, 2
- Face shield, 1
- Chemical gloves, 2 pair
- Dust mask, 1

Personnel:
Two Operators/Crew
Equipment Condition:
TWPS Operational

WARNING

Chemical hazard. Wear a protective face shield, chemical gloves, and a chemical apron when handling cleaning wastewater. Avoid inhaling chemical fumes. If wastewater spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin. Promptly change contaminated clothing after accidental chemical exposure.

1. Setup to recirculate the cleaning wastewater and citric acid (refer to Figure 1).
    a. The cleaning waste hoses from the TWPS (1) should have been disconnected from the cleaning waste storage tank and Adaptor A-10 before beginning this procedure. Refer to the applicable cleaning or preservation work package.
    b. Move the P-1 diesel-driven raw water pump to a position near the tank. The P-2 raw water pump may be used if the P-1 pump is not available.
    c. Connect the female end of one red-banded waste hose (2) to the male end of an A-16 adaptor already on the cleaning waste tank (3).
    d. Connect the male end of the waste hose (2) to the P-1 pump inlet.
    e. Connect Adaptor A-04 to the pump outlet.
    f. Connect the female end of one or more red-banded waste hose(s) as desired (4) to the male end of Adaptor A-04.
    g. Connect the female end of another A-16 adaptor (5) to the male end of the hose(s) (4).
    h. Connect the male end of the A-16 adaptor (5) to the female end of an A-16 adaptor already on the cleaning waste tank (6).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0020 00**
OPERATOR INSTRUCTIONS
CLEANING, PRESERVATION, AND CLEANING WASTE
NEUTRALIZATION AND PUMP-OUT

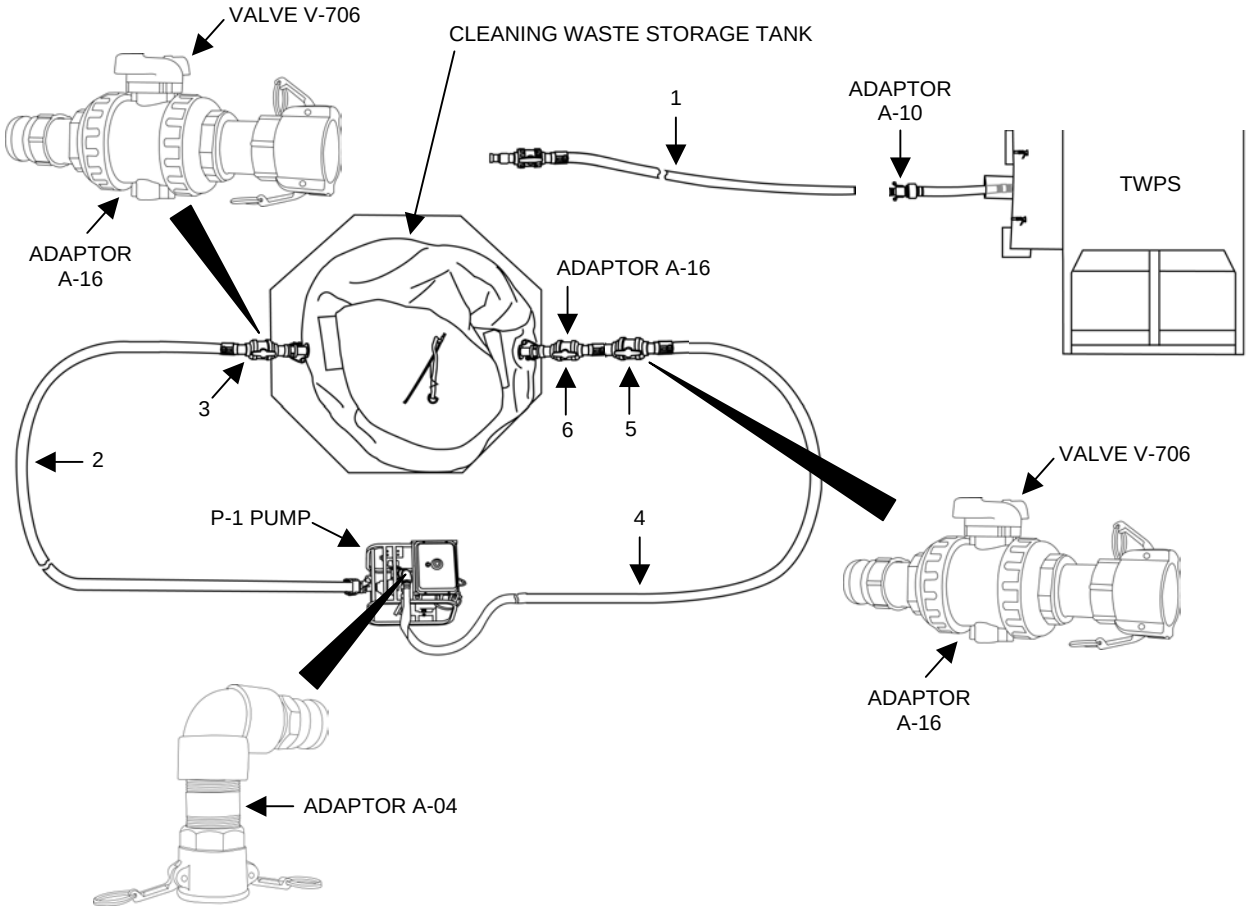

Figure 1. Cleaning Waste Recirculation Set-Up.

WARNING

Chemical hazard. Wear a protective face shield, chemical gloves, and a chemical apron when handling cleaning wastewater or neutralizing chemicals. Avoid inhaling chemical fumes or chemical powder. If chemical wastewater or chemical powder spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

2. Mix and neutralize the cleaning wastewater and neutralizing chemical (refer to Figure 1).
    a. Open the three A-16 adaptor valves V-706
    b. Start the P-1 pump and run for 10 minutes to mix the cleaning wastewater and neutralizing chemical.
    c. Stop the P-1 pump.
    d. Partially unzip the tank top and obtain a wastewater sample.

e. Measure the pH of the wastewater sample using the pH meter from the WQAS-P (Army) or the Portable TDS Meter Kit (Marine Corps). Most wastewater treatment plants accept wastewater with a pH between 6 and 9.
f. If the pH must be reduced, use the priming pitcher to measure 500 ml of citric acid and pour into the tank. Close the zipper, start the pump and mix for 10 minutes. Repeat steps c through f until the pH is within the desired range.
g. The RO acid cleaning waste will be at a pH of approximately 4. Soda ash (sodium carbonate, NSN 6810-01-386-9964, 50 lb container) or acid neutralizer (AN) available from any water treatment sales outlet may be used to increase the pH. Use the priming pitcher to add 1000 ml at a time. Close the zipper, start the pump and mix for 10 minutes. Repeat steps c, d, e, and g until the pH is within the desired range.

3. Pump out the cleaning wastewater (refer to Figure 2).
   a. Stop the P-1 pump if running.
   b. Close the A-16 adaptor valve V-706 on the cleaning waste storage tank outlet to the pump suction (3).
   c. Close the discharge hose A-16 adaptor valve V-706 (5), and the mating A-16 adaptor valve V-706 on the tank inlet (6).
   d. Disconnect the hose A-16 Adaptor (5) from the A-16 adaptor on the tank inlet (6).
   e. Hold the discharge hose end (4) above pump level to prevent wastewater spillage and remove the A-16 adaptor (5) from the end of the hose.
   f. Add hoses to the discharge hose as needed to reach the waste-hauling tank. Connect the A-16 adaptor (5) to the end of the last hose. Leave the V-706 valve closed.
   g. Open the A-16 adaptor valve V-706 on the cleaning waste tank outlet (3).
   h. Start the P-1 pump. Reduce the speed to about half throttle initially.
   i. Direct the discharge hose A-16 adaptor (5) into the waste hauling tank and slowly open the valve V-706 to discharge the wastewater into the waste-hauling tank.
   j. As the cleaning waste storage tank nears empty, lift the tank to shift the wastewater to the outlet.
   k. Drain the final amount of cleaning wastewater from the hoses and pump into buckets and empty into the waste-hauling tank.

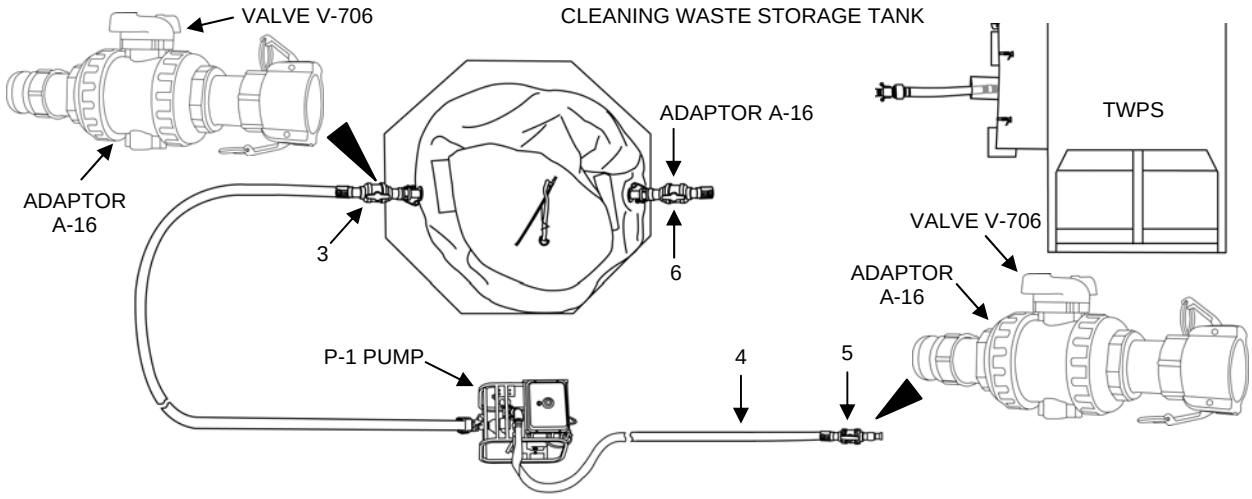

Figure 2. Cleaning Waste Pump-Out Set-Up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0020 00**
OPERATOR INSTRUCTIONS
CLEANING, PRESERVATION, AND CLEANING WASTE
NEUTRALIZATION AND PUMP-OUT

4. Reset the P-1 pump for normal operation if it is to be used.
5. Follow the Return to Normal Operation procedure steps in the cleaning or preservation work package.
6. If not returning to normal operations, rinse the pump out with water.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

0021 00

INITIAL SETUP

Materials/Parts:
AC-120 Bisulfite, (1) 12 oz packet (Box #4)
Measuring Bottle for bisulfite (Box #4)
Chemical scoop (Box #4)
AC-210 Citric Acid, (1) 20 lb. bucket
AC-310 Membrane Detergent Cleaner, (4) 1 Gallon Containers (Box #4)
AC-350 Caustic, (4) 1 Gallon Containers (Box #5)
Three 2 x 10, Red-Banded, Cleaning Waste Hoses
Adaptor A-10 (Box #1)
Adaptor A-12 (Box #1)
Cleaning Waste Storage Module if used

- One 1500-gallon cleaning waste storage tank
- Two Adaptors A-16 (A-TWPS, Box #1)

One 2 x 50, green-banded, raw water hose if the cleaning waste storage module is not used
Personal protective gear (Box #1)

- Chemical apron, 2
- Face shield, 1
- Chemical gloves, 2 pair
- Dust mask, 1

Personnel Required
Two Operators/Crew
Equipment Condition
TWPS Operational
At least 2000 gallons of useable product water must be available in the distribution tanks

GENERAL

MF cleaning is performed when indicated by an MF Trans-Membrane Pressure High alarm. TMP is typically 3 to 5 psi at 50 to 60 gpm MF Feed Flow after cleaning. The alarm setting and the maximum allowable pressure (psi) are dependent on the water temperature (^{0}F) as indicated in the chart below.

Temp	TMP Alarm psi	TMP Max psi
32	28	30
45	25	28
55	21	25
65	18	22
75	16	20
85	14	18
95	13	16

CAUTION

Excessive pressure will damage the MF elements.

MF cleaning should be performed within 40 hours after the alarm first indicates a high TMP. Do not exceed the maximum pressure listed for various temperatures in the chart above. Clean sooner if required.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

MF cleaning consists of two cleaning stages. In the first stage the MF fibers are cleaned with a low pH, acid solution. AC-210 Citric Acid is used for the acid cleaning. In the second stage the MF fibers are cleaned with a high pH, caustic detergent solution. AC-310 detergent plus AC-350 caustic are used together for the caustic detergent cleaning. Both cleaning stages are required to properly clean the MF fibers.

Extended cleaning is required if the operator has chosen to wait 40 hours after the first transmembrane pressure (TMP) alarm, the maximum TMP has been exceeded, the water temperature does not reach at least 100° F during the cleaning cycle, or the TMP is higher than the normal reading after cleaning (3 to 5 psi at 50 to 60 gpm MF Feed Flow).

MF CLEANING

The procedures that follow describe the steps for performing MF Cleaning.

MF Backwash

1. Set up the Cleaning Waste Storage Tank if needed as follows (see Figure 1):
    a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
    b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
    c. Connect an A-16 Adaptor to both connections on the waste tank. Close shut-off valve V-706 on both of the A-16 adaptors.
    d. Be sure that the zipper on the waste tank is zipped closed.

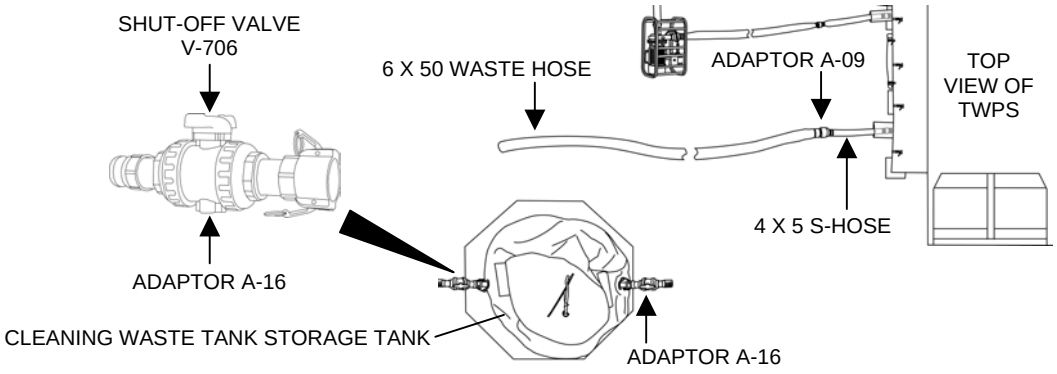

Figure 1. Cleaning Waste Storage Tank Set-Up.

    e. In combat deployment the waste may be discharged into a depression in the ground located at an elevation below the TWPS.

2. Put citric acid in the cleaning waste tank for neutralizing the cleaning solution when the solution is flushed into the tank as follows:

WARNING

Acid chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin. Promptly change contaminated clothing after accidental chemical exposure.

   a. Make sure a bucket of water is placed near the cleaning waste tank to rinse any area of skin or clothing that comes in contact with citric acid.
   b. Open the cleaning waste tank zipper.
   c. Open an extra AC-210 Citric Acid bucket. Pour all of the contents into the cleaning waste tank. If using a different source of citric acid, pour in 20 lbs of citric acid. (After all of the cleaning waste has been discharged into the tank, the pH will be approximately 9).
   d. Close the cleaning waste tank zipper.
   e. Rinse the pitcher and chemical gloves in the bucket of water before removing the gloves.

3. Shutdown the TWPS to the Standby condition as follows (see Figure 2 for valve location):
   a. Perform a **Standby Shutdown Without Draining Down** as described by WP 0017, Standby or Short Term Shutdown.
   b. Do not shut off the TQG and leave the air compressor on.
   c. Stop the raw water pumps when the MF feed tank is 1/2 to 3/4 full.

WARNING

Do not open Main RO Feed Tank Drain Valve V-412. Failure to observe this warning will result in high-pressure backwash air and water discharging back into the tank when the MF is backwashed.

   d. Open RO Feed Tank Auxiliary Drain Valve V-210 located at the operating station end of the RO Feed Tank.
   e. Open RO Feed Pump Drain Valve V-211.

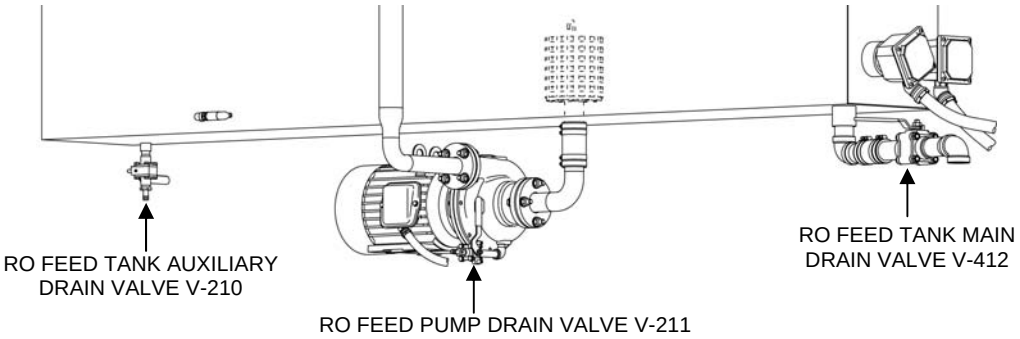

Figure 2. Valves for Shutdown to Standby for MF Acid Cleaning.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

4. Backwash the MF as follows:
    a. Backwash the MF in the MF CLEAN MODE.
        1) When the compressor stops (if running), set the MF CLEAN MODE SWITCH to BACKWASH.
        2) When the Clean light flashes, start the MF feed pump.
        3) Then push the MF BACKWASH START.
            a) The automatic backwash cycles but ends without the rewet step.
            b) The backwash light flashes while the backwash is in progress. When finished, the backwash light is off.
            c) When the backwash is completed, the MF feed pump will stop.
        4) Drain the MF Feed Tank.
            a) Disconnect the MF feed pump suction hose from the MF feed tank. Pull the pump back.
            b) Lift the tank to drain it as completely as possible.
        5) Reconnect the MF feed pump suction hose to the MF feed tank.
        6) Fill the MF Feed tank with product water from the product water distribution system by connecting the end of the product distribution hose to raw water Adaptor A-05 and opening V-107.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

NOTE

Open one of the 12 oz sodium bisulfite packets and pour it into the bottle provided in the BII. The bisulfite powder will be used to neutralize the chlorine in the product water when product water is required for cleaning.

        7) Using the bottle of bisulfite, fill the bottle cap with bisulfite twice and empty it into the MF feed tank while it is filling with product water. This neutralizes the chlorine in the product water that will be used for the second backwash and the MF rinse after MF acid cleaning.
    b. Backwash the MF a second time but with product water as follows:
        1) When the compressor stops, start the MF feed pump.
        2) Immediately push MF BACKWASH START for a second backwash using product water from the MF feed tank.
            a) The automatic backwash cycles but ends without the rewet step.
            b) The backwash light flashes while the backwash is in progress. When finished, the light is off.
            c) The MF feed pump stops when the backwash is completed.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

Acid Cleaning Solution Preparation

1. Remove the 3-in. hose from the TWPS inlet and cap the inlet.
2. Prepare water for the MF acid clean as follows (see Figure 3 for valve location):
    a. Begin this step as soon as the second backwash is complete.
    b. Make sure the RO feed tank is drained.
    c. Close RO Feed Tank Drain Valves V-210 and V-412.
    d. Open Clean Mixing Valve V-703.
    e. Close HP Pump Inlet Valve V-212.
    f. Close RO Feed Pump Drain Valve V-211.

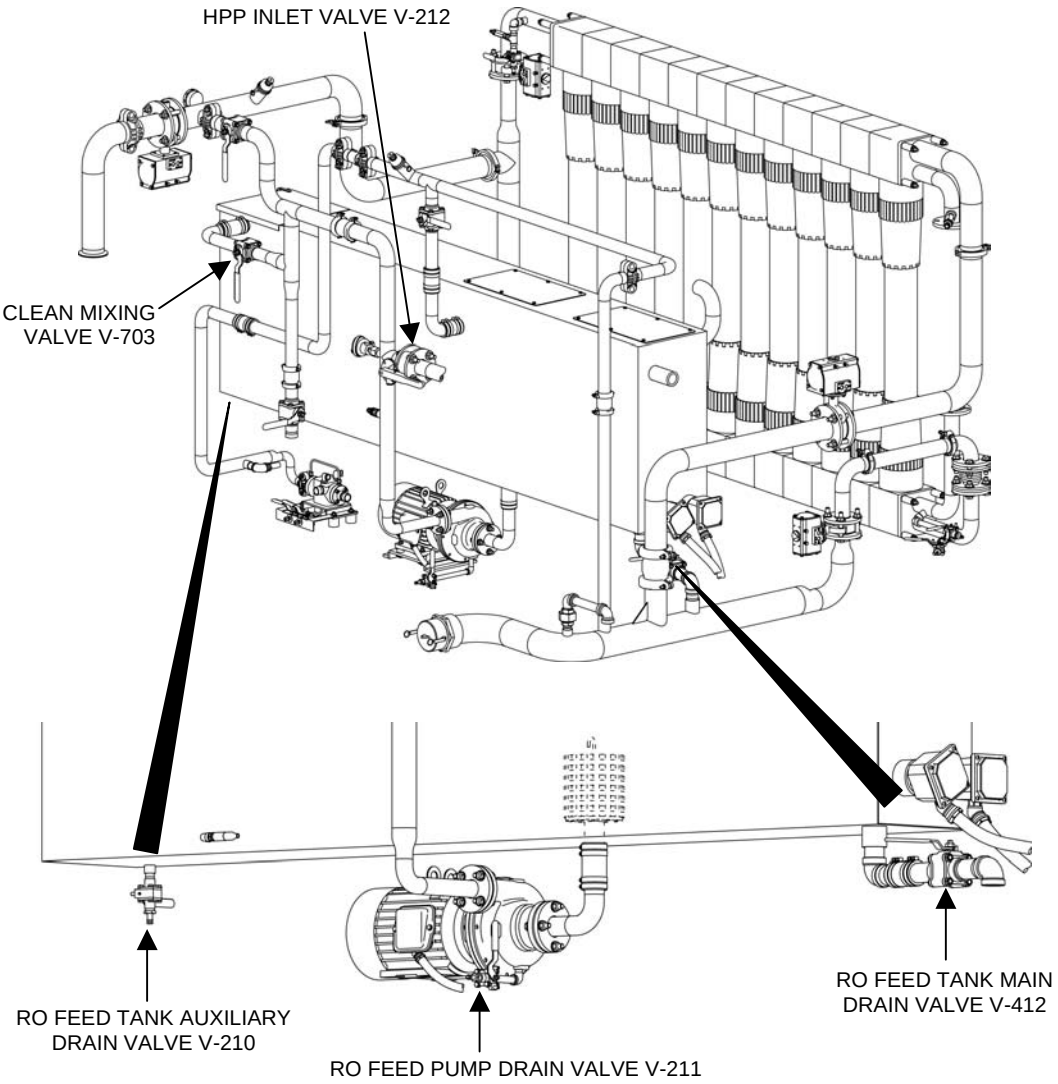

Figure 3. Valves for Preparing Acid Cleaning Solution for MF Acid Cleaning.

g. Using the distribution system auxiliary hose, fill the RO Feed Tank to just over the top of the baffle plate (90-95% level) with product water from the distribution system.

WARNING

Chemical dust. Wear a dust mask, a protective face shield, and chemical gloves when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

h. Add one cap of sodium bisulfite from the sodium bisulfite bottle to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
i. Set the System Mode switch to RO CLEAN.
j. Reset the RO Feed Tank Low Alarm.
k. Start the RO feed pump. This circulates the solution from the RO feed tank, through the RO feed pump, through Clean Mixing Valve V-703, and back into the tank to provide mixing when citric acid is added to the water. Silence any alarms.
l. Set the Tank Heater Switch to AUTO 2.

3. Prepare the acid cleaning solution as follows:

WARNING

Acid chemical. Wear a dust mask, a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

4. Make sure a bucket of product water is placed in the operator station and also near the wastewater tanks to rinse any area of skin or clothing that comes in contact with acid cleaner.
5. Hook the RO feed tank cover open.
6. Open the AC-210 Citric Acid bucket. Use the chemical scoop and ***VERY SLOWLY*** pour the AC-210 Citric Acid into the RO tank to ensure that it is mixed thoroughly with the water and to avoid splashing chemicals. Repeat until the bucket is empty. Maintain recirculation.
7. Close the RO feed tank cover.
8. Rinse the scoop and then the chemical gloves with product water in the bucket before removing.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

MF Drain

1. Drain Down #1: Drain the water from the MF as follows:
    a. Stop the RO feed pump.
    b. Set the Tank Heater Switch to OFF.
    c. Set the System Mode switch to STANDBY.
    d. Set the MF Clean Switch to DRAIN #1.
        1) After a 5 second delay, the PLC automatic control purges the water from the MF with air.
        2) The PLC automatically cycles valves back to Standby at the end of the drain down.
        3) The MF CLEAN light flashes during operation and turns off when the drain down is complete.
2. Open the following MF system vents/ drains (see Figure 4 for valve location):
    a. Open MF Vent Valve V-114.
    b. Open MF Filtrate Drain Valve V-203.
    c. Open MF Shell Drain Valve V-403.

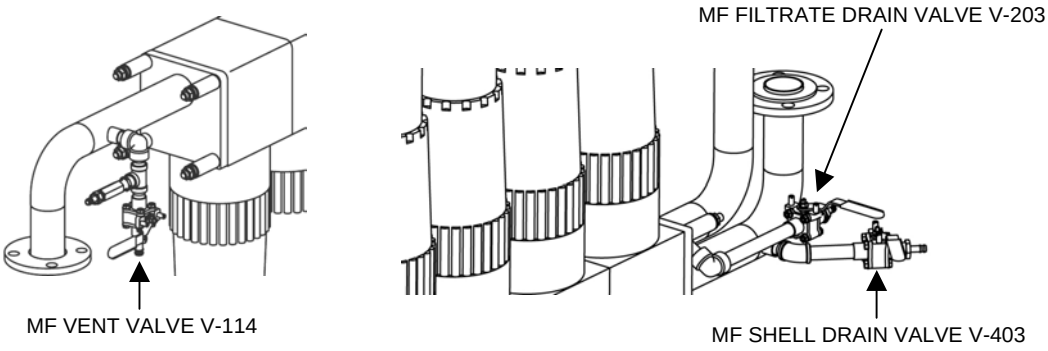

Figure 4. MF Vent / Drain Valve Location.

MF Acid Cleaning

1. Set the waste hoses for acid cleaning as follows (see Figure 5):
    a. Disconnect 4 x 6 in. Adaptor A-09 and the 6 in. red-banded waste out hose from the 4 in x 5 ft. waste outlet hose of the TWPS
    b. Check Adaptors A-10, A-12, and A-16 to make sure that there are gaskets inside the female ends and that the gaskets are in good condition to ensure leak-tight connections.
    c. Connect 4 x 2 in. Adaptor A-10 to the 4 in x 5 ft. waste outlet hose.
    d. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 5):
        1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
        2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
        3) Connect Adaptor A-12 to the end of the last hose.
        4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and close the valves on these two adaptors.
        5) Make sure Valve V-706 on the other Adaptor A-16 on the waste tank is closed.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS **0021 00**

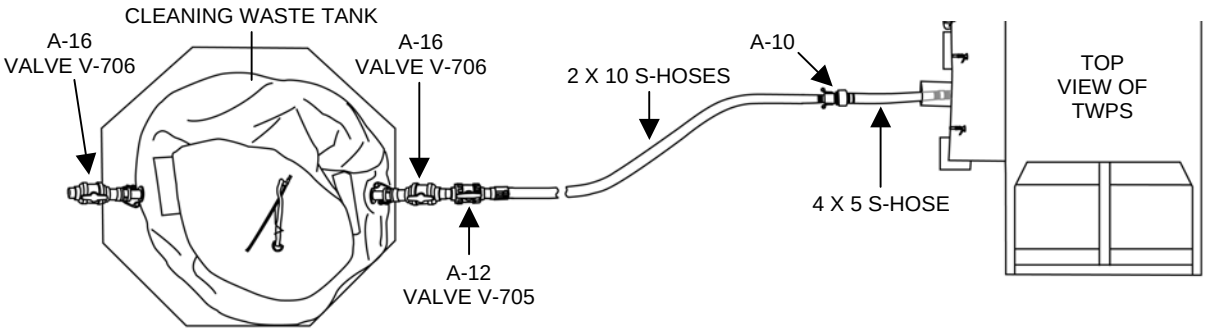

Figure 5. MF Acid Cleaning Waste Hose Set-Up with the Cleaning Waste Tank.

e. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 6):
   1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
   2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
   3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
   4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
   5) Close Adaptor A-12 Valve V-705.
   6) Direct A-12 discharge into a depression in the ground away from the TWPS.

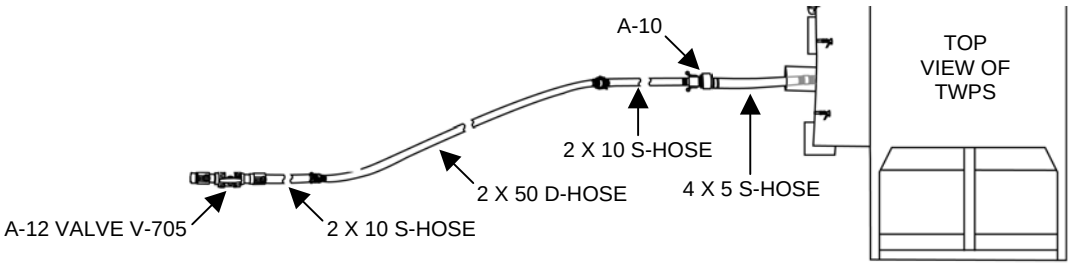

Figure 6. MF Acid Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

2. Set valves for MF acid cleaning as follows (see Figure 7 for valve location):
   a. Close MF Vent Valve V-114.
   b. Open MF Clean Feed Valve V-704.
   c. Be sure that Clean Return Valve V-702 is open.
   d. Be sure that Clean Mixing Valve V-703 is closed.
   e. Close MF Filtrate Drain Valve V-203.
   f. Close MF Shell Drain Valve V-403.
   g. Be sure that Adaptor A-12 Valve V-705 on the cleaning waste hose is closed (see Figure 5 or Figure 6 for valve location).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
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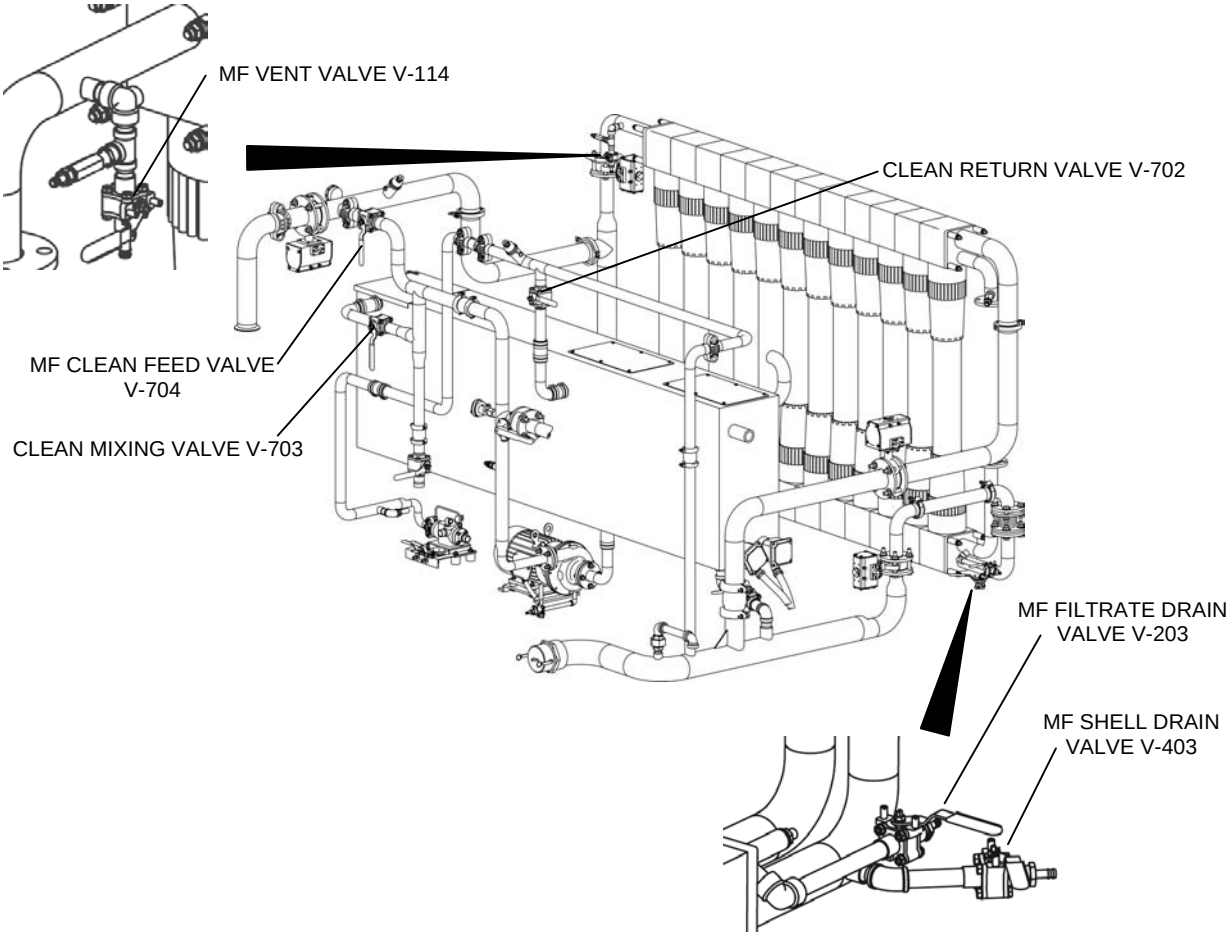

Figure 7. Valves for MF Acid Cleaning.

3. Recirculate the acid cleaning solution through the MF as follows:
    a. Set the MF Clean Switch to FILL/RECIRC. The RO pump starts to automatically fill the MF modules and establish recirculation through the MF modules.
    b. Turn the Tank Heater Switch to AUTO 2. The heaters heat the cleaning solution and automatically cut off when the temperature reaches 110 degrees F.
    c. Check that there is an indication of MF Flow at the OCP display. If not, make sure that the valves are properly positioned.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

NOTE

The CLEAN light flashes during the cleaning cycle and turns off when the cycle is completed (approximately 26 minutes). The RO pump stops. If the heaters were on, they also turn off at the completion of the cleaning cycle.

Extended cleaning is required if the operator has chosen to wait 40 hours after the first transmembrane pressure (TMP) alarm, the maximum TMP has been exceeded, the water temperature does not reach at least 100° F during the cleaning cycle, or the TMP is higher than the normal reading after cleaning (3 to 5 psi at 50 to 60 gpm MF Feed Flow).

d. If extended cleaning is required, perform the following steps:
    1) Set the MF CLEAN switch to SOAK. This interrupts the clean cycle and leaves the cleaning solution in the MF modules to soak.
    2) Soak for 15 minutes.
    3) Set the MF Clean switch back to FILL/RECIRC for one minute.
    4) Repeat the SOAK / FILL/RECIRC sequence for a total of one hour.
e. Set the MF Clean switch back to FILL/RECIRC to continue with the normal cycle and timing to completion.
f. While cleaning the MF modules, refill the MF feed tank with product water from the distribution system. This water will be used to rinse the MF system.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

g. Add two caps of bisulfite from the bisulfite bottle to the MF feed tank while refilling.

4. Drain #2: Drain the acid cleaning solution from the RO feed tank and MF modules as follows:
    a. Set the Tank Heater Switch to OFF.
    b. Close Clean Return Valve V-702 (see Figure 7 for valve location).
    c. If the cleaning waste tank is used, open valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 5 for valve location).
    d. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
    e. If the cleaning waste tank is not used, open valve V-705 on Adaptor A-12 at the end of the cleaning waste hoses (see Figure 6).
    f. Set the MF Clean Switch to Drain #2. The RO feed pump starts and flushes the cleaning solution from the tank through the MF and out the waste hose.

**TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS** **0021 00**

NOTE

When the RO feed tank level reaches the Low Level Switch, the alarm sounds and the RO feed pump stops.

CAUTION

Failure to close MF Clean Feed Valve V-704 at this point will result in water flow back into the RO feed tank rather than out as required.

g. Wait for the RO feed pump to stop, then close MF Clean Feed Valve V-704 (see Figure 7 for valve location).

5. Drain #3: Set the MF Clean switch to Drain #3 to purge the remaining acid cleaning solution from the MF modules with air as follows:
   a. A normal air purge drain down cycle automatically sequences.
   b. Cleaning solution drains out through the cleaning waste hoses.
   c. During the Drain #3 cycle, slightly open MF Clean Feed Valve V-704 for just a moment to push cleaning solution out of the cleaning bypass piping.
   d. The Clean light flashes during operation and turns off when complete.
6. Rinse the MF system with product water as follows:
   a. Remove the cap from the MF inlet and reconnect the 3-in. TWPS inlet hose.
   b. Set the MF Clean switch to RINSE.
      1) This initiates an automatic rinse cycle using product water from the MF feed tank. The Clean light flashes during this cycle.
      2) The MF Feed Pump starts automatically.
      3) The MF Feed Pump stops.
      4) The Clean Light turns off at the end of the cycle.
   c. The cycle ends in STANDBY (the standby light comes on.)
7. End the MF Acid Clean by setting the MF Clean switch to OFF.

WARNING

Acid chemical. Wear a protective face shield, chemical gloves, and a chemical apron when there is a potential for contact with citric acid solution. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

8. Flush the RO feed tank with product water as follows (see Figure 8 for valve location):
   a. Open Main RO Feed Tank Drain Valve V-412 to drain the remaining solution.
   b. Flush the RO feed tank with water using the distribution system auxiliary hose to remove residual cleaning solution.
   c. While flushing the RO feed tank, place the hose from RO Feed Pump Drain Valve V-211 into a bucket. Open the valve just long enough to flush the pump, then close the valve.
   d. Empty the bucket into the 1500-gallon cleaning waste tank.
   e. After flushing the RO tank, allow the tank to drain then close RO Tank Drain Valve V-412.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
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MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

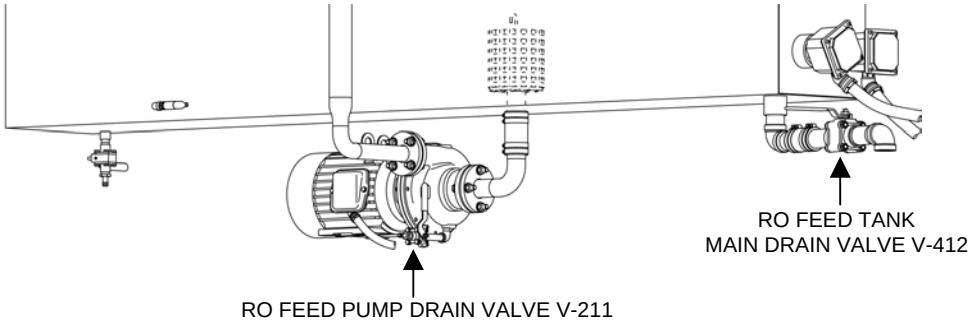

Figure 8. Valves for Flushing the RO Feed Tank.

MF Caustic Detergent Cleaning

The MF caustic detergent cleaning procedure is to be performed as a continuation of the MF acid cleaning procedure. Perform the MF caustic detergent cleaning as follows:

1. Prepare water for MF caustic detergent cleaning as follows:
    a. If using the cleaning waste tank, close valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 5 for valve location).
    b. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
    c. If not using the cleaning waste tank, close valve V-705 at then end of the waste hoses (see Figure 6).
    d. Remove the 3-in. hose from the TWPS inlet connection and cap the inlet connection on the TWPS.
    e. Be sure RO Feed Tank Drain Valve V-412 is closed (see Figure 8 for valve location).
    f. Open Clean Mixing Valve V-703 (see Figure 9 for valve location).
    g. Using the distribution system auxiliary hose, fill the RO feed tank to just over the top of the baffle plate (90-95% level) with product water from the distribution system.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

    h. Add one cap of sodium bisulfite from the bisulfite bottle to the RO feed tank while filling the tank to neutralize the chlorine in the product water.

i. Set the System Mode switch to RO CLEAN.
j. Reset the RO Feed Tank Low Alarm.
k. Start the RO feed pump. This circulates the solution from the RO feed tank, through the RO feed pump, through Clean Mixing Valve V-703, and back into the tank to provide mixing when the membrane detergent cleaner and caustic are added to the water.
l. Silence any alarms.
m. Set the Tank Heater switch to AUTO 2.

2. Prepare the caustic detergent cleaning solution as follows:

WARNING

Caustic chemical. Wear a protective face shield, chemical gloves, and chemical apron when handling caustic solution. Contact with caustic will result in severe chemical burns. Keep water ready when handling. Avoid inhaling chemical fumes. If caustic spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in severe irritation of the nose, throat and eyes. Contact with skin will result in severe chemical burns if not rinsed immediately.

NOTE

Rapid pouring of detergent into the tank will cause the detergent to stick to the tank bottom and not mix. Unmixed detergent may be drawn to the pump and interrupt pumping.

a. Make sure a bucket of product water is placed in the operator station to rinse any area of skin or clothing that comes in contact with caustic.
b. Hook the RO feed tank cover open.
c. ***VERY SLOWLY*** add AC-310 Membrane Detergent Cleaner into the RO feed tank as follows:
    1) Open a container of AC-310 Detergent and very slowly pour it into the RO feed tank. Pour into the area of water flow from the mixing recirculation water flow.
    2) Continue until all four of the detergent containers have been emptied.
d. Add AC-350 Caustic into the RO feed tank as follows:
    1) Take one caustic container and remove the outer plastic bags.
    2) Hold the container inside the RO feed tank and remove the cap.
    3) Hold the container near the water (but not underwater) to avoid splashing and slowly empty the container into the water.
    4) When empty, rinse with water in the tank (now it may be held under water) then reinstall the cap.
    5) Immediately rinse the outside of the container in the bucket containing product water before discarding.
    6) Repeat until 4 containers of caustic have been added to the water in the RO feed tank.
e. Close the RO feed tank cover.
f. Rinse the chemical gloves in the bucket containing clean water before removing.
g. After mixing, stop the RO feed pump.
h. Turn the Tank Heater Switch to OFF.
i. Set System Mode switch to STANDBY.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
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MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

3. Set valves for MF caustic detergent cleaning as follows (see Figure 9 for valve location):
    a. Open MF Clean Feed Valve V-704.
    b. Open Clean Return Valve V-702.
    c. Close Clean Mixing Valve V-703.
    d. Be sure that Valve V-705 on Adaptor A-12 is closed (see Figure 5 or Figure 6).

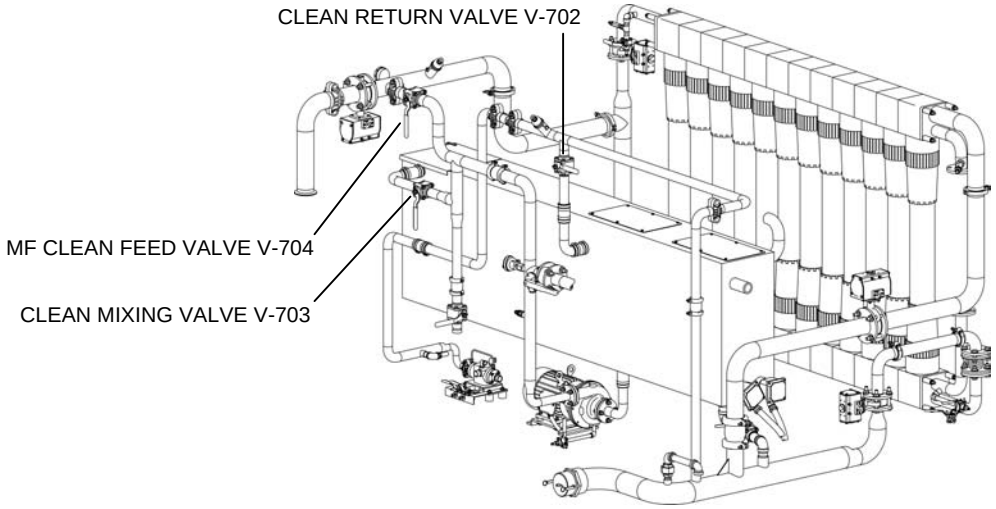

Figure 9. Valves for MF Caustic Detergent Cleaning.

4. Recirculate the caustic detergent cleaning solution through the MF modules as follows:
    a. Set the MF Clean switch to FILL/RECIRC. The RO pump starts to automatically fill the MF modules and establish recirculation through the MF modules.
    b. Turn the Tank Heater switch to AUTO 2. The heaters heat the cleaning solution and automatically cut off when the temperature reaches 110 degrees F.
    c. Check that there is an indication of MF Flow at the OCP display. If not, make sure that the valves are properly positioned.

NOTE

The CLEAN light flashes during the cleaning cycle and turns off when the cycle is completed (approximately 26 minutes). The RO pump stops. If the heaters were on, they also turn off at the completion of the cleaning cycle.

Extended cleaning is required if the transmembrane pressure (TMP) is higher than the normal reading after the last time the MF was cleaned (3 to 5 psi at 50 to 60 gpm MF Feed Flow).

5. If extended cleaning is required, soak the MF module fibers in the cleaning solution as follows:
    a. Set the MF Clean switch to SOAK. This interrupts the clean cycle and leaves the cleaning solution in the MF modules to soak.
    b. Turn the Tank Heater Switch to OFF.
    c. Soak for 15 minutes.
    d. Set the MF Clean switch back to FILL/RECIRC for one minute.

e. Repeat the SOAK / FILL/RECIRC sequence for a total of up to one hour.
f. Set the MF Clean switch back to FILL/RECIRC to continue with the normal cycle and timing to completion.
g. While cleaning the MF modules, refill the MF feed tank with product water from the distribution system. This water will be used to rinse the MF system.

6. Drain #2: Drain the caustic cleaning solution from the RO feed tank and MF modules as follows (see Figure 9 for valve location):
   a. Set the Tank Heater switch to OFF.
   b. Close Clean Return Valve V-702.
   c. If using the cleaning waste storage tank, open valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 5 for valve location).
   d. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
   e. If not using the waste tank, open valve V-705 on Adaptor A-12 at the end of the cleaning waste hoses (see Figure 6).
   f. Set the MF Clean switch to DRAIN #2. The RO feed pump starts and flushes the cleaning solution from the tank through the MF and out the waste hose.

NOTE

When the tank level reaches the Low Level Switch, the alarm sounds and the RO feed pump stops. Occasionally the RO pump will lose prime before reaching the low level. In this case, if the RO pump does not stop within 15 seconds from when the tank level reads zero, stop the RO pump.

CAUTION

Failure to close MF Clean Feed Valve V-704 will result in water flow back into the RO feed tank rather than out as required.

   e. After the RO feed pump is stopped, close MF Clean Feed Valve V-704.

7. Drain #3: Set the Clean switch to Drain #3 to purge the remaining caustic detergent cleaning solution from the MF modules with air as follows:
   a. A normal air purge drain down cycle automatically sequences.
   b. Cleaning solution drains out through the cleaning waste hoses.
   c. During the drain #3 cycle, slightly open MF Clean Feed Valve V-704 for just a moment to push cleaning solution out of the cleaning bypass piping.
   d. The Clean light flashes during operation and turns off when complete.
8. Rinse the MF system with product water as follows:

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0021 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

a. Remove the TWPS inlet cap and connect the 3-in. inlet hose to the TWPS inlet.
b. Add product water to the MF feed tank until the tank is ½ full.
c. Add one cap of sodium bisulfite to the MF feed tank while filling to neutralize the chlorine in the product water.
d. Set the CLEAN switch to RINSE.
    1) This turns on the MF feed pump and initiates an automatic rinse cycle using product water from the MF feed tank.
    2) The MF feed pump stops at the end of the cycle.
    3) The CLEAN light flashes during the cycle and turns off at the end of the cycle.
    4) The cycle ends in STANDBY.

9. Flush the RO feed tank with product water as follows (see Figure 10 for valve location):
    a. Open Main RO Feed Tank Drain Valve V-412 to drain any remaining caustic detergent cleaning solution from the tank to the waste out hose.
    b. Flush the tank with water using the distribution system auxiliary hose to remove residual cleaning solution.
    c. While flushing the RO feed tank:
        1) Place the hose from RO Feed Pump Drain Valve V-211 into a bucket. Open the valve just long enough to flush the pump, then close the valve.
        2) Empty the bucket into the 1500-gallon cleaning waste tank.

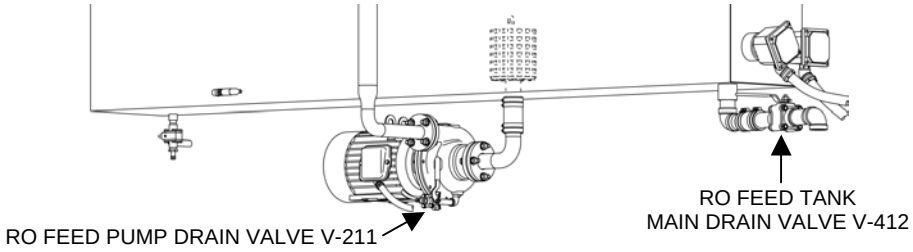

Figure 10. Valves for Flushing RO Feed Tank.

    d. After flushing the RO tank, allow the tank to drain then close RO Tank Drain Valve V-412.

10. End the MF Caustic Detergent Cleaning as follows (see Figure 5):
    a. Set MF Clean switch to OFF.

WARNING

Caustic chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling the cleaning and drain hoses. Contact with caustic will result in severe chemical burns. Keep water ready when handling. Failure to observe this warning may result in severe irritation of the nose, throat, eyes, and skin.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS MICRO-FILTRATION SYSTEM CLEANING – OPERATION UNDER USUAL CONDITIONS **0021 00**

b. If using the cleaning waste tank perform the following steps:
    1) Close valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 5 for valve location).
    2) Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
    3) Disconnect Adaptor A-12 from the Adaptor A-16.
    4) Direct the cleaning waste hose into an empty bucket, open Adaptor A-12 Valve V-705 and drain the contents of the hose into the bucket.
    5) Open the top of the waste tank and empty the bucket into the waste tank. Then close the tank.
c. If not using the cleaning waste tank, simply leave valve V-705 on Adaptor A-12 open (see Figure 6).
d. When drained, disconnect the cleaning waste hose from Adaptor A-10.

11. Refer to WP 0020, Cleaning, Preservation, and Cleaning Waste Neutralization and Pump-Out, for the procedures to neutralize the wastewater and pump it out of the cleaning waste storage tank.
12. Return to normal operation as follows:
    a. Remove Adaptor A-10 from the 4 x 5 waste hose at the waste discharge of the TWPS.
    b. Connect Adaptor A-09 and the 6-inch x 50-ft. red-banded waste out hose to the 4 x 5 waste hose (see Figure 1) for hose layout).
    c. Follow the procedure for **Startup After Short Term Shutdown** in **WP 0015** to return to normal operation.
    d. If the RO was also cleaned, discharge the product on the ground for 10 minutes before connecting the product hose to the distribution tank.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

0022 00

INITIAL SETUP

Materials/Parts:
AC-120 Bisulfite, (1) 12 oz packet (Box #4)
Measuring Bottle for bisulfite
AC-210 Citric Acid, (1) 20# pail
Three 2 in. x 10 ft. Cleaning Waste Hoses
Adaptor A-10 (Box #1)
Adaptor A-12 (Box #1)
Cleaning Waste Storage Module if used

- One 1500 gallon cleaning waste storage tank
- Two Adaptors A-16 (Box #1)

One 2-in. x 50-ft. raw water hose if cleaning waste storage module is not used
Personal protective gear (Box #1)

- Chemical apron, 2
- Face shield, 1
- Chemical gloves, 2 pair
- Dust mask, 1

Personnel Required
Two Operators/Crew
Equipment Condition
TWPS Operational
At least 500 gallons of useable product water must be available in the distribution tanks

GENERAL

RO acid cleaning is performed when indicated by the % Clean calculation and the % Salt Rejection display on the OCP. Table 1 identifies the % Clean and % Salt Rejection criteria that indicates that RO acid cleaning is needed. RO % Clean and RO % Salt Rejection are described in more detail in WP 0016, Maintaining Normal Operation.

Table 1. RO Acid Cleaning Schedule.

RO % Clean	% Salt Rejection	Problem Indicated	Cleaning Required
Less than 90% and a decrease of 10% or more since beginning the mission or last cleaning.	Decreased	Scale	RO Acid Cleaning (Low pH cleaner AC-210 Citric Acid)

AC-210 Citric Acid is used for the RO acid cleaning.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

RO ACID CLEANING

The procedures that follow describe the steps for performing RO Acid Cleaning.

1. Set up the Cleaning Waste Storage Tank if needed as follows (see Figure 1):
    a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
    b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
    c. Connect an A-16 Adaptor to both connections on the waste tank. Close shut-off valve V-706 on both of the A-16 adaptors.
    d. Be sure that the zipper on the waste tank is zipped closed.

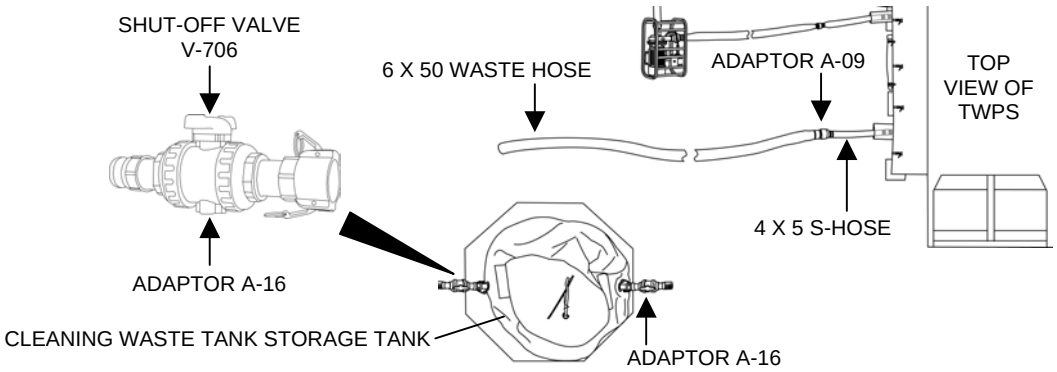

Figure 1. Cleaning Waste Storage Tank Set-Up.

    e. In combat deployment the waste may be discharged into a depression in the ground located at an elevation below the TWPS.
2. Shutdown the TWPS to the Standby condition and drain the TWPS as follows (see Figure 2 for valve location):
    a. Perform a **Standby Shutdown Without Draining Down** as described WP 0017, Standby or Short Term Shutdown.
    b. Do not shut off the TQG and leave the air compressor on.
    c. Open main RO Feed Tank Drain Valve V-412 to drain the RO feed tank.
    d. Open RO Vessel Drain Valve V-408.
    e. Open HP Pump Outlet Drain Valves V-301 and V-302.
    f. Open RO Feed Piping Drain Valve V-304.
    g. Open RO Feed Pump Drain Valve V-211.
    h. Close Main RO Feed Tank Drain Valve V-412 and RO Feed Pump Drain Valve V-211 when the tank is drained.
    i. Close valves V-408, V-301, V-302, and V-304 when the RO vessels are drained.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

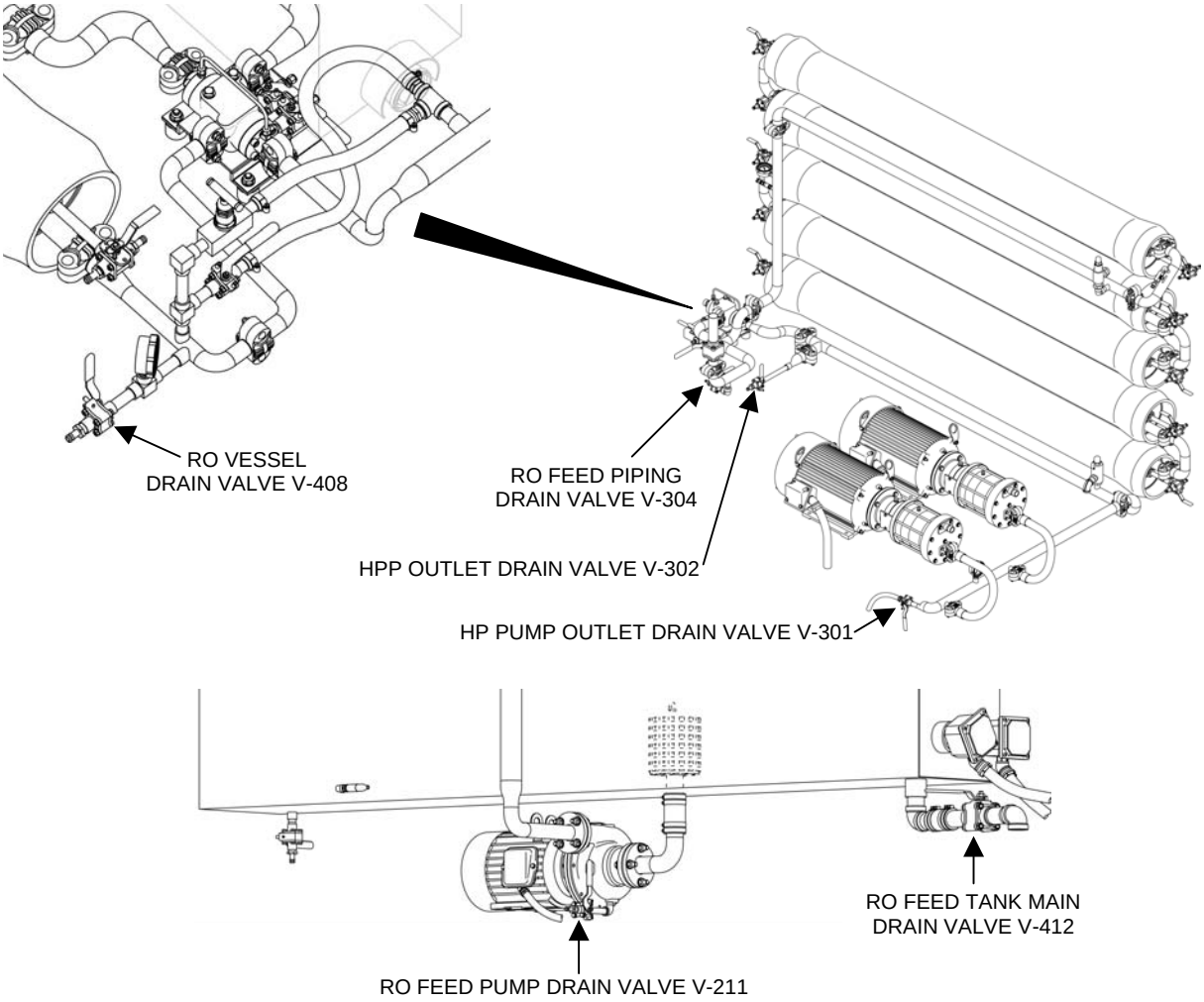

Figure 2. Valves for Shutdown to Standby and Drain for RO Acid Clean.

3. Set the waste hoses for acid cleaning as follows (see Figure 3):
    a. Disconnect 4 x 6 in. Adaptor A-09 and the 6 in. red-banded waste out hose from the 4 in x 5 ft. waste outlet hose of the TWPS
    b. Check Adaptors A-10, A-12, and A-16 to make sure that there are gaskets inside the female ends and that the gaskets are in good condition to ensure leak-tight connections.
    c. Connect 4 x 2 in. Adaptor A-10 to the 4 in x 5 ft. waste outlet hose.
    d. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 3):
        1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
        2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
        3) Connect Adaptor A-12 to the end of the last hose.

4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and close the valves on these two adaptors.
5) Make sure Valve V-706 on the other Adaptor A-16 on the waste tank is closed.

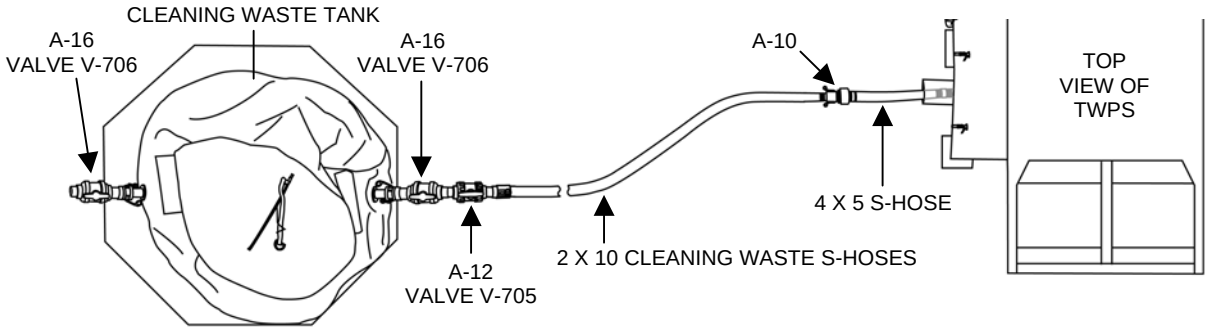

Figure 3. Cleaning Waste Hose Set-Up with the Cleaning Waste Tank.

e. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 4):
   1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
   2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
   3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
   4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
   5) Open Adaptor A-12 Valve V-705.
   6) Direct A-12 discharge into a depression in the ground away from the TWPS.

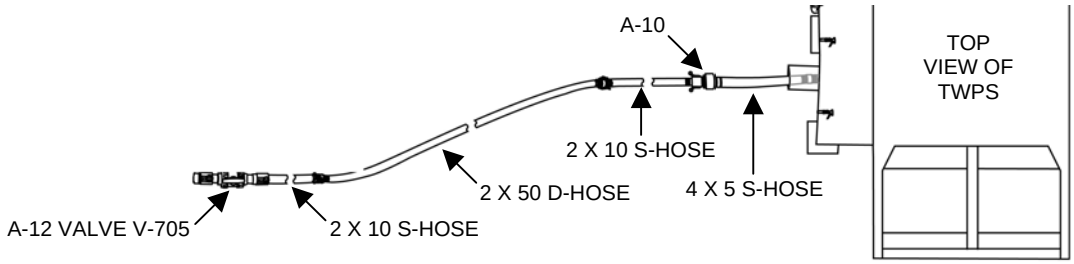

Figure 4. Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

4. Remove the 3-in.hose from the TWPS inlet and cap the inlet.
5. Prepare water for RO acid cleaning as follows (see Figure 5 for valve location):
   a. Be sure Main RO Feed Tank Drain Valve V-412 is closed.
   b. Open Clean Mixing Valve V-703.
   c. Close HP Pump Inlet Valve V-212.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

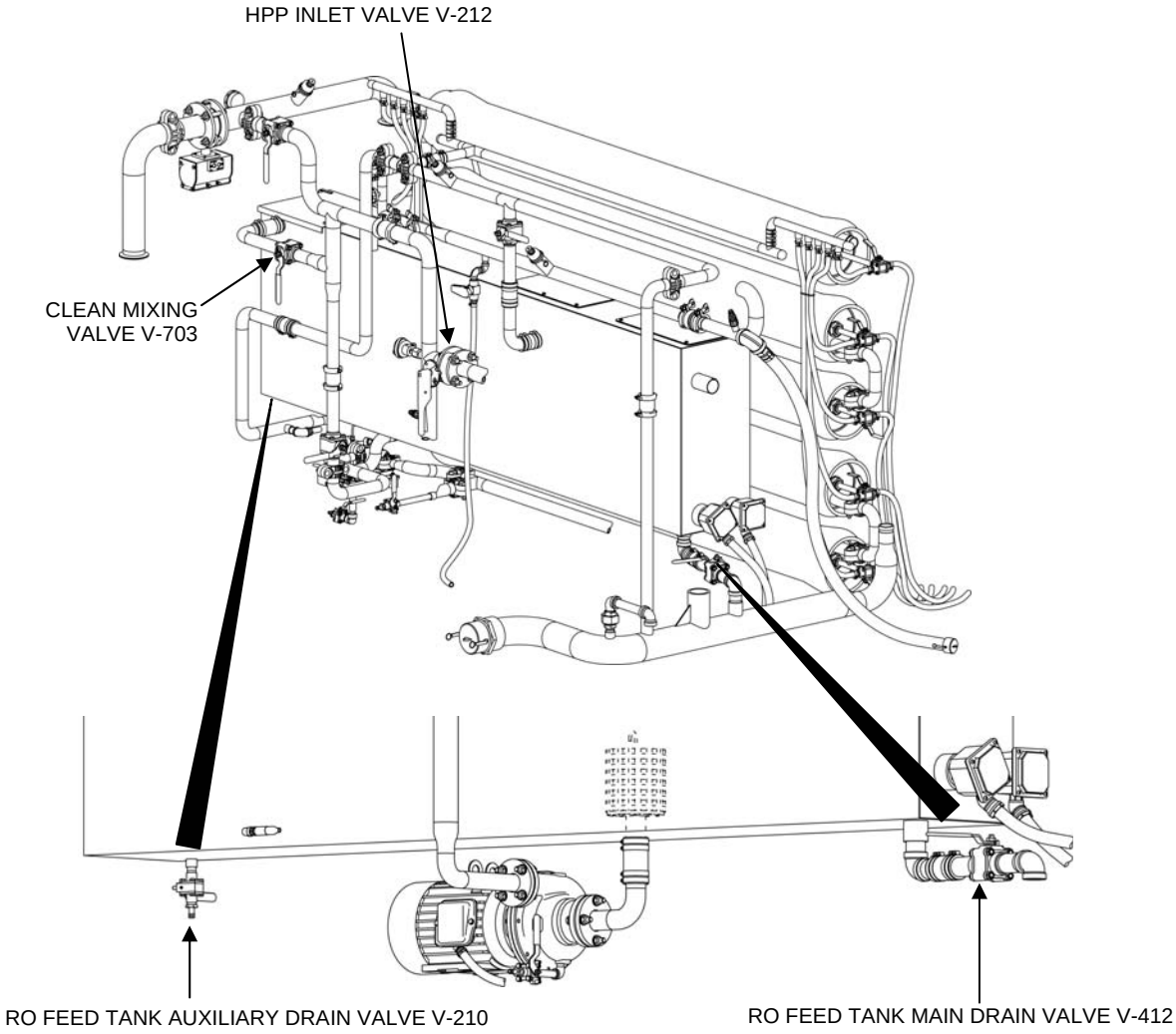

Figure 5. Valves for Preparing Water for RO Acid Cleaning.

d. Set the SYSTEM MODE SWITCH to RO CLEAN.
e. Using the distribution system auxiliary hose, fill the RO feed tank to just over the top of the baffle plate (90-95% level) with product water from the distribution system.

WARNING

Chemical dust. Wear a dust mask, a protective face shield, and chemical gloves when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin. Promptly change contaminated clothing after accidental chemical exposure.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in RO membrane failure.

NOTE

Open one of the 12oz sodium bisulfite packets and pour it into the bottle provided in the BII. The bisulfite powder will be used to neutralize the chlorine in the product water when product water is required for cleaning.

f. Add one cap of sodium bisulfite from the sodium bisulfite bottle to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
g. Reset the RO Feed Tank Low Alarm.
h. Start the RO feed pump. This circulates the solution from the RO feed tank, through the RO feed pump, through Clean Mixing Valve V-703, and back into the tank to provide mixing when the citric acid is added to the water. Silence any alarms.
i. Set the Tank Heater Switch to AUTO 2.

6. Prepare the RO acid cleaning solution as follows:

WARNING

Acid chemical. Wear a dust mask, a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

NOTE

Rapid pouring of citric acid into the tank will cause the cleaner to stick to the tank bottom and not mix. Unmixed cleaner may be drawn to the pump and interrupt pumping.

a. Make sure a bucket of product water is placed in the operator station and also near the wastewater tanks to rinse any area of skin or clothing that comes in contact with acid cleaner.
b. Hook the RO feed tank cover open.
c. Open the AC-210 Citric Acid bucket. Use the chemical scoop and ***VERY SLOWLY*** pour the AC-210 Citric Acid into the RO tank to ensure that it is mixed thoroughly with the water and to avoid splashing chemicals. Repeat until the bucket is empty. Maintain recirculation.
d. Close the RO feed tank cover.
e. Rinse the scoop and then the chemical gloves with product water in the bucket before removing.

7. Set valves to recirculate the acid cleaning solution from the RO feed tank, through the RO feed pump, through the RO elements, and back to the RO feed tank as follows:

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

a. Be sure that Adaptor A-12 Valve V-705 on the 2 x 10 cleaning waste (suction) hoses is closed (see Figure 6 for valve location).

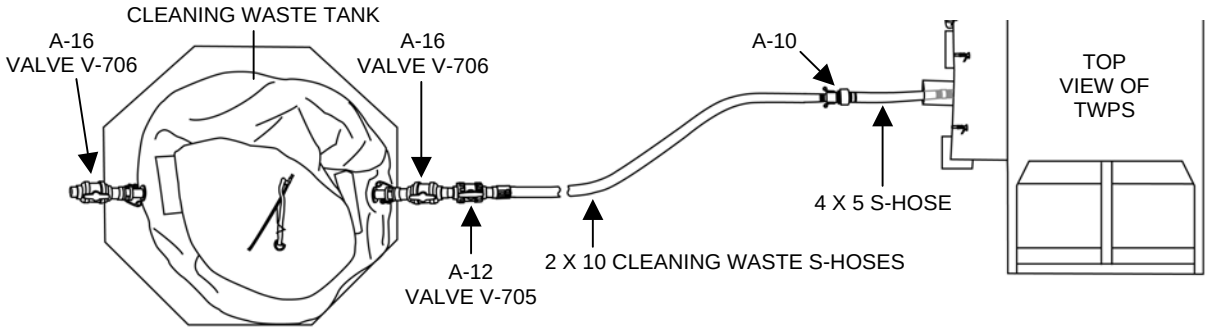

Figure 6. Adaptor A-12 Valve V-705 in Cleaning Waste Hose Line.

b. Close the Distribution Tank Adaptor A-15 Valve V-525 and disconnect the product hose (see Figure 7 for valve location).

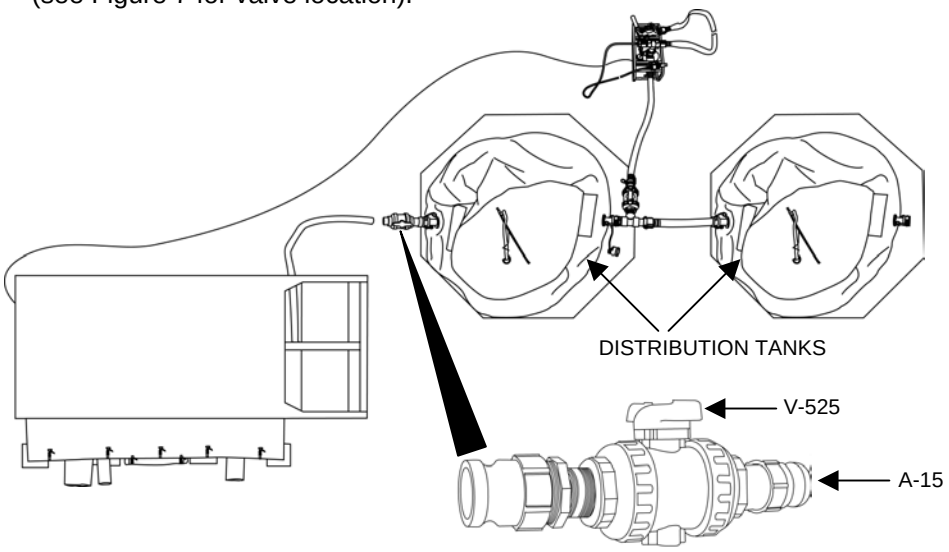

Figure 7. Distribution Tank Adaptor A-15 Valve V-525.

c. Direct the product utility hose to discharge into the RO feed tank through the open tank cover (see Figure 8).
d. Open Product Utility Valve V-511.
e. Open RO Clean Feed Valve V-701.
f. Open Clean Return Valve V-702.
g. Close Clean Mixing Valve V-703.
h. Continue recirculation for one hour.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

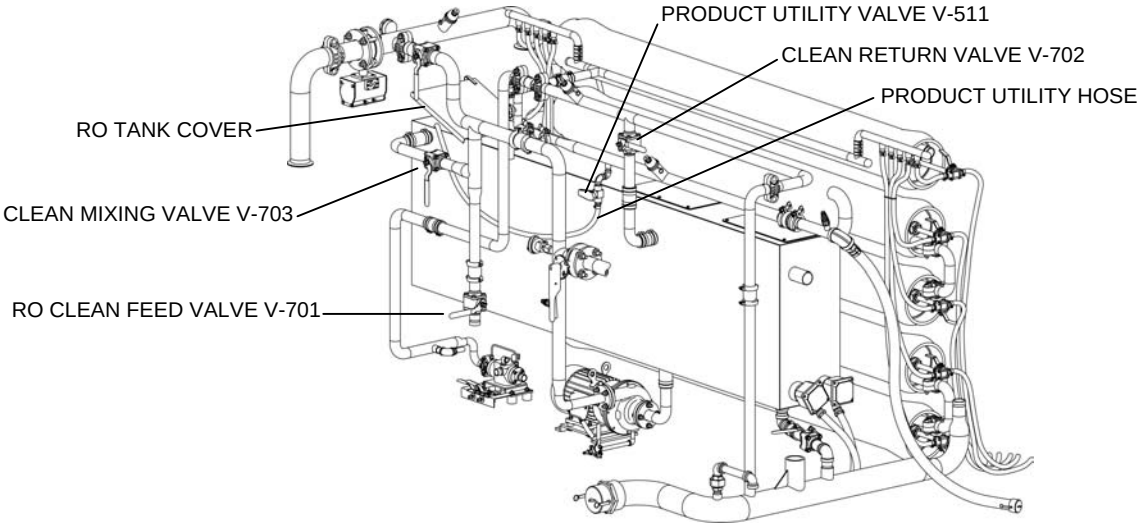

Figure 8. Valves for RO Acid Cleaning.

8. Drain the RO vessels and RO feed tank as follows:
    a. Stop the RO feed pump and set the heater switch to OFF.
    b. Close Clean Return Valve V-702.
    c. Open valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 6 for valve location).
    d. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
    e. Start the RO feed pump.
        1) The cleaning solution is pumped from the tank through the RO and out through the waste hose.
        2) When the low level is reached, the pump stops and the alarm sounds. Silence the alarm.
    f. Open Main RO Feed Tank Drain Valve V-412.
    g. When drained, rinse the tank with product water from the distribution system auxiliary hose.
9. Flush the RO vessels with product water as follows:
    a. Close Main RO Feed Tank Drain Valve V-412.
    b. Using the distribution system auxiliary hose, fill the RO feed tank to the top of the baffle plate (90-95% level) with product water from the distribution system.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in RO membrane failure.

c. Add one cap of sodium bisulfite to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
d. Reset the RO Feed Tank Low Alarm.
e. Start the RO Feed Pump. Silence any alarms.
    1) This flushes product water through the RO vessels and out the waste hose.
    2) When the low level is reached, the pump stops and the alarm sounds.

10. Repeat the product water flush of the RO vessels (steps 9b through 9e).
    a. While repeating the product water flush of the RO vessels, momentarily open the following drain valves (see Figure 9 for valve location):
        1) RO Feed Pump Drain Valve V-211
        2) High Pressure Pump Outlet Drain Valves V-301 and V-302
        3) Feed Piping Drain Valve V-304
        4) Turbocharger Feed Side Drain Valve V-303
        5) Turbocharger Reject Side Drain Valve V-410
    b. Momentarily opening and closing these valves allows enough water through the valves to flush them. Leave the valves in the closed position when completing the flushing process.

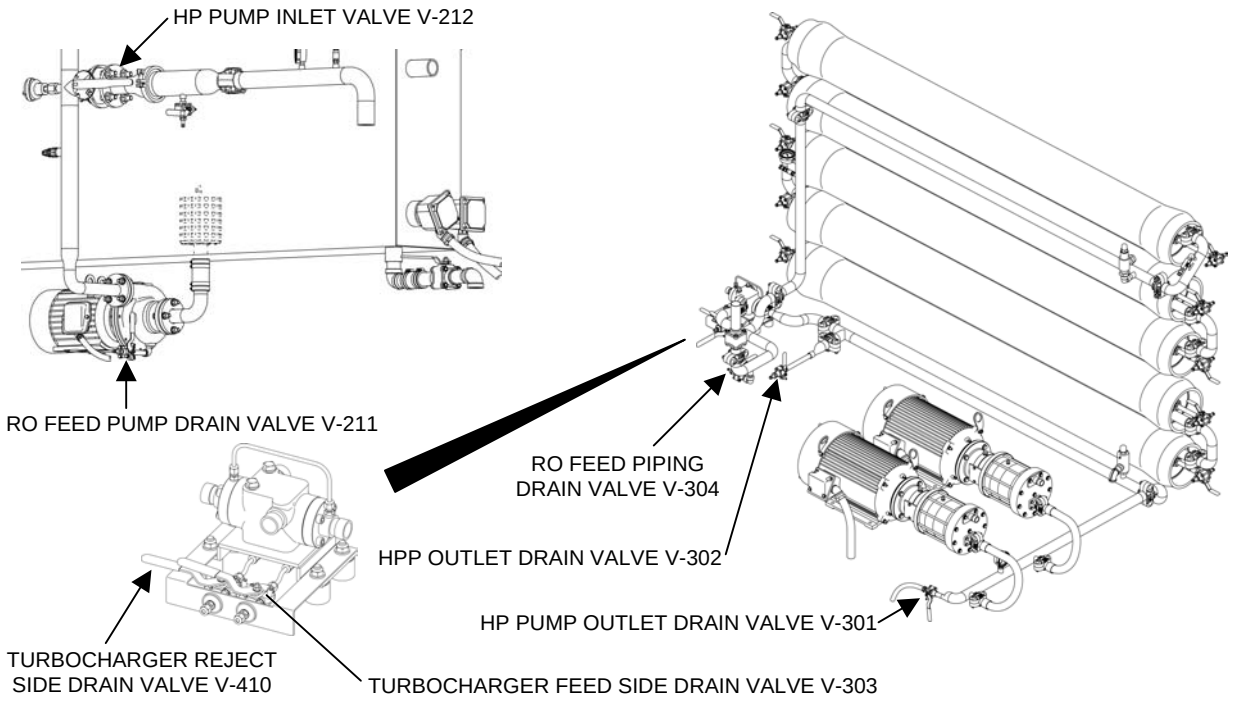

Figure 9. Valves for Second RO Product Water Flush.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0022 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

11. End the RO Acid Cleaning as follows:
    a. Set SYSTEM MODE SWITCH to Standby.
    b. Close RO Clean Feed Valve V-701 (see Figure 8 for valve location).

WARNING

Acid chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

    c. Open the HP Pump Inlet Valve V-212 (see Figure 9 for valve location).
    d. If using the cleaning waste storage tank, perform the following steps:
        1) Close valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 6 for valve location).
        2) Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
        3) Disconnect Adaptor A-12 from the Adaptor A-16.
        4) Direct the cleaning waste hose into an empty bucket, open Adaptor A-12 Valve V-705 and drain the contents of the hose into the bucket.
        5) Open the top of the waste tank and empty the bucket into the waste tank. Then close the tank.
    e. If not using the cleaning waste tank, simply leave valve V-705 on Adaptor A-12 open (see Figure 4).
    f. When drained, disconnect the cleaning waste hose from Adaptor A-10.
    g. Close Product Utility Hose Valve V-511 and remove the hose from the RO feed tank.
12. Refer to WP 0020, Cleaning, Preservation, and Cleaning Waste Neutralization and Pump-Out, for the procedures to neutralize the wastewater and pump it out of the cleaning waste storage tank.
13. Return to normal operation as follows:
    a. Remove Adaptor A-10 from the 4 x 5 waste out hose at the waste discharge of the TWPS.
    b. Remove the cap from the MF inlet and reconnect the 3-in. TPWS inlet hose.
    c. Connect Adaptor A-09 and the 6-inch x 50-ft. red-banded waste out hose to the 4 x 5 waste hose (see Figure 1) for hose layout).
    d. Follow the procedure for **Startup After Short Term Shutdown** in **WP 0015** to return to normal operation.
    e. Discharge the product on the ground for 10 minutes before connecting the product hose to the distribution tank. .

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS REVERSE OSMOSIS SYSTEM DETERGENT CLEANING – OPERATION UNDER USUAL CONDITIONS

0023 00

INITIAL SETUP

Materials/Parts:
AC-120 Bisulfite, (1) 12 oz packet (Box #4)
Measuring Bottle for bisulfite
AC-310 Membrane Detergent Cleaner, (4) 1 Gallon Containers (Box #4)
Three 2 in. x 10 ft. Cleaning Waste Hoses
Adaptor A-10 (Box #1)
Adaptor A-12 (Box #1)
Cleaning Waste Storage Module if used

- One 1500 gallon cleaning waste storage tank
- Two Adaptors A-16 (Box #1)

One 2-in. x 50-ft. raw water hose if cleaning waste storage module is not used
Personal protective gear (Box #1)

- Chemical apron, 2
- Face shield, 1
- Chemical gloves, 2 pair
- Dust mask, 1

Personnel Required
Two Operators/Crew
Equipment Condition
TWPS Operational
At least 500 gallons of useable product water must be available in the distribution tanks

GENERAL

RO detergent cleaning is performed when indicated by the % Clean calculation and the % Salt Rejection display on the OCP. Table 1 identifies the % Clean and % Salt Rejection criteria that indicates that RO detergent cleaning is needed. RO % Clean and RO % Salt Rejection are described in more detail in WP 0016, Maintaining Normal Operation.

Table 1. RO Detergent Cleaning Schedule.

RO % Clean	% Salt Rejection	Problem Indicated	Cleaning Required
Less than 90% and a decrease of 10% or more since beginning the mission or last cleaning.	Unchanged	Silt or biological fouling	RO Detergent Cleaning (High pH cleaner AC-310 Detergent)

AC-310 membrane detergent cleaner is used for the RO detergent cleaning. Caustic is **NOT** used for this cleaning procedure. (Use of caustic for this cleaning procedure will destroy the RO membranes.)

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0023 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM DETERGENT CLEANING – OPERATION UNDER USUAL CONDITIONS

RO DETERGENT CLEANING

The procedures that follow describe the steps for performing RO Detergent Cleaning.

1. Set up the cleaning waste storage tank if needed as follows (see Figure 1):
    a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
    b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
    c. Connect an A-16 Adaptor to both connections on the waste tank. Close shut-off valve V-706 on both of the A-16 adaptors.
    d. Be sure that the zipper on the waste tank is zipped closed.

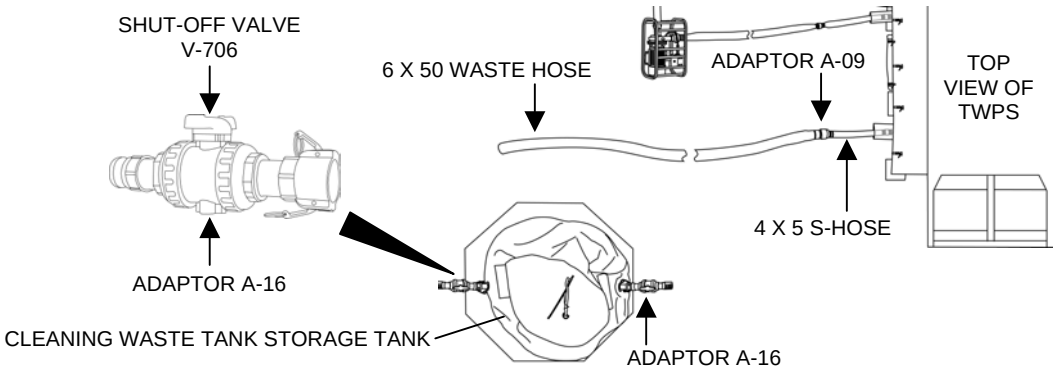

Figure 1. Cleaning Waste Tank Set-Up.

    e. In combat deployment the waste may be discharged into a depression in the ground located at an elevation below the TWPS.
2. Shutdown the TWPS to the Standby condition and drain the TWPS as follows (see Figure 2 for valve location):
    a. Perform a **Standby Shutdown Without Draining Down** as described WP 0017, Standby or Short Term Shutdown.
    b. Do not shut off the TQG and leave the air compressor on.
    c. Open main RO Feed Tank Drain Valve V-412 to drain the RO feed tank.
    d. Open RO Vessel Drain Valve V-408.
    e. Open HP Pump Outlet Drain Valves V-301 and V-302.
    f. Open RO Feed Piping Drain Valve V-304.
    g. Open RO Feed Pump Drain Valve V-211.
    h. Close Main RO Feed Tank Drain Valve V-412 and RO Feed Pump Drain Valve V-211 when the tank is drained.
    i. Close valves V-408, V-301, V-302, and V-304 when the RO vessels are drained.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0023 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM DETERGENT CLEANING – OPERATION
UNDER USUAL CONDITIONS

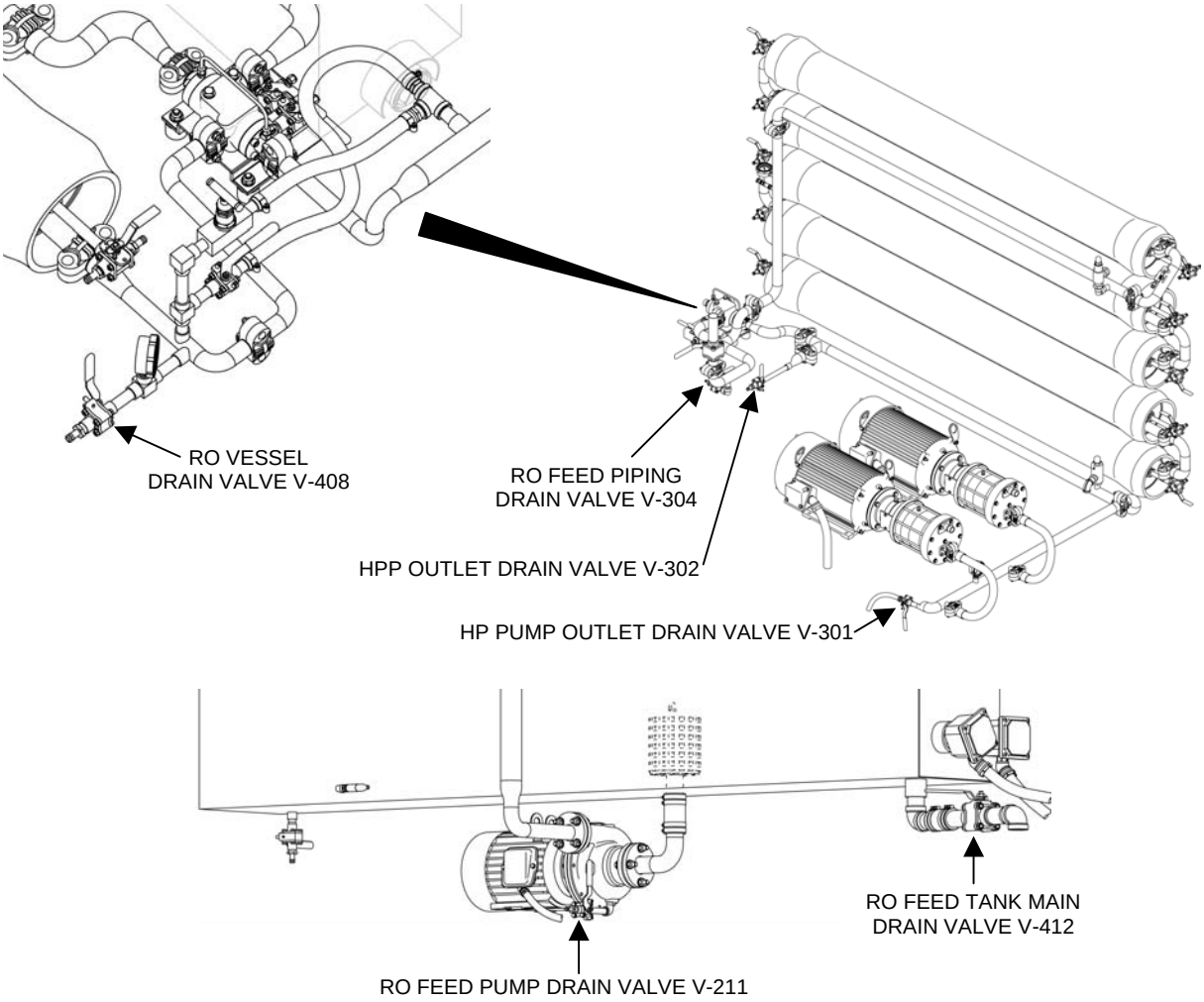

Figure 2. Valves for Shutdown to Standby and Drain for RO Detergent Cleaning.

3. Set the waste hoses for RO detergent cleaning as follows (see Figure 3):
    a. Disconnect 4 x 6 in. Adaptor A-09 and the 6 in. red-banded waste out hose from the 4 in x 5 ft. waste outlet hose of the TWPS
    b. Check Adaptors A-10, A-12, and A-16 to make sure that there are gaskets inside the female ends and that the gaskets are in good condition to ensure leak-tight connections.
    c. Connect 4 x 2 in. Adaptor A-10 to the 4 in x 5 ft. waste outlet hose.
    d. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 3):
        1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
        2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
        3) Connect Adaptor A-12 to the end of the last hose.

4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and close the valves on these two adaptors.
5) Make sure Valve V-706 on the other Adaptor A-16 on the waste tank is closed.

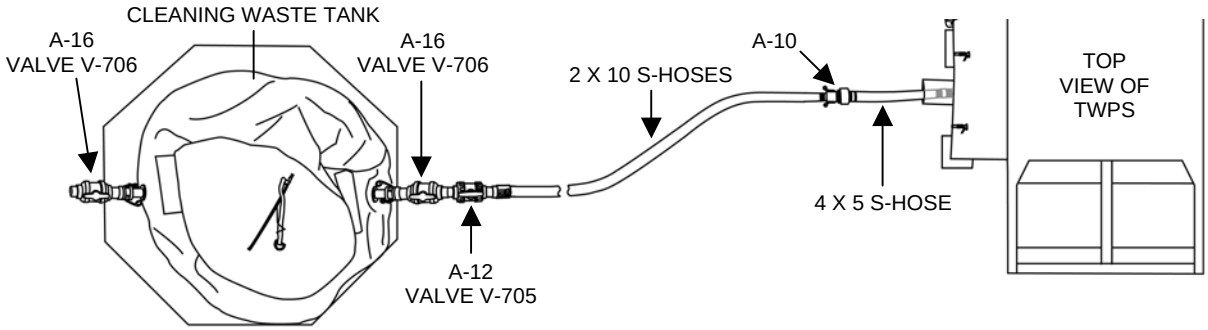

Figure 3. RO Detergent Cleaning Waste Hose Set-Up with the Cleaning Waste Tank.

e. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 4):
   1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
   2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
   3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
   4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
   5) Close Adaptor A-12 Valve V-705.
   6) Direct A-12 discharge into a depression in the ground away from the TWPS.

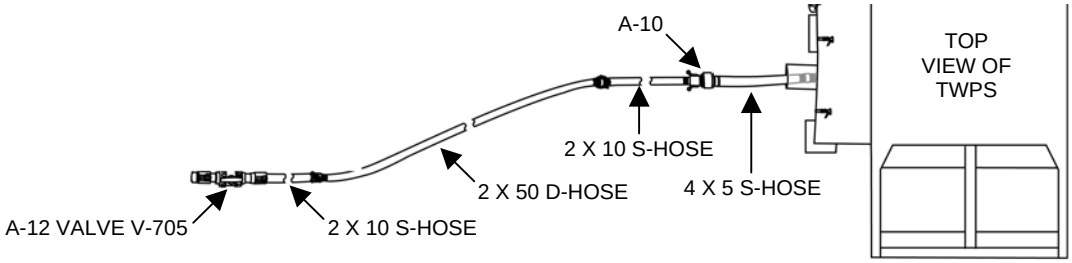

Figure 4. RO Detergent Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

4. Remove the 3-in.hose from the TWPS inlet and cap the inlet.
5. Prepare water for RO detergent cleaning as follows (see Figure 5 for valve location):
   a. Be sure Main RO Feed Tank Drain Valve V-412 is closed.
   b. Open Clean Mixing Valve V-703.
   c. Close HP Pump Inlet Valve V-212.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0023 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM DETERGENT CLEANING – OPERATION
UNDER USUAL CONDITIONS

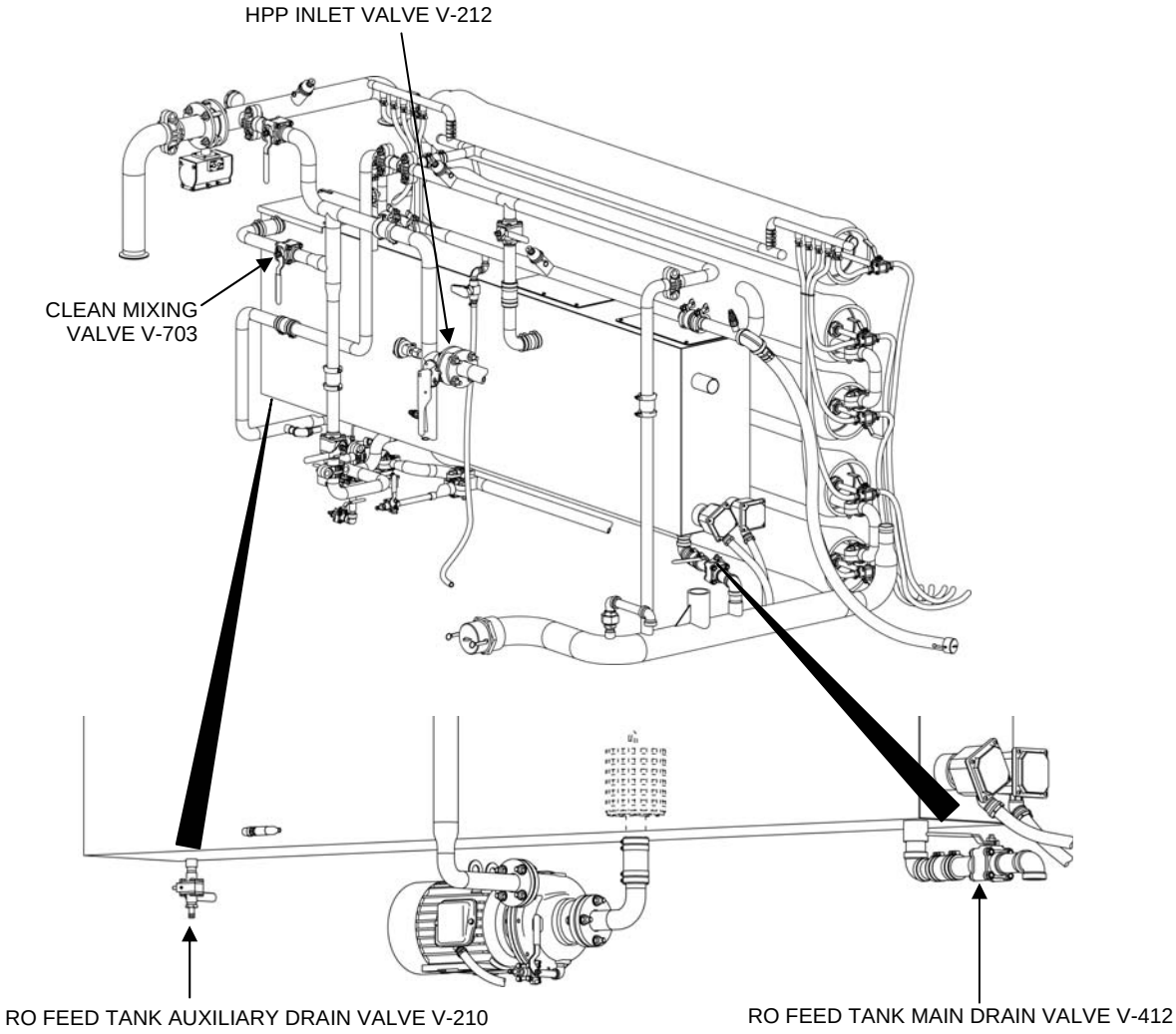

Figure 5. Valves for Preparing Water for RO Detergent Cleaning.

d. Set the SYSTEM MODE SWITCH to RO CLEAN.
e. Using the distribution system auxiliary hose, fill the RO feed tank to just over the top of the baffle plate (90-95% level) with product water from the distribution system.

WARNING

Chemical dust. Wear a dust mask, a protective face shield, and chemical gloves when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin. Promptly change contaminated clothing after accidental chemical exposure.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0023 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM DETERGENT CLEANING – OPERATION
UNDER USUAL CONDITIONS

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in RO membrane failure.

NOTE

Open one of the 12oz sodium bisulfite packets and pour it into the bottle provided in the BII. The bisulfite powder will be used to neutralize the chlorine in the product water when product water is required for cleaning.

f. Add one cap of sodium bisulfite from the sodium bisulfite bottle to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
g. Reset the RO Feed Tank Low Alarm.
h. Start the RO feed pump. This circulates the solution from the RO feed tank, through the RO feed pump, through Clean Mixing Valve V-703, and back into the tank to provide mixing when the membrane detergent cleaner is added to the water. Silence any alarms.
i. Set the Tank Heater Switch to AUTO 2.

6. Prepare the RO detergent cleaning solution as follows:

WARNING

Chemical hazard. Wear a dust mask, a protective face shield, chemical gloves, and a chemical apron when handling detergent cleaner. Avoid eye and skin contact. Keep water ready when handling. Avoid inhaling or ingesting dust. Wash thoroughly after handling. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Do not add caustic when detergent cleaning the RO.

NOTE

Rapid pouring of membrane detergent cleaner into the tank will cause the cleaner to stick to the tank bottom and not mix. Unmixed cleaner may be drawn to the pump and interrupt pumping.

a. Make sure a bucket of product water is placed in the operator station and also near the wastewater tanks to rinse any area of skin or clothing that comes in contact with acid cleaner.
b. Hook the RO feed tank cover open.
c. ***VERY SLOWLY*** add AC-310 Membrane Detergent Cleaner into the RO tank to ensure that it is mixed thoroughly with the water and to avoid splashing chemicals. Repeat until four (4) containers of detergent have been added. Maintain recirculation.
d. Close the RO feed tank cover.
e. Rinse the chemical gloves with product water in the bucket before removing.

7. Set valves to recirculate the detergent cleaning solution from the RO feed tank, through the RO feed pump, through the RO elements, and back to the RO feed tank as follows
    a. Be sure that Adaptor A-12 Valve V-705 on the 2 x 10 cleaning waste (suction) hoses is closed (see Figure 6 for valve location).

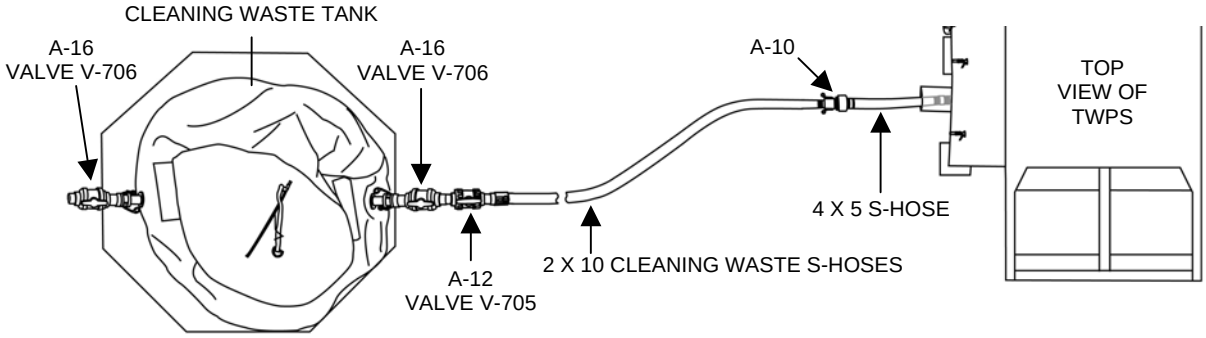

Figure 6. Adaptor A-12 Valve V-705 in Cleaning Waste Hose Line.

b. Close the Distribution Tank Adaptor A-15 Valve V-525 and disconnect the product hose (see Figure 7 for valve location).

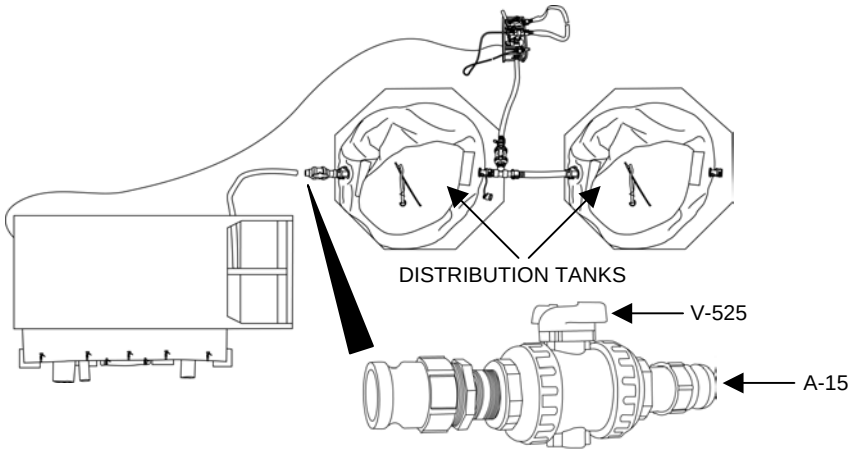

Figure 7. Distribution Tank Adaptor A-15 Valve V-525.

c. Direct the product utility hose to discharge into the RO feed tank through the open tank cover (see Figure 8).
d. Open Product Utility Valve V-511.
e. Open RO Clean Feed Valve V-701.
f. Open Clean Return Valve V-702.
g. Close Clean Mixing Valve V-703.
h. Continue recirculation for one hour. If extended cleaning is required, continue for up to 4 hours total. Refer to WP0016.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0023 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM DETERGENT CLEANING – OPERATION UNDER USUAL CONDITIONS

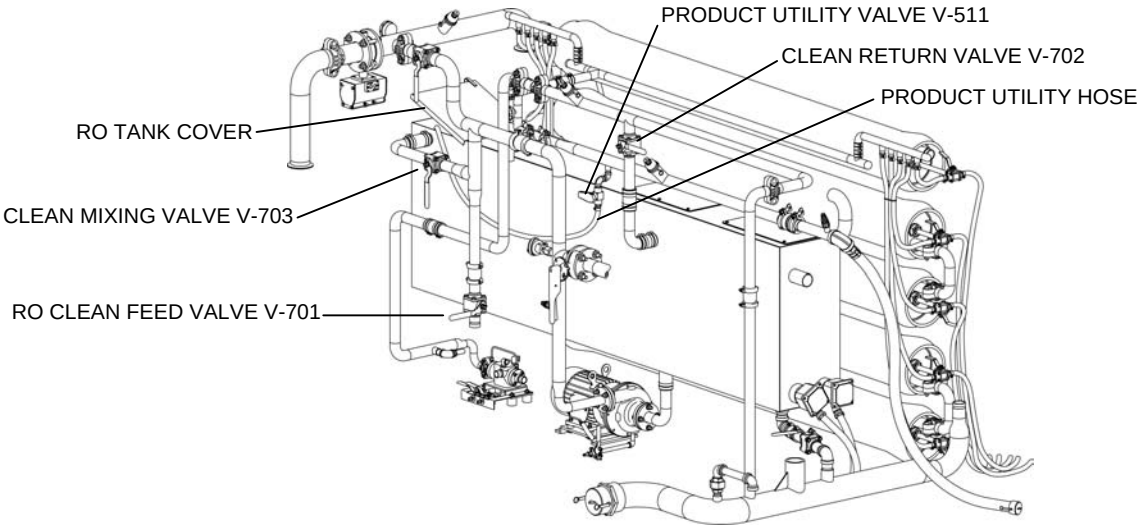

Figure 8. Valves for RO Detergent Cleaning.

8. Drain the RO vessels and RO feed tank as follows:
    a. Stop the RO feed pump.
    b. Close Clean Return Valve V-702.
    c. If using the cleaning waste storage tank, open valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 6 for valve location).
    d. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
    e. If not using the cleaning waste storage tank, open valve V-705 on Adaptor A-12 at the end of the cleaning waste hoses (see Figure 4).
    f. Start the RO feed pump.
        1) The cleaning solution is pumped from the tank through the RO and out through the waste hose.
        2) When the low level is reached, the pump stops and the alarm sounds. Silence the alarm.
    g. Open Main RO Feed Tank Drain Valve V-412.
    h. When drained, rinse the tank with product water from the distribution system auxiliary hose.
9. Flush the RO vessels with product water as follows:
    a. Close Main RO Feed Tank Drain Valve V-412.
    b. Using the distribution system auxiliary hose, fill the RO feed tank to the top of the baffle plate (90-95% level) with product water from the distribution system.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0023 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM DETERGENT CLEANING – OPERATION UNDER USUAL CONDITIONS

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in RO membrane failure.

c. Add one cap of sodium bisulfite to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
d. Reset the RO Feed Tank Low Alarm.
e. Start the RO Feed Pump. Silence any alarms.
    1) This flushes product water through the RO vessels and out the waste hose.
    2) When the low level is reached, the pump stops and the alarm sounds.

10. Repeat the product water flush of the RO vessels (steps 9b through 9e).
    a. While repeating the product water flush of the RO vessels, momentarily open the following drain valves (see Figure 9 for valve location):
        1) RO Feed Pump Drain Valve V-211
        2) High Pressure Pump Outlet Drain Valves V-301 and V-302
        3) Feed Piping Drain Valve V-304
        4) Turbocharger Feed Side Drain Valve V-303
        5) Turbocharger Reject Side Drain Valve V-410
    b. Momentarily opening and closing these valves allows enough water through the valves to flush them. Leave the valves in the closed position when completing the flushing process.

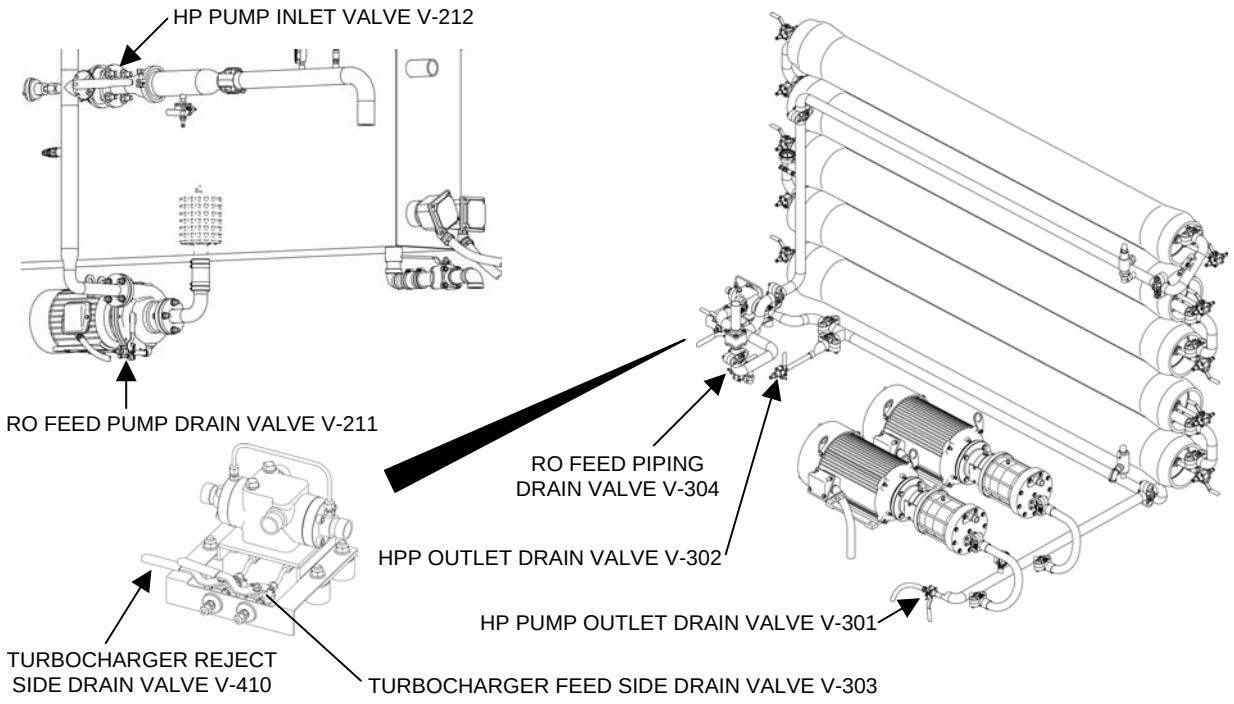

Figure 9. Valves for Second RO Product Water Flush.

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11. End the RO Detergent Cleaning as follows:
    a. Set SYSTEM MODE SWITCH to Standby.
    b. Close RO Clean Feed Valve V-701 (see Figure 8 for valve location).

WARNING

Chemical hazard. Wear a protective face shield, chemical gloves, and a chemical apron when handling detergent cleaner. Avoid eye and skin contact. Keep water ready when handling. Avoid inhaling or ingesting dust. Wash thoroughly after handling. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

    c. Open the HP Pump Inlet Valve V-212 (see Figure 9 for valve location).
    d. If using the cleaning waste storage tank, perform the following steps:
        1) Close valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 6 for valve location).
        2) Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
        3) Disconnect Adaptor A-12 from the Adaptor A-16.
        4) Direct the cleaning waste hose into an empty bucket, open Adaptor A-12 Valve V-705 and drain the contents of the hose into the bucket.
        5) Open the top of the waste tank and empty the bucket into the waste tank. Then close the tank.
    e. If not using the cleaning waste storage tank, simply leave valve V-705 on Adaptor A-12 at the end of the cleaning waste hoses open (see Figure 4).
    f. When drained, disconnect the cleaning waste hose from 4 x 2 Adaptor A-10.
    g. Rinse the inside of the hose sections with water from the distribution system auxiliary hose.
    h. Close Product Utility Hose Valve V-511 and remove the hose from the RO feed tank.
12. Refer to WP 0020, Cleaning, Preservation, and Cleaning Waste Neutralization and Pump-Out, for the procedures to neutralize the wastewater and pump it out of the cleaning waste storage tank.
13. Return to normal operation as follows:
    a. Remove the cap from the MF inlet and reconnect the 3-in. TPWS inlet hose.
    b. Remove Adaptor A-10 from the 4 x 5 waste out hose and rinse.
    c. Connect Adaptor A-09 and the 6-inch x 50-ft. red-banded waste out hose to the 4 x 5 waste hose (see Figure 1) for hose layout).
    d. Follow the procedure for **Startup After Short Term Shutdown** in **WP 0015** to return to normal operation.
    e. Discharge the product on the ground for 10 minutes before connecting the product hose to the distribution tank. This will flush any remaining cleaning chemicals from the product side of the RO.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0024 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING WITH REVERSE OSMOSIS
SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

INITIAL SETUP

Materials/Parts:
AC-120 Bisulfite, (1) 12 oz packet (Box #4)
Plastic Jar for bisulfite (Box #4)
Chemical scoop (Box #4)
AC-210 Citric Acid, (1) #20 bucket
Additional Citric Acid for cleaning waste neutralization if used, 28 lbs.
AC-310 Membrane Detergent Cleaner, (4) 1 Gallon Containers (Box #4)
AC-350 Caustic, (4) 1 Gallon Containers (Box #5)
Three 2" x 10' Cleaning Waste Hoses
Adaptor A-10 (Box #1)
Adaptor A-12 (Box #1)
Cleaning Waste Storage Module if used
- One 1500 gallon rinse waste tank
- Two Adaptors A-16 (A-TWPS, Box #1)

One 2-in. x 50-ft. raw water hose if cleaning waste storage module is not used
Personal protective gear (Box #1)
- Chemical apron, 2
- Face shield, 1
- Chemical gloves, 2 pair
- Dust mask, 1

Personnel Required
Two Operator/Crew
Equipment Condition
TWPS Operational
At least 2000 gallons of useable product water must be available in the distribution tanks

GENERAL

MF Cleaning with RO Acid Cleaning is performed whenever the TWPS is placed in a long-term term shut-down in preparation for storage. It should also be performed if the TWPS is to be shut down during deployment for longer than 54 hours and it is not certain how long the TWPS will be shut down before it is started up again. Cleaning in preparation for storage is performed regardless of the TMP, % Clean, and % Salt Rejection values. The purpose of cleaning in preparation for storage is to preserve and extend the useful life of the MF modules and RO elements.

MF cleaning with RO acid cleaning combines the MF cleaning and RO acid cleaning procedures in the following order:
- MF Backwash
- Acid Cleaning Solution Preparation
- MF Drain
- RO Acid Cleaning
- MF Acid Cleaning
- MF Caustic Detergent Cleaning

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0024 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING WITH REVERSE OSMOSIS
SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

MF CLEANING WITH RO ACID CLEANING

The procedures that follow describe the steps for performing MF Cleaning with RO Acid Cleaning.

MF Backwash

1. Set up the cleaning waste storage tank if needed as follows (see Figure 1):
    a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
    b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
    c. Connect an A-16 Adaptor to both connections on the waste tank. Close shut-off valve V-706 on both of the A-16 adaptors.
    d. Be sure that the zipper on the waste tank is zipped closed.

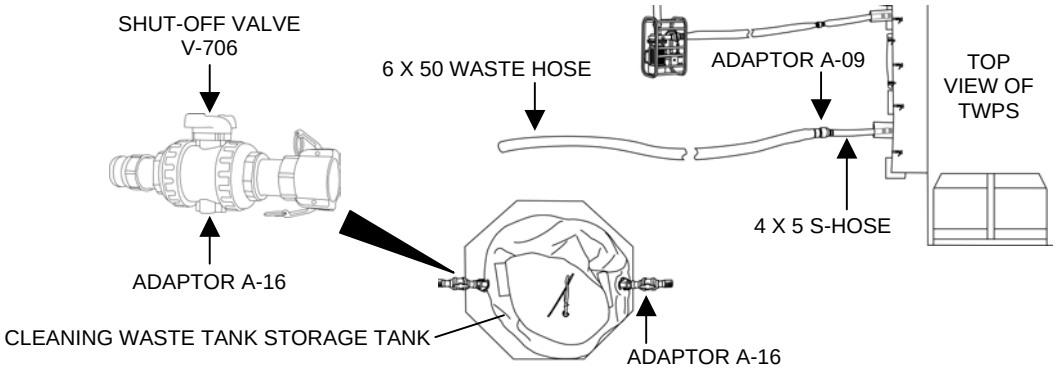

Figure 1. Cleaning Waste Tank Set-Up.

    e. In combat deployment the waste may be discharged into a depression in the ground located at an elevation below the TWPS.
2. Put citric acid in the cleaning waste tank for neutralizing the cleaning solution when the solution is flushed into the tank as follows:

WARNING

Acid chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

    a. Make sure a bucket of water is placed near the cleaning waste tank to rinse any area of skin or clothing that comes in contact with citric acid.
    b. Open the cleaning waste tank zipper.
    c. Open an extra AC-210 Citric Acid bucket. Pour all of the contents into the cleaning waste tank. If using a different source of citric acid, pour in 20 lbs of citric acid. (After all of the cleaning waste has been discharged into the tank, the pH will be approximately 9).
    d. Close the cleaning waste tank zipper.

e. Rinse the pitcher and chemical gloves in the bucket of water before removing the gloves.

3. Shutdown the TWPS to the Standby condition as follows (see Figure 2 for valve location):
   a. Perform a **Standby Shutdown Without Draining Down** as described by WP 0017, Standby or Short Term Shutdown.
   b. Do not shut off the TQG and leave the air compressor on.
   c. Stop the raw water pumps when the MF feed tank is 1/2 to 3/4 full.

WARNING

Do not open Main RO Feed Tank Drain Valve V-412. Failure to observe this warning will result in high-pressure backwash air and water discharging back into the tank when the MF is backwashed.

   d. Open RO Feed Tank Auxiliary Drain Valve V-210.
   e. Open RO Vessel Drain Valve V-408.
   f. Open Feed Piping Drain Valve V-304.
   g. Open HP Pump Outlet Drain Valves V-301 and V-302.
   h. Open RO Feed Pump Drain Valve V-211.

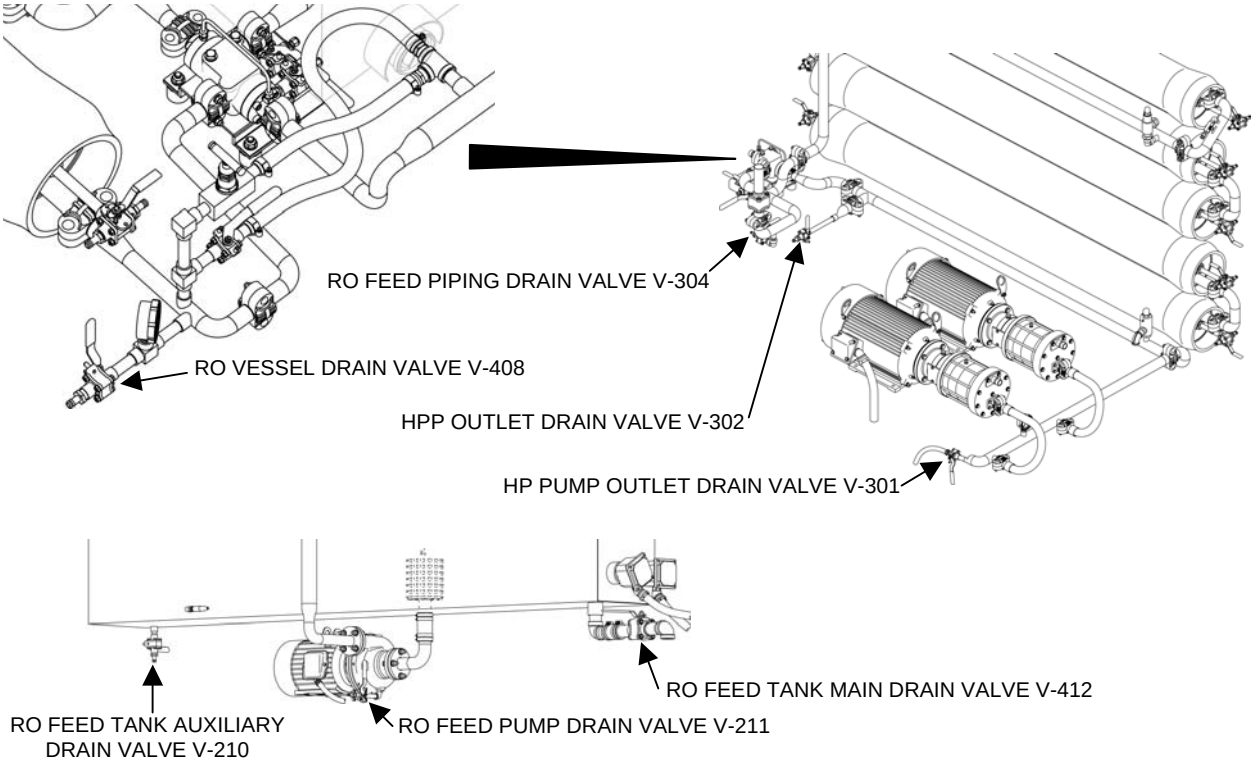

Figure 2. Valves for Shutdown to Standby for MF and RO Acid Cleaning.

2. Backwash the MF as follows:
    a. Backwash the MF in the MF CLEAN MODE.
        1) When the compressor stops (if running), set the MF CLEAN MODE SWITCH to BACKWASH.
        2) When the Clean light flashes, start the MF feed pump.
        3) Then push MF BACKWASH START.
            a) The automatic backwash cycles but ends without the rewet step.
            b) The backwash light flashes while the backwash is in progress. When finished, the backwash light is off.
            c) When the backwash is completed, the MF feed pump will stop.
        4) Drain the MF feed tank.
            a) Disconnect the MF feed pump suction hose from the MF feed tank. Pull the pump back.
            b) Lift the tank to drain it as completely as possible.
        5) Reconnect the MF feed pump suction hose to the MF feed tank.
        6) Fill the MF feed tank with product water from the product water distribution system by connecting the end of the product distribution hose to raw water Adaptor A-05 and opening V-107.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin. Promptly change contaminated clothing after accidental chemical exposure.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

NOTE

Open one of the 12 oz sodium bisulfite packets and pour it into the bottle provided in the BII. The bisulfite powder will be used to neutralize the chlorine in the product water when product water is required for cleaning.

        7) Using the bottle of bisulfite, fill the bottle cap with bisulfite twice and empty it into the MF feed tank while it is filling with product water. This neutralizes the chlorine in the product water that will be used for the second backwash and the MF rinse after MF acid cleaning.
    b. Backwash the MF a second time but with product water as follows:
        1) When the compressor stops, start the MF feed pump.
        2) Immediately push MF BACKWASH START for a second backwash using product water from the MF feed tank.
            a) The automatic backwash cycles but ends without the rewet step.
            b) The backwash light flashes while the backwash is in progress. When finished, the light is off.
            c) The MF feed pump stops when the backwash is completed.

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OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING WITH REVERSE OSMOSIS
SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

Acid Cleaning Solution Preparation

1. Remove the 3-in.hose from the TWPS inlet and cap the inlet.
2. Prepare water for the RO and MF acid clean as follows (see Figure 3 for valve location):
    a. Begin this step as soon as the second backwash is complete.
    b. Make sure the RO feed tank is drained.
    c. Close RO Vessel Drain Valve V-408.
    d. Close RO Feed Tank Drain Valves V-210 and V-412.
    e. Open Clean Mixing Valve V-703
    f. Close RO Feed Piping Drain Valve V-304.
    g. Close HPP Outlet Drain Valves V-301 and V-302.
    h. Close RO Feed Pump Drain Valve V-211.
    i. Close HPP Inlet Valve V-212.

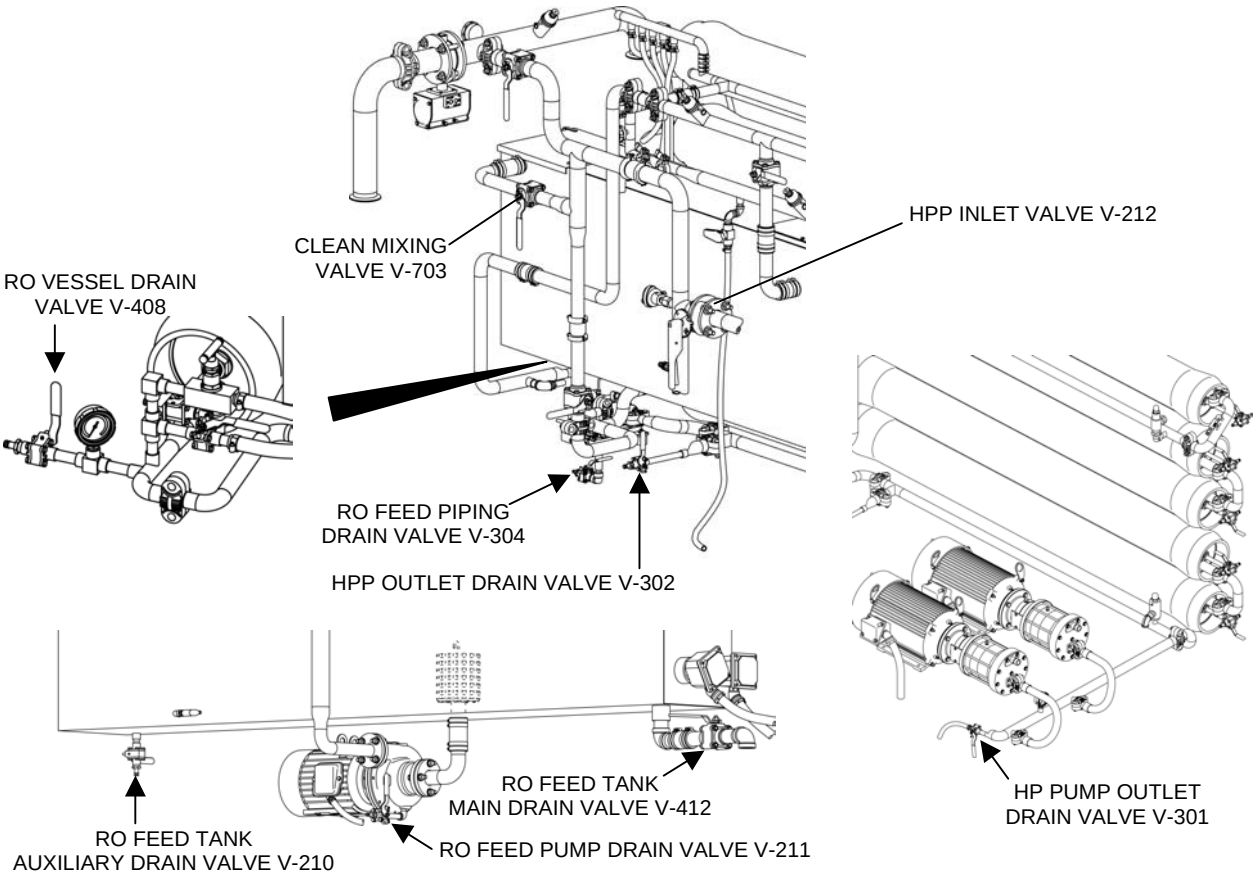

Figure 3. Valves for Preparing Acid Cleaning Solution for MF and RO Acid Cleaning.

    j. Using the distribution system auxiliary hose, fill the RO feed tank to just over the top of the baffle plate (90-95% level) with product water from the distribution system.

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MICRO-FILTRATION SYSTEM CLEANING WITH REVERSE OSMOSIS
SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

WARNING

Chemical dust. Wear a dust mask, a protective face shield, and chemical gloves when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

k. Add one cap of sodium bisulfite from the sodium bisulfite bottle to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
l. Set the System Mode switch to RO CLEAN.
m. Reset the RO Feed Tank Low Alarm.
n. Start the RO feed pump. This circulates the solution from the RO feed tank, through the RO feed pump, through Clean Mixing Valve V-703, and back into the tank to provide mixing when the citric acid is added to the water. Silence any alarms.
o. Set the Tank Heater Switch to AUTO 2.

3. Prepare the acid cleaning solution as follows:

WARNING

Acid chemical. Wear a dust mask, a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

a. Make sure a bucket of product water is placed in the operator station and also near the wastewater tanks to rinse any skin or clothing that comes in contact with acid cleaner.
b. Hook the RO feed tank cover open.
c. Open the AC-210 Citric Acid bucket. Use the chemical scoop and ***VERY SLOWLY*** pour the AC-210 Citric Acid into the RO tank to ensure that it is mixed thoroughly with the water and to avoid splashing chemicals. Repeat until the bucket is empty. Maintain recirculation.
d. Close the RO feed tank cover.
e. Rinse the scoop and then the chemical gloves with product water in the bucket before removing.

MF Drain

After preparing the acid cleaning solution, check that the MF Backwash light is off indicating that the 2nd backwash is done. Then continue as follows:

1. Drain Down #1: Drain the water from the MF modules as follows:
   a. Stop the RO feed pump.
   b. Set the Tank Heater Switch to OFF.

c. Set the System Mode switch to STANDBY.
d. Set the MF CLEAN Switch to DRAIN #1.
   1) After a 5 second delay, PLC automatic control purges water from the MF with air.
   2) The PLC automatically cycles valves back to Standby at the end of drain down.
   3) The MF CLEAN light flashes during operation and turns off when the drain down is complete.

2. When complete, set the MF CLEAN switch to OFF.
3. Open the following MF vents/ drains (see Figure 4 for valve location):
   a. Open MF Vent Valve V-114.
   b. Open MF Filtrate Drain Valve V-203.
   c. Open MF Shell Drain Valve V-403.

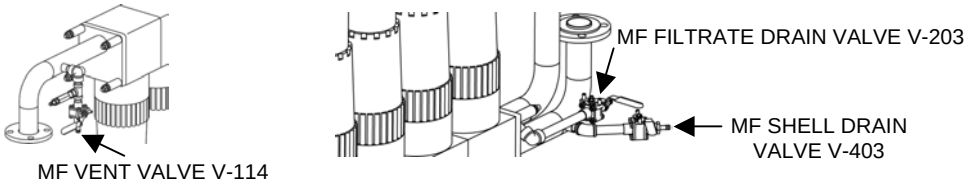

Figure 4. MF Vent / Drain Valve Location.

RO Acid Cleaning

1. Set the waste hoses for acid cleaning as follows (see Figure 5).
   a. Disconnect the 6 in. waste out hose with 4 x 6 Adaptor A-09 from the 4 in. x 5 ft. waste outlet hose at the waste outlet of the TWPS.
   b. Check Adaptors A-10, A-12, and A-16 to make sure that there are gaskets inside the female ends and that the gaskets are in good condition to ensure leak-tight connections.
   c. Connect 4 x 2 Adaptor A-10 to the 4 in. x 5 ft. waste outlet hose.
   d. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 5):
      1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
      2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
      3) Connect Adaptor A-12 to the end of the last hose.
      4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and close the valves on these two adaptors.
      5) Make sure Valve V-706 on the other Adaptor A-16 on the waste tank is closed.

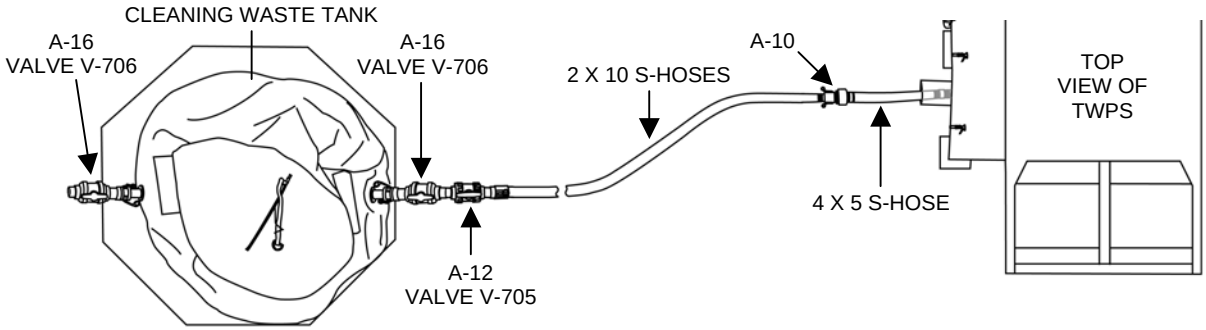

Figure 5. MF Acid Cleaning Waste Hose Set-Up with the Cleaning Waste Tank.

d. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 6):
   1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
   2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
   3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
   4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
   5) Close Adaptor A-12 Valve V-705.
   6) Direct A-12 discharge into a depression in the ground away from the TWPS.

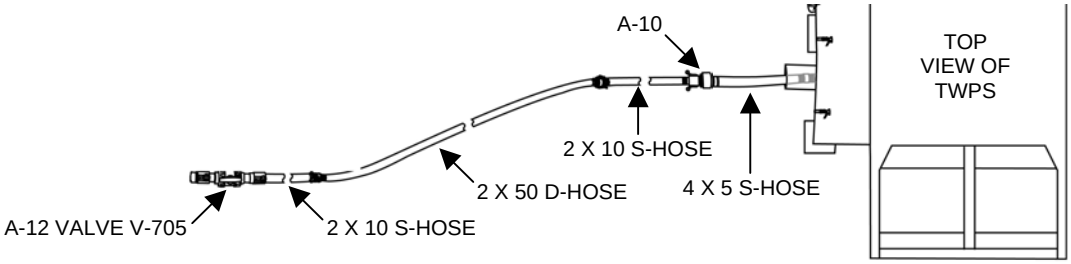

Figure 6. MF Acid Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

NOTE

When cleaning in preparation for storage (stand down from deployment), the acid cleaning solution is first used to clean the RO. Following the RO acid cleaning, the acid cleaning solution is then used to acid clean the MF.

2. Set valves for RO acid cleaning as follows:
   a. Make sure the RO feed pump is off.
   b. Be sure that Adaptor A-12 Valve V-705 on the 2 x 10 cleaning waste (suction) hoses is closed (see Figure 5 or Figure 6) for valve location).

c. Close the distribution tank Adaptor A-15 valve V-525 and disconnect the product hose (see Figure 7).

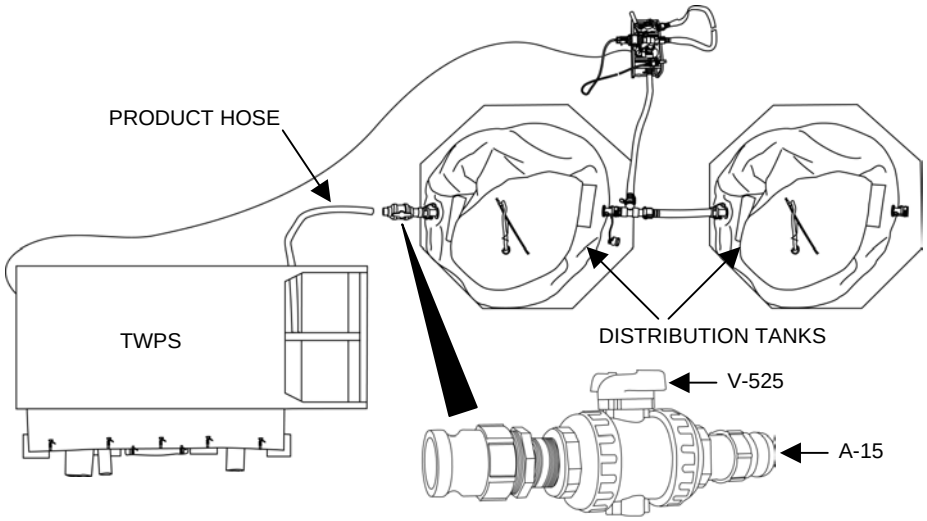

Figure 7. Distribution Tank Adaptor A-15 Valve V-525.

d. Direct the product utility hose to discharge into the RO feed tank through the open tank cover (see Figure 8).
e. Open the Product Utility Valve V-511.
f. Open RO Clean Feed Valve V-701.
g. Open Clean Return Valve V-702.
h. Close Clean Mixing Valve V-703.

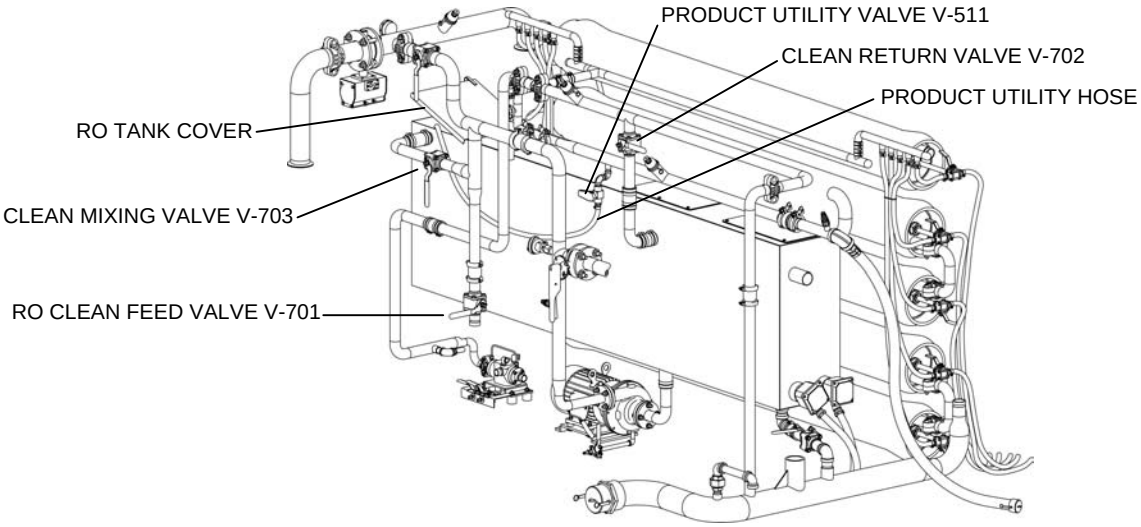

Figure 8. Valves For RO Acid Cleaning.

3. Recirculate the RO acid cleaning solution from the RO feed tank, through the RO feed pump, through the RO elements, and back to the RO feed tank as follows:
    a. Set the SYSTEM MODE SWITCH to RO CLEAN.
    b. Start the RO feed pump.
    c. Set the Tank Heater switch to AUTO 2.
    d. The RO reject flow indicates whether or not cleaning solution is recirculating.
    e. Continue recirculation for one hour.
4. Force-air drain the RO elements as follows:
    a. Stop the RO feed pump.
    b. Turn the Tank Heater switch to OFF.
    c. Close RO Clean Feed Valve V-701.
    d. Close Product Utility Valve V-511
    e. Make sure RO Air Purge Valve V-913 is closed (see Figure 9 for valve location).
    f. Connect one end of the auxiliary air hose (from BII) to the quick-disconnect fitting in Air System Section 1 above the compressor opposite Pressure Gauge PI-902.
    g. Connect the other end of the auxiliary air hose to the quick-disconnect fitting at RO Air Purge Valve V-913 in the feed inlet to RO vessel #1.
    h. Slowly and only partially open RO Purge Valve V-913. This will force most of the cleaning solution out of the RO, back through Clean Return Valve V-702, and into the RO feed tank so that it can be used to clean the MF.
    i. Close Valve V-913 when air is observed to be discharging into the RO feed tank.
    j. Disconnect the auxiliary air hose first at Valve V-913 then at Air System Section 1. Return the auxiliary air hose to the BII.

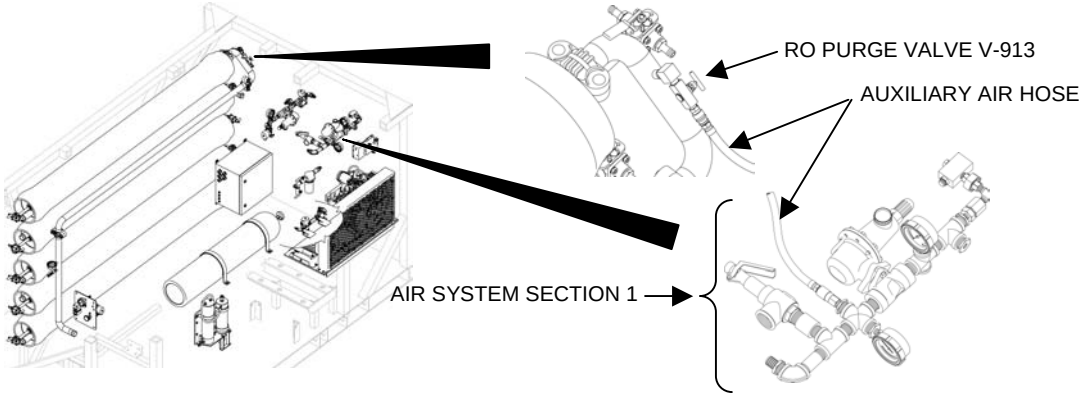

Figure 9. Auxliary Air Hose Connections for Force-Air Draining the RO Elements.

5. End the RO acid cleaning as follows:
    a. Set the SYSTEM MODE SWITCH to STANDBY.
    b. Place the hose from RO Vessel Drain Valve V-408 into a bucket. Open the valve. Drain the remaining solution into the bucket. Close the valve when draining is completed.
    c. Place the hose from HP Pump Outlet Drain Valve V-302 into a bucket. Open the valve. Drain the remaining solution into the bucket. Close the valve when draining is completed.
    d. Place the hose from RO Feed Piping Drain Valve V-304 into a bucket. Open V-304 and V-701. Drain the remaining solution into the bucket. Close both valves when draining is completed.
    e. Empty the bucket(s) into the RO feed tank.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0024 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING WITH REVERSE OSMOSIS
SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

MF Acid Cleaning

1. Set valves for MF acid cleaning as follows (see Figure 10 for valve location):
   a. Close MF Vent Valve V-114.
   b. Open MF Clean Feed Valve V-704.
   c. Be sure that Clean Return Valve V-702 is open.
   d. Be sure that Clean Mixing Valve V-703 is closed.
   e. Close MF Filtrate Drain Valve V-203.
   f. Close MF Shell Drain Valve V-403.
   g. Be sure that Adaptor A-12 Valve V-705 on the cleaning waste hose is closed (see Figure 5 or Figure 6 for valve location).

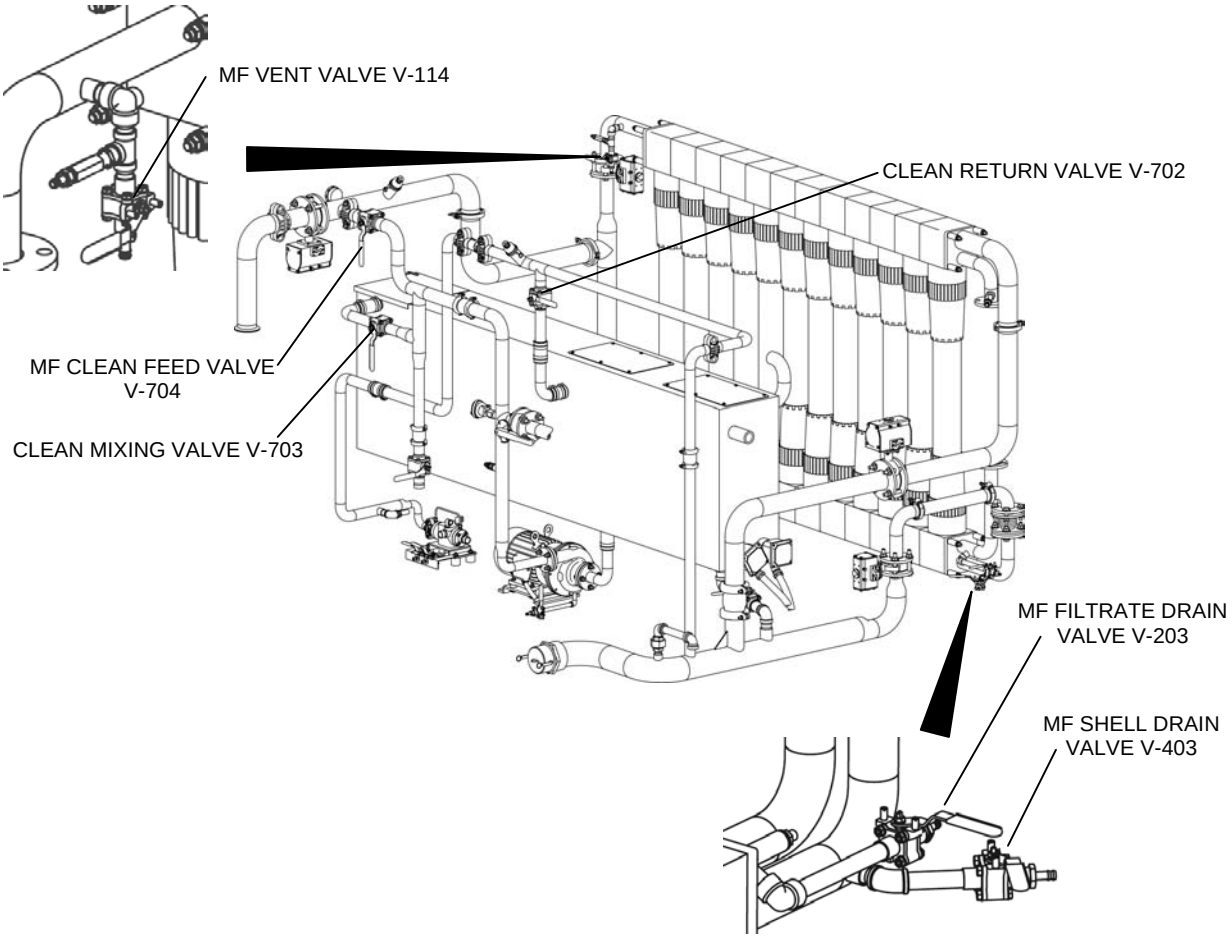

Figure 10. Valves for MF Acid Cleaning.

2. Recirculate the acid cleaning solution through the MF as follows:
    a. Set the MF Clean Switch to FILL/RECIRC. The RO pump starts to automatically fill the MF modules and establish recirculation through the MF modules.
    b. Turn the Tank Heater Switch to AUTO 2. The heaters heat the cleaning solution and automatically cut off when the temperature reaches 110 degrees F.
    c. Check that there is an indication of MF Flow at the OCP display. If not, make sure that the valves are properly positioned.

NOTE

The CLEAN light flashes during the cleaning cycle and turns off when the cycle is completed (approximately 26 minutes). The RO pump stops. If the heaters were on, they also turn off at the completion of the cleaning cycle.

Extended cleaning is required if the operator has chosen to wait 40 hours after the first transmembrane pressure (TMP) alarm, the maximum TMP has been exceeded, the water temperature does not reach at least 100° F during the cleaning cycle, or the TMP is higher than the normal reading after cleaning (3 to 5 psi at 50 to 60 gpm MF Feed Flow).

    d. If extended cleaning is required, perform the following steps:
        1) Set the MF Clean switch to SOAK. This interrupts the clean cycle and leaves the cleaning solution in the MF modules to soak.
        2) Soak for 15 minutes.
        3) Set the MF Clean switch back to FILL/RECIRC for one minute.
        4) Repeat the SOAK / FILL/RECIRC sequence for a total of one hour.
    e. Set the MF Clean switch back to FILL/RECIRC to continue with the normal cycle and timing to completion.
    f. While cleaning the MF modules, refill the MF feed tank with product water using the distribution system auxiliary hose. This water will be used to rinse the MF system.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

    g. Add two caps of bisulfite from the bisulfite bottle to the MF feed tank while refilling.
3. Drain #2: Drain the acid cleaning solution from the RO feed tank and MF modules as follows:
    a. Set the Tank Heater Switch to OFF.
    b. Close Clean Return Valve V-702 (see Figure 10 for valve location).
    c. If using the cleaning waste storage tank, open valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 5 for valve location).

d. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
e. If not using the cleaning waste storage tank, open valve V-705 on Adaptor A-12 at the end of the cleaning waste hoses (see Figure 6).
f. Set the MF Clean Switch to Drain #2. The RO feed pump starts and flushes the cleaning solution from the tank through the MF and out the waste hose.

NOTE

When the RO feed tank level reaches the Low Level Switch, the alarm sounds and the RO feed pump stops. Occasionally the RO pump will lose prime before reaching the low level. In this case, if the RO pump does not stop within 15 seconds from when the tank level reads zero, stop the RO pump.

CAUTION

Failure to close MF Clean Feed Valve V-704 at this point will result in water flow back into the RO feed tank rather than out as required.

g. Wait for the RO feed pump to stop, then close MF Clean Feed Valve V-704 (see Figure 10 for valve location).

4. Drain #3: Set the MF Clean switch to Drain #3 to purge the remaining acid cleaning solution from the MF modules with air as follows:
   a. A normal air purge drain down cycle automatically sequences.
   b. Cleaning solution drains out through the cleaning waste hoses.
   c. During the Drain #3 cycle, slightly open MF Clean Feed Valve V-704 for just a moment to push cleaning solution out of the cleaning bypass piping.
   d. The Clean light flashes during the cycle and turns off when complete.
5. Rinse the MF system with product water as follows:
   a. Remove the cap from the MF inlet and reconnect the 3-in. TPWS inlet hose.
   b. Set the MF Clean switch to RINSE.
      1) This initiates an automatic rinse cycle using product water from the MF feed tank. The Clean light flashes during this cycle.
      2) The MF feed pump starts automatically.
      3) The MF feed pump stops.
      4) The Clean Light turns off at the end of the cycle.
   c. The cycle ends in STANDBY (the standby light comes on.)
6. End the MF Acid Clean by setting the MF Clean switch to OFF.

WARNING

Acid chemical. Wear a protective face shield, chemical gloves, and a chemical apron when there is a potential for contact with citric acid solution. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

7. Flush the RO feed tank with product water as follows (see Figure 11 for valve location):
    a. Open Main RO Feed Tank Drain Valve V-412 to drain the remaining solution.
    b. Flush the RO feed tank with water using the distribution system auxiliary hose to remove residual cleaning solution.
    c. While flushing the RO feed tank:
        1) Place the hose from RO Feed Pump Drain Valve V-211 into a bucket. Open the valve just long enough to flush the pump, then close the valve.
        2) Place the hose from HP Pump Outlet Drain Valve V-301 into a bucket. Open the valve. Drain the remaining solution into the bucket. Close the valve when draining is completed.
        3) Place the hose from RO Feed Piping Drain Valve V-304 into a bucket. Open V-304 and V-701. Drain the remaining solution into the bucket. Close both valve when draining is completed.
        4) Place the hose from HP Pump Outlet Drain Valve V-302 into a bucket. Open the valve. Drain the remaining solution into the bucket. Close the valve when draining is completed.
        5) Empty the bucket(s) into the 1500-gallon cleaning waste storage tank.
    d. After flushing the RO tank, allow the tank to drain then close RO Tank Drain Valve V-412.

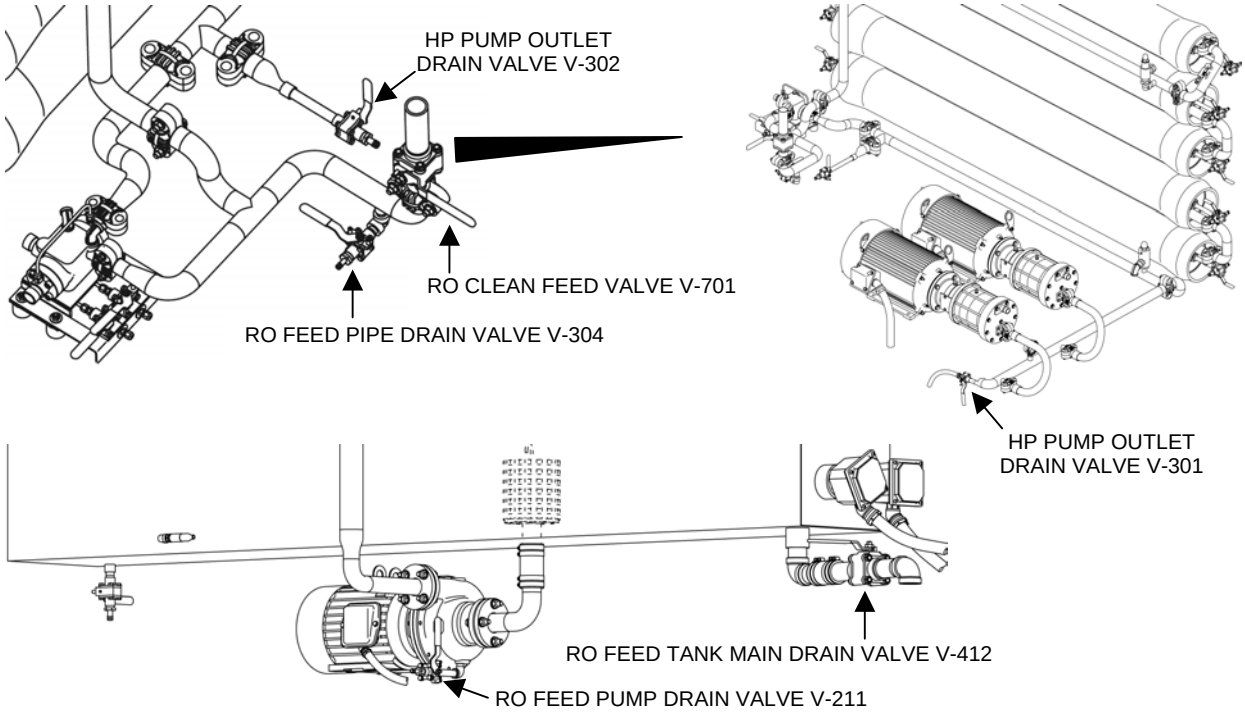

Figure 11. Valves for Flushing the RO Feed Tank.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0024 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING WITH REVERSE OSMOSIS
SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

MF Caustic Detergent Cleaning

1. Close Adaptor A-12 valve V-705 on the cleaning waste hoses.
2. Prepare water for MF caustic detergent cleaning as follows:
   a. Remove the 3-in. hose from the TWPS inlet connection and cap the inlet connection.
   b. Be sure RO Feed Tank Drain Valve V-412 is closed (see Figure 11 for valve location).
   c. Open Clean Mixing Valve V-703 (see Figure 10 for valve location).
   d. Using the distribution system auxiliary hose, fill the RO feed tank to just over the top of the baffle plate (90-95% level) with product water from the distribution system.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for cleaning will result in MF membrane failure.

   e. Add one cap of sodium bisulfite from the bisulfite bottle to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
   f. Set the System Mode switch to RO CLEAN.
   g. Reset the RO Feed Tank Low Alarm.
   h. Start the RO feed pump. This circulates the solution from the RO feed tank, through the RO feed pump, through clean mixing valve V-703, and back into the tank to provide mixing when the membrane detergent cleaner and caustic are added to the water.
   i. Silence any alarms.
   j. Set the Tank Heater switch to AUTO 2.
3. Prepare the caustic detergent cleaning solution as follows:

WARNING

Caustic chemical. Wear a protective face shield, chemical gloves, and chemical apron when handling caustic solution. Contact with caustic will result in severe chemical burns. Keep water ready when handling. Avoid inhaling chemical fumes. If caustic spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in severe irritation of the nose, throat and eyes. Contact with skin will result in severe chemical burns if not rinsed immediately.

NOTE

Rapid pouring of detergent into the tank will cause the detergent to stick to the tank bottom and not mix. Unmixed detergent may be drawn to the pump and interrupt pumping.

   a. Make sure a bucket of product water is placed in the operator station to rinse any area of skin or clothing that comes in contact with caustic.

b. Hook the RO feed tank cover open.
c. **VERY SLOWLY** add AC-310 Membrane Detergent Cleaner into the RO feed tank as follows:
    1) Open a container of AC-310 Detergent and very slowly pour it into the RO feed tank. Pour into the area of water flow from the mixing recirculation water flow.
    2) Continue until all four of the detergent containers have been emptied.
d. Add AC-350 Caustic into the RO feed tank as follows:
    1) Take one caustic container and remove the outer plastic bags.
    2) Hold the container inside the RO feed tank and remove the cap.
    3) Hold the container near the water (but not underwater) to avoid splashing and slowly empty the container into the water.
    4) When empty, rinse with water in the tank (now it may be held under water) then reinstall the cap.
    5) Immediately rinse the outside of the container in the bucket containing product water before discarding.
    6) Repeat until 4 containers of caustic have been added to the water in the tank.
e. Close the RO feed tank cover.
f. Rinse the chemical gloves in the bucket of product water before removing.
g. After mixing, stop the RO feed pump.
h. Turn the Tank Heater Switch to OFF.
i. Set System Mode switch to STANDBY.

4. Set valves for MF caustic detergent cleaning as follows (see Figure 12 for valve location):
    a. Open MF Clean Feed Valve V-704.
    b. Open Clean Return Valve V-702.
    c. Close Clean Mixing Valve V-703.
    d. Be sure that Valve V-705 on Adaptor A-12 on the cleaning waste hoses is closed (see Figure 5 or Figure 6 for valve location).

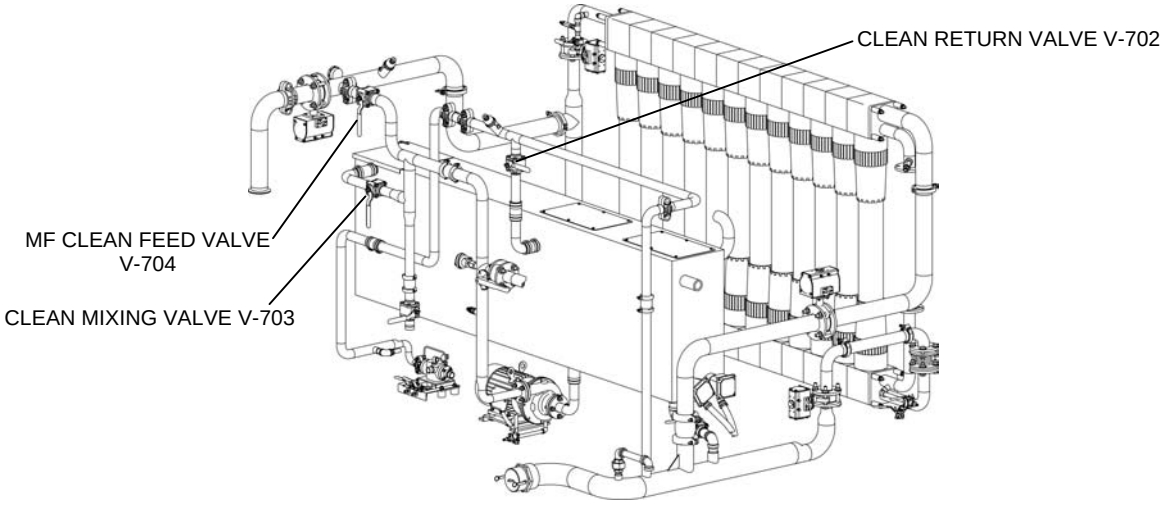

Figure 12. Valves for MF Caustic Detergent Cleaning.

5. Recirculate the caustic detergent cleaning solution through the MF modules as follows:
    a. Set the MF Clean switch to FILL/RECIRC. The RO pump starts to automatically fill the MF modules and establish recirculation through the MF modules.
    b. Turn the Tank Heater switch to AUTO 2. The heaters heat the cleaning solution and automatically cut off when the temperature reaches 110 degrees F.
    c. Check that there is an indication of MF flow. If not, make sure that the valves are properly positioned.

NOTE

The CLEAN light flashes during the cleaning cycle and turns off when the cycle is completed (approximately 26 minutes). The RO pump stops. If the heaters were on, they also turn off at the completion of the cleaning cycle.

Extended cleaning is required if the operator has chosen to wait 40 hours after the first transmembrane pressure (TMP) alarm, the maximum TMP has been exceeded, the water temperature does not reach at least 100° F during the cleaning cycle, or the TMP is higher than the normal reading after cleaning (3 to 5 psi at 50 to 60 gpm MF Feed Flow).

    d. If extended cleaning is required, perform the following steps:
        1) Set the MF Clean switch to SOAK. This interrupts the clean cycle and leaves the cleaning solution in the MF modules to soak.
        2) Soak for 15 minutes.
        3) Set the MF Clean switch back to FILL/RECIRC for one minute.
        4) Repeat the SOAK / FILL/RECIRC sequence for a total of one hour.
    e. Set the MF Clean switch back to FILL/RECIRC to continue with the normal cycle and timing to completion.
6. Drain #2: Drain the caustic cleaning solution from the RO feed tank and MF modules as follows (see Figure 12 for valve location):
    a. Set the Tank Heater switch to OFF.
    b. Close Clean Return Valve V-702.
    c. If using the cleaning waste storage tank, open valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 5 for valve location).
    d. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
    e. If not using the cleaning waste storage tank, open valve V-705 on Adaptor A-12 at the end of the cleaning waste hoses (see Figure 6).
    f. Set the MF Clean switch to DRAIN #2. The RO feed pump starts and flushes the cleaning solution from the tank through the MF and out the waste hose.

NOTE

When the tank level reaches the Low Level Switch, the alarm sounds and the RO feed pump stops. Occasionally the RO pump will lose prime before reaching the low level. In this case, if the RO pump does not stop within 15 seconds from when the tank level reads zero, stop the RO pump.

CAUTION

Failure to close MF Clean Feed Valve V-704 will result in water flow back into the RO feed tank rather than out as required.

g. Wait for the RO feed pump to stop, then close MF Clean Feed Valve V-704.

7. Drain #3: Set the Clean switch to Drain #3 to purge the remaining caustic detergent cleaning solution from the MF modules with air as follows:
   a. A normal air purge drain down cycle automatically sequences.
   b. Cleaning solution drains out through the cleaning waste hoses.
   c. During the Drain #3 cycle, slightly open MF Clean Feed Valve V-704 for just a moment to push cleaning solution out of the cleaning bypass piping.
   d. The Clean light flashes during operation and turns off when complete.
8. Flush the RO feed tank with product water as follows (see Figure 13 for valve location):
   a. Open Main RO Feed Tank Drain Valve V-412 to drain any remaining caustic detergent cleaning solution from the tank to the waste out hose.
   b. Flush the tank with water using the distribution system auxiliary hose to remove residual cleaning solution.
   c. While flushing the RO Feed Tank:
      1) Place the hose from RO Feed Pump Drain Valve V-211 into a bucket. Open the valve just long enough to flush the pump, then close the valve.

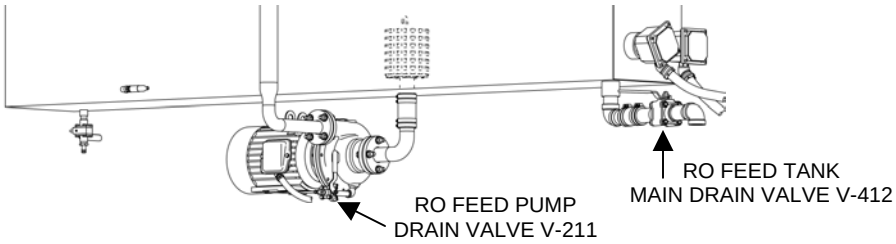

Figure 13. Valves for Flushing RO Feed Tank.

      2) Place the hoses from MF Filtrate Drain Valve V-203 and MF Shell Drain Valve V-403 into a bucket (see Figure 14 for valve location). Open the valves and drain the remaining solution into the bucket. Close the valves when draining is complete.

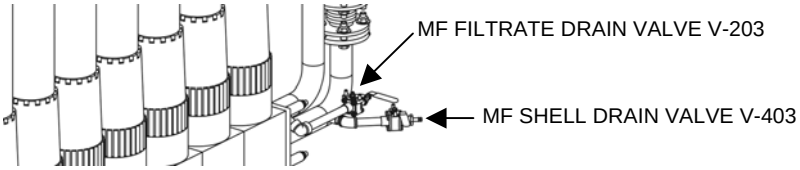

Figure 14. MF Filtrate and Shell Drain Valves.

      3) When water stops draining from a drain tube, disconnect the tube from its valve and hold the end up to drain the residual water from the tube. Then reconnect the tube to its valve. (It is not necessary to perform this step for a drain tube that is secured to its valve with a hose clamp.)
      4) Empty the bucket into the 1500-gallon cleaning waste storage tank.
   d. After flushing the RO tank, allow the tank to drain then close RO Tank Drain Valve V-412.
9. Set the MF Clean switch to OFF.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0024 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM CLEANING WITH REVERSE OSMOSIS
SYSTEM ACID CLEANING – OPERATION UNDER USUAL CONDITIONS

PRESERVATION

1. Perform the RO preservation procedures as described in WP 0025, RO System Preservation.
2. The MF is preserved as a result of the caustic detergent cleaning steps in this procedure. At the end of the MF Caustic Detergent Cleaning, the caustic detergent cleaning solution was drained and then air-purged from the MF modules. The MF modules are NOT rinsed with product water. Residual caustic detergent cleaning solution left in the MF fibers serves to preserve the fibers until the next time the TWPS is deployed.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS REVERSE OSMOSIS SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

0025 00

INITIAL SETUP

Materials/Parts:

AC-120 Bisulfite Bucket, 10 lb.
Measuring Bottle for Bisulfite (Box #4)
Chemical scoop (Box #4)
Three 2-in. x 10 ft. Cleaning Waste Hoses
Adaptor A-10 (Box #1)
Adaptor A-12 (Box #1)
Cleaning Waste Storage Module if used

- One 1500 gallon cleaning waste storage tank
- Two adaptors A-16 (A-TWPS, Box #1)

One 2 in. x 50 ft. raw water discharge hose if cleaning waste storage module not used
Personal protective gear (Box #1)

- Two chemical aprons
- One face shield
- Two chemical gloves
- One dust mask

Personnel Required:

Two Operators/Crew

Equipment Condition:

Short Term Shutdown, WP0017, has been performed, the TQG and Air Compressor are left on
All drain and vent valves closed as instructed in WP0018.
Product 3-way valves set to normal operating position as instructed in WP0018.
WP0024 must be completed prior to performing **RO Preservation in Preparation for Storage**.
At least 150 gallons of useable product water must be available in the distribution tanks

GENERAL

RO preservation procedures are performed when the TWPS is placed in an extended shutdown (shutdown longer than 54 hours during deployment) or when the TWPS is shutdown in preparation for storage (stand down from deployment). Preservation is necessary to ensure that biological growth does not become established on the RO element membrane surfaces during the shutdown period. If they are not preserved and a biological film grows on the membranes, the TWPS will not meet performance requirements when placed back in operation. If the biological growth is severe enough, the RO elements will require extensive cleaning/soaking and may need to be replaced.

Sodium bisulfite is used as the preservative for the RO membranes. For an extended shutdown, a bisulfite preservative solution is flushed through the RO elements once and discharged into a waste tank. For a shutdown in preparation for storage, the bisulfite preservative solution is recirculated through the RO elements for a period of one hour, then discharged into a waste tank.

The procedures covered in this work package include:

- RO Preservation Flush for Extended Shutdown
- RO Preservation in Preparation for Storage (WP0024 procedures must first be performed)

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0025 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

RO PRESERVATION FLUSH FOR EXTENDED SHUTDOWN

NOTE

If the daily high temperatures are lower than 40 degrees F and the TWPS is shaded from direct sun exposure, biological growth is unlikely to occur. Under these conditions, it would not be necessary to preserve the RO membranes and MF fibers during an extended shut-down.

This procedure is a part of the extended shutdown procedure (WP 0018). Follow the extended shutdown procedure and complete the preservation in sequence as instructed.

1. Make sure the cleaning waste storage tank is set up as follows (see Figure 1):
   a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
   b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
   c. Connect an A-16 Adaptor to both connections on the waste tank. Close shut-off valve V-706 on both of the A-16 adaptors.
   d. Be sure that the zipper on the waste tank is zipped closed.

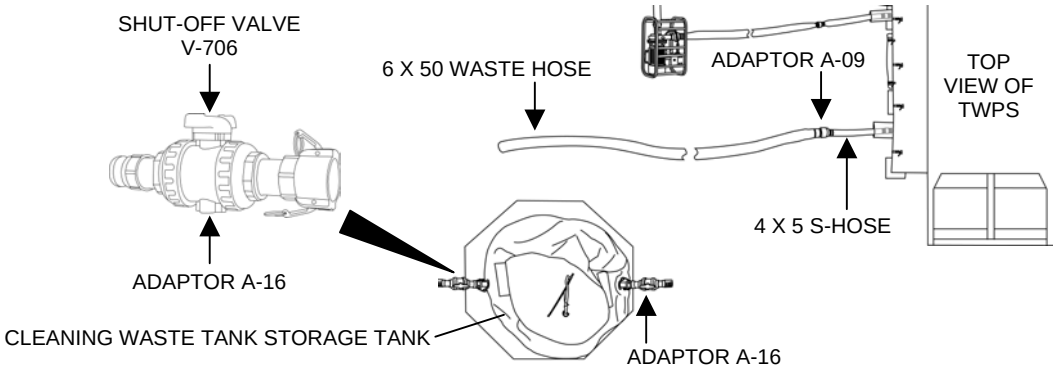

Figure 1. Cleaning Waste Storage Tank Set-Up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0025 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

2. Make sure the cleaning waste hoses are set up as follows (see Figure 2):
    a. Disconnect 4 x 6 in. Adaptor A-09 and the 6 in. red-banded waste out hose from the 4 in x 5 ft. waste outlet hose of the TWPS
    b. Connect 4 x 2 in. Adaptor A-10 to the 4 in x 5 ft. waste outlet hose.
    c. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 2):
        1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
        2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
        3) Connect Adaptor A-12 to the end of the last hose.
        4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and **open** the valves on these two adaptors.
        5) Make sure Valve V-706 on the other Adaptor A-16 on the waste tank is **closed**.

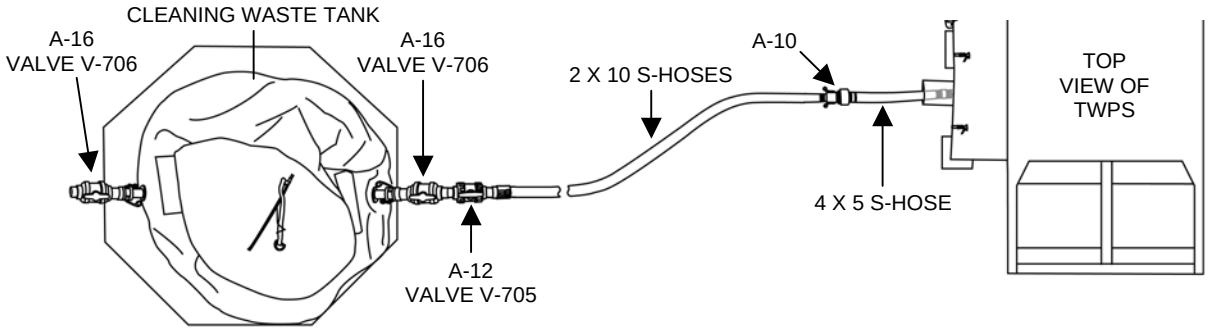

Figure 2. Cleaning Waste Hose Set-Up with the Cleaning Waste Tank.

    d. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 3):
        1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
        2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
        3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
        4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
        5) Open Adaptor A-12 Valve V-705.
        6) Direct A-12 discharge into a depression in the ground away from the TWPS.

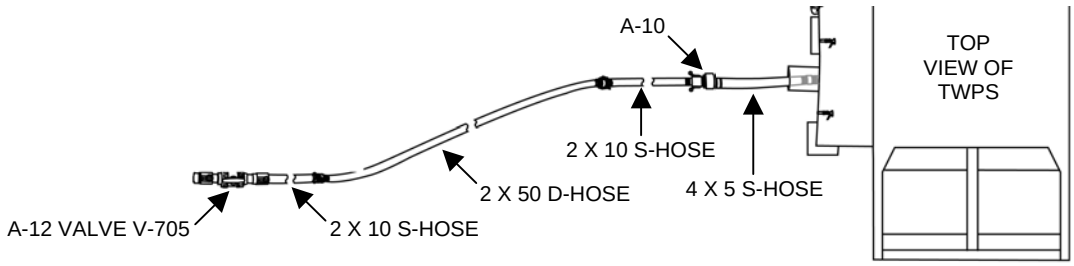

Figure 3. Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

e. Check the Adaptor A-10, A-12, and A-16 connections to make sure that there are gaskets inside the female ends and that the connections are tight to prevent solutions from leaking at the adaptor connections.

3. Prepare water for the RO preservation flush as follows (see Figure 4 for valve location):
   a. Make sure Main RO Feed Tank Drain Valve V-412 is closed.
   b. Close MF Clean Feed Valve V-704.
   c. Open Clean Mixing Valve V-703.
   d. Close RO Clean Feed Valve V-701.
   e. Close HP Pump Inlet Valve V-212.
   f. Close Clean Return Valve V-702.

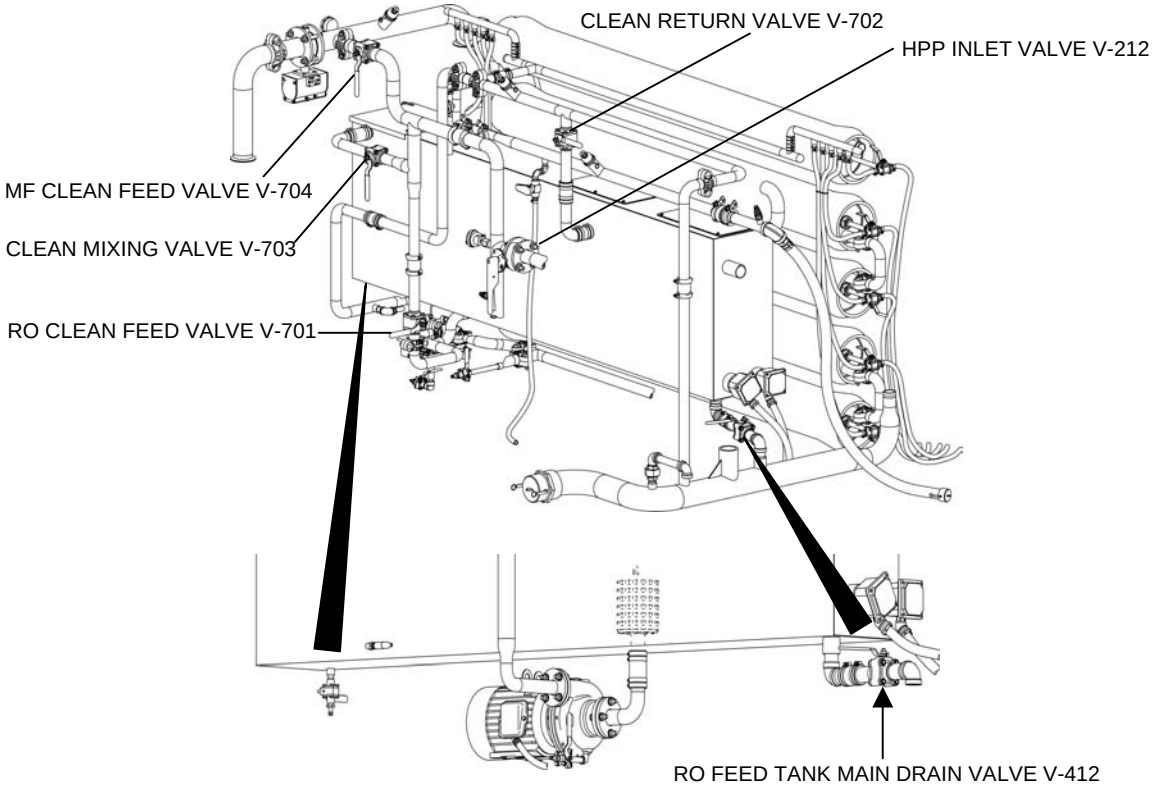

Figure 4. Valves for Preparing Water for RO Preservation Flush.

   g. Set the SYSTEM MODE SWITCH to RO CLEAN.
   h. Using the distribution system auxiliary hose, fill the RO feed tank to about 3 in. above the **bottom** of the baffle plate (about the 45% level).
   i. Reset the RO feed tank low alarm.
   j. Start the RO feed pump. This circulates solution through the RO feed pump and back into the RO feed tank through Clean Mixing Valve V-703 to provide mixing when bisulfite is added to the water.

4. Prepare the bisulfite preservation solution as follows:

WARNING

Hazardous chemical dust and/or fumes. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in irritation of the nose, throat, eyes, and skin. Promptly change contaminated clothing after accidental chemical exposure.

   a. Make sure a bucket of product water is placed in the operator station to rinse hands and face if needed.
   b. Hook the RO feed tank cover open.
   c. Open the AC–120 Bisulfite bucket. Use the chemical scoop and ***VERY SLOWLY*** pour the AC-120 Bisulfite into the RO feed tank. Repeat until approximately 1/2 of the bisulfite has been added. Maintain recirculation. Place the cover back on the bucket.
   d. Rinse the chemical scoop and chemical gloves in the bucket containing product water before removing.

5. Set the valves to flush the bisulfite preservation solution through the RO elements and out the waste hose to the cleaning waste tank follows:
   a. Close the distribution tank Adaptor A-15 valve V-525 (see Figure 5 for valve location).
   b. Disconnect the product hose from the adaptor.

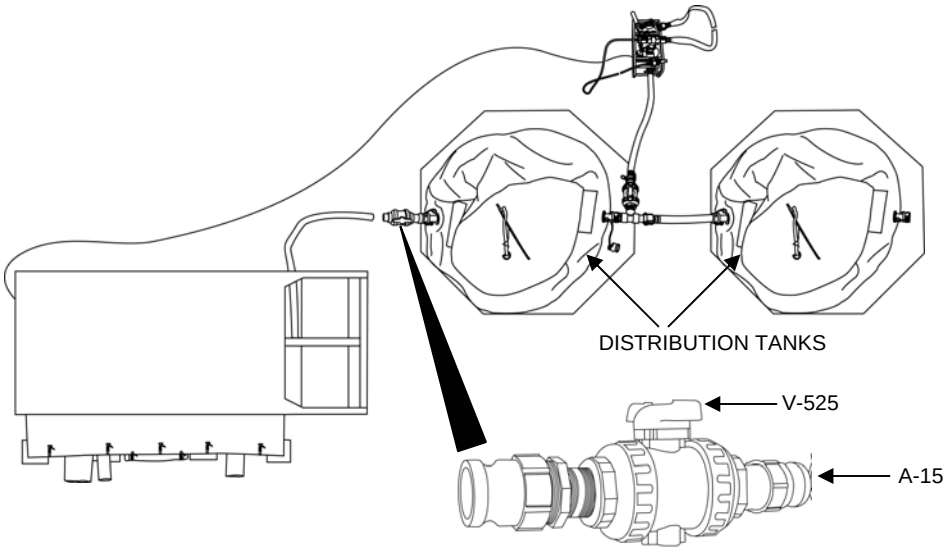

Figure 5. Distribution Tank Adaptor A-15 Valve V-525.

c. Direct the product utility hose to discharge into the RO feed tank through the open tank cover (see Figure 6 for valve location).
d. Open Product Utility Valve V-511.
e. Open RO Clean Feed Valve V-701.
f. Close Clean Mixing Valve V-703.
    1) The preservation solution is pumped from the RO feed tank through the RO and out through the waste hose into the cleaning waste tank.
    2) When the low level is reached in the RO feed tank, the pump stops and the alarm sounds.

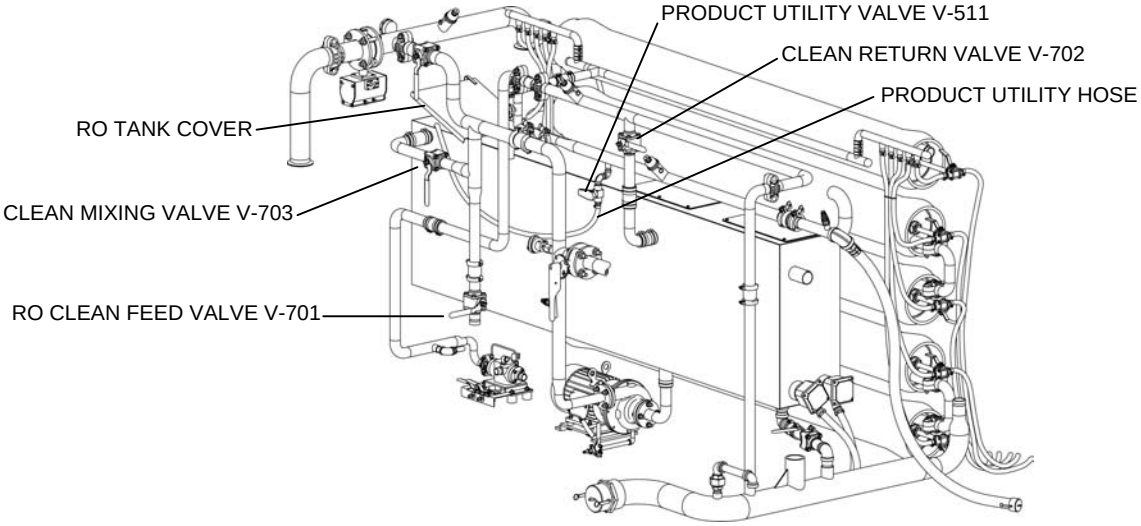

Figure 6. Valves for RO Preservation Flush

6. Set the SYSTEM MODE SWITCH to Standby.
7. Open Main Tank Drain Valve V-412 (see Figure 7 for valve location).
8. When drained, flush the RO feed tank with product water from the distribution auxiliary hose.
9. Open all RO system drain valves as follows (see Figure 7 for valve location):
    a. RO Vessel Drain Valve V-408
    b. RO Feed Tank Auxiliary Drain Valve V-210
    c. Turbocharger Reject Side Drain Valve V-410
    d. Turbocharger Feed Side Drain Valve V-303
    e. Feed Piping Drain Valve V-304
    f. HP Pump Outlet Drain Valves V-301 and V-302
    g. RO Feed Pump Drain Valve V-211

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0025 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

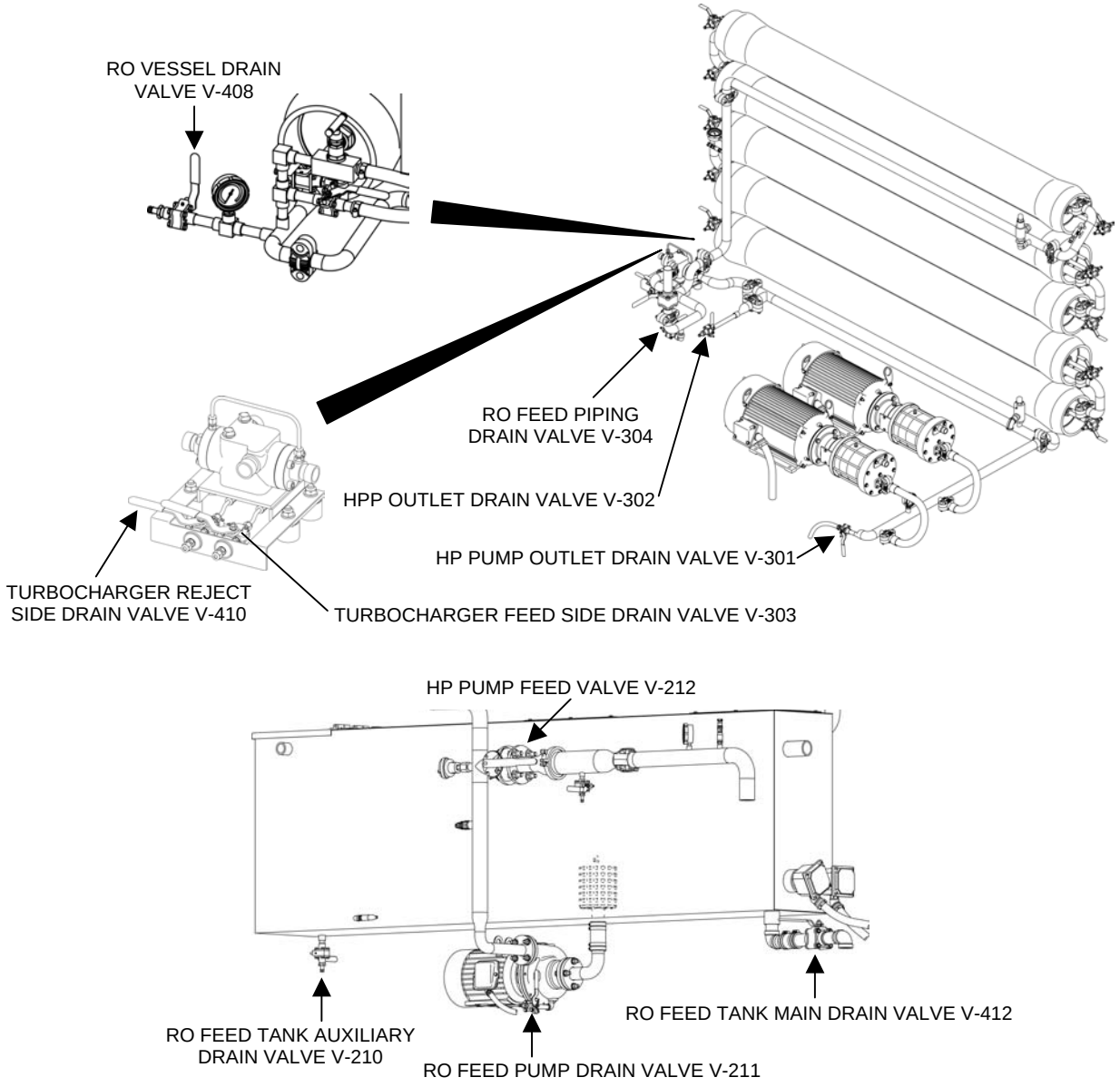

Figure 7. Valves to Operate at the End of RO Preservation Flush.

10. Set the RO product 3-way valves to the drain position (see Figure 8).

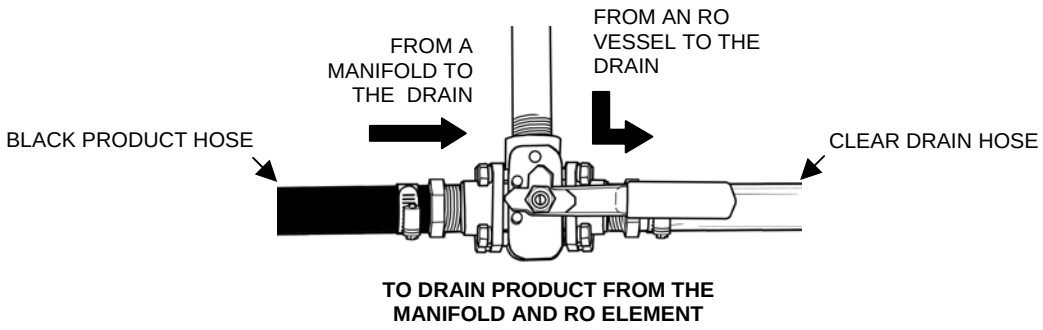

Figure 8. Product RO Element Three Way Valve in the Drain Position.

11. When water stops draining from a drain tube, disconnect the tube from its valve and hold the end up to drain the residual water from the tube. Then reconnect the tube to its valve. (It is not necessary to perform this step for a drain tube that is secured to its valve with a hose clamp.)
12. This completes the RO Preservation Flush for Extended Shutdown.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0025 00**
OPERATOR INSTRUCTIONS
REVERSE OSMOSIS SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

RO PRESERVATION IN PREPARATION FOR STORAGE

NOTE

This procedure is only used for long-term indefinite shutdown or at the end of the current mission deployment. This procedure immediately follows completion of MF Caustic Detergent Cleaning from WP 0024, MF Cleaning with RO Cleaning.

1. Make sure the cleaning waste storage tank is set up as follows (see Figure 9):
    a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
    b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
    c. Connect an A-16 Adaptor to both connections on the waste tank. Close shut-off valve V-706 on both of the A-16 adaptors.
    d. Be sure that the zipper on the waste tank is zipped closed.

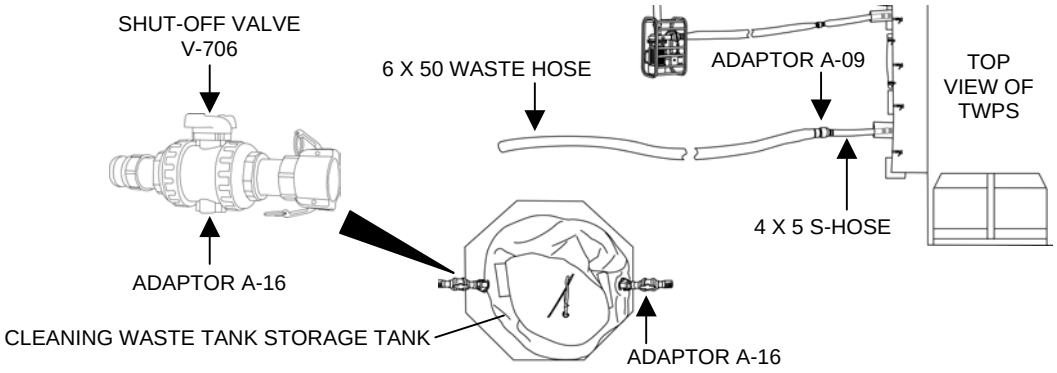

Figure 9. Cleaning Waste Storage Tank Set-Up.

2. Make sure the cleaning waste hoses are set up as follows (see Figure 10):
    a. Disconnect 4 x 6 in. Adaptor A-09 and the 6 in. red-banded waste out hose from the 4 in x 5 ft. waste outlet hose of the TWPS
    b. Check Adaptors A-10, A-12, and A-16 to make sure that there are gaskets inside the female ends and that the gaskets are in good condition to ensure leak-tight connections.
    c. Connect 4 x 2 in. Adaptor A-10 to the 4 in x 5 ft. waste outlet hose.
    d. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 10):
        1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
        2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
        3) Connect Adaptor A-12 to the end of the last hose.
        4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and **open** the valves on these two adaptors.
        5) Make sure Valve V-706 on the other Adaptor A-16 on the waste tank is **closed**.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0025 00**
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REVERSE OSMOSIS SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

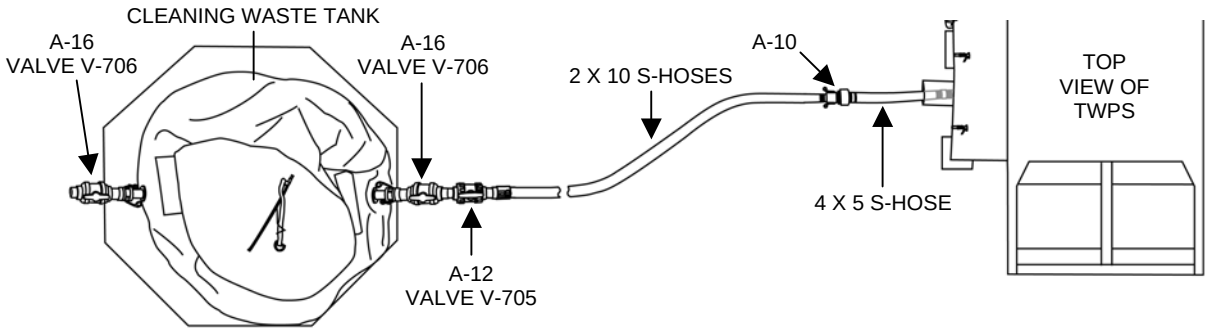

Figure 10. Cleaning Waste Hose Set-Up with the Cleaning Waste Tank.

e. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 11):
   1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
   2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
   3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
   4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
   5) **Open** Adaptor A-12 Valve V-705.
   6) Direct A-12 discharge into a depression in the ground away from the TWPS.

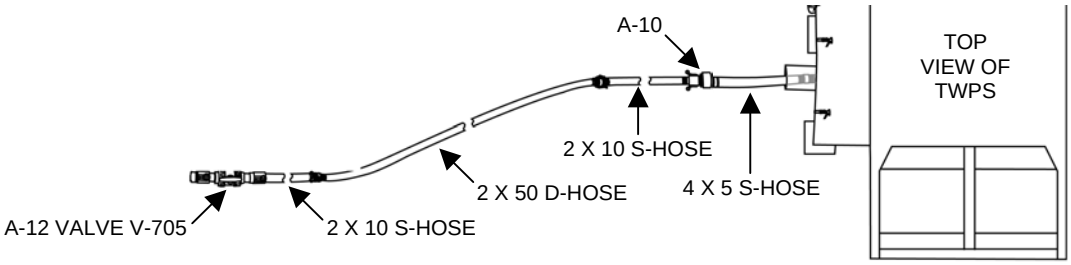

Figure 11. Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

3. Prepare water for RO preservation as follows (see Figure 12 for valve location):
    a. Make sure Main RO Feed Tank Drain Valve V-412 and RO Feed Tank Auxiliary Drain Valve V-210 are closed.
    b. Close MF Clean Feed Valve V-704.
    c. Open Clean Mixing Valve V-703.
    d. Close RO Clean Feed Valve V-701.
    e. Close HP Pump Inlet Valve V-212.
    f. Close Clean Return Valve V-702.

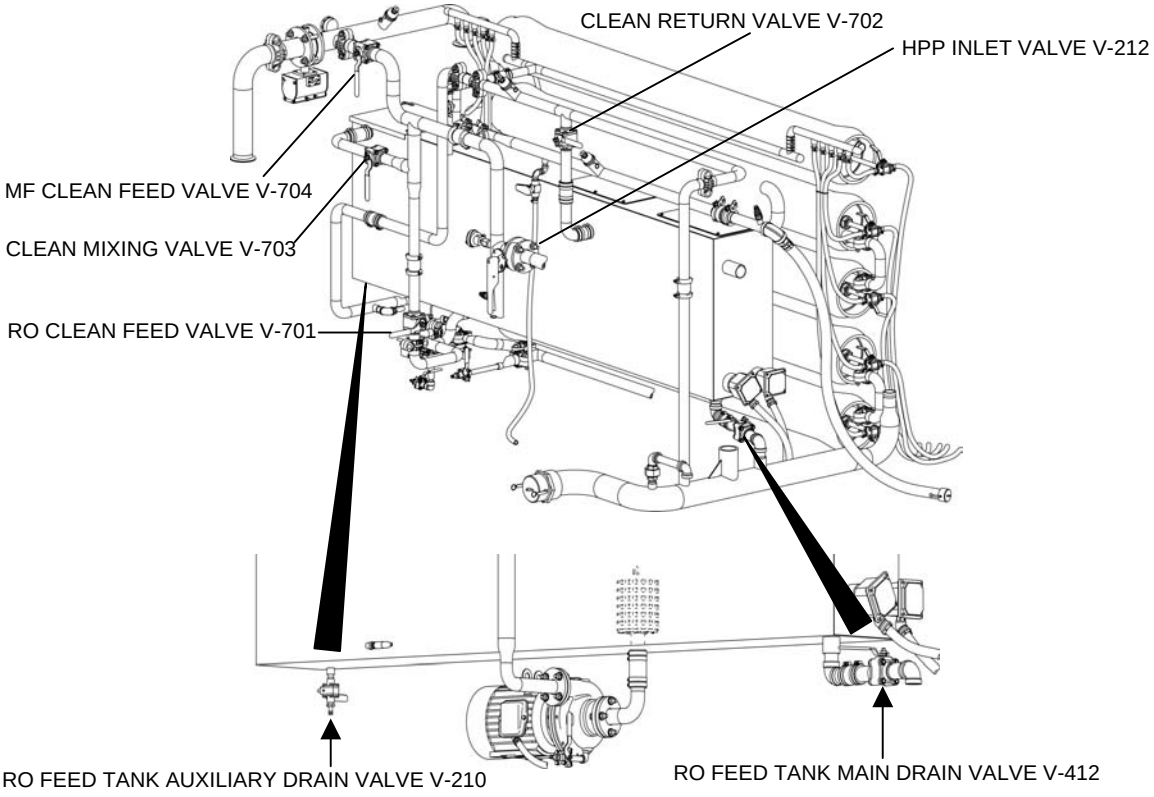

Figure 12. Valves for Preparing Water for RO Preservation.

    g. Set the SYSTEM MODE SWITCH to RO CLEAN.
    h. Using the distribution system auxiliary hose, fill the RO feed tank to just over the top of the baffle plate (90-95% level) with product water from the distribution system.
    i. Reset the RO feed tank low alarm.
    j. Start the RO feed pump. This circulates water through the RO feed pump and back into the RO feed tank through Clean Mixing Valve V-703 to provide mixing when bisulfite is added to the water.
    k. Silence any alarms.

4. Prepare the bisulfite preservation solution.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

   a. Make sure a bucket of product water is placed in the operator station to rinse hands and face if needed.
   b. Hook the RO feed tank cover open
   c. Open the AC–120 Bisulfite bucket. Use the chemical scoop and ***VERY SLOWLY*** pour the AC-120 Bisulfite into the RO feed tank. Repeat until the bucket is empty. Maintain recirculation.
   d. Rinse the chemical scoop and chemical gloves in the bucket containing product water before removing.

5. Set valves to recirculate the bisulfite preservation solution from the RO feed tank, through the RO feed pump, through the RO elements, and back to the RO feed tank.
   a. Make sure that Adaptor A-12 Valve V-705 on the cleaning waste hoses is **closed** (see Figure 10 or Figure 11).
   b. Close Distribution Tank Adaptor A-15 Valve V-525 (see Figure 13 for valve location).
   c. Disconnect the product hose from the adaptor.

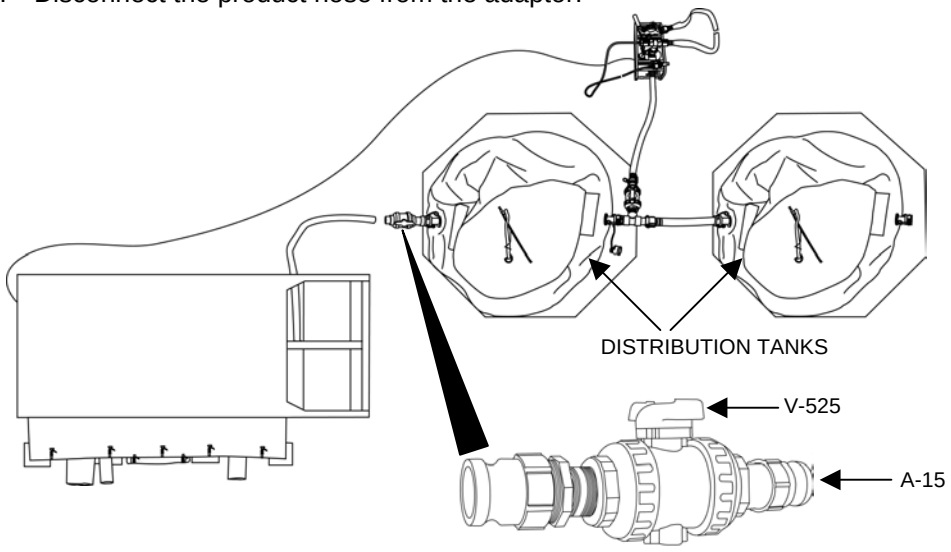

Figure 13. Distribution Tank Adaptor A-15 Valve V-525.

d. Direct the product utility hose to discharge into the RO feed tank through the open tank cover (see Figure 14 for valve location).
e. Open Product Utility Valve V-511.
f. Open RO Clean Feed Valve V-701.
g. Open Clean Return Valve V-702.
h. Close Clean Mixing Valve V-703.
i. Continue recirculation for one hour.

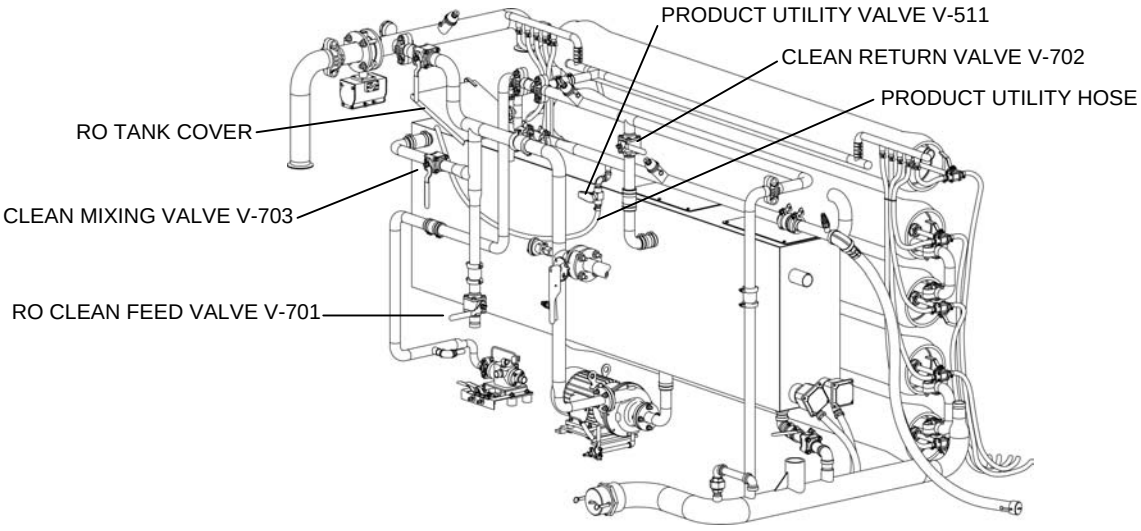

Figure 14. Valves for RO Preservation.

6. Drain the RO vessels and RO feed tank as follows:
   a. Stop the RO feed pump.
   b. Close Clean Return Valve V-702.
   c. **Open** Adaptor A-12 Valve V-705 on the cleaning waste hoses (see Figure 10 or Figure 11.
   d. Start the RO Feed Pump.
      1) The preservation solution is pumped from the tank through the RO and out through the waste hose into the cleaning waste tank.
      2) When the low level is reached, the pump stops and the alarm sounds.
   e. Open Main Tank Drain Valve V-412 (see Figure 15 for valve location).
   f. When drained, flush the tank with product water from the distribution auxiliary hose.
   g. Open all RO system drain valves (see Figure 15 for valve location).
      1) RO Vessel Drain Valve V-408
      2) RO Feed Tank Auxiliary Drain Valve V-210
      3) Turbocharger Reject Side Drain Valve V-410
      4) Turbocharger Feed Side Drain Valve V-303
      5) Feed Piping Drain Valve V-304
      6) HP Pump Outlet Drain Valves V-301 and V-302
      7) RO Feed Pump Drain Valve V-211

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0025 00**
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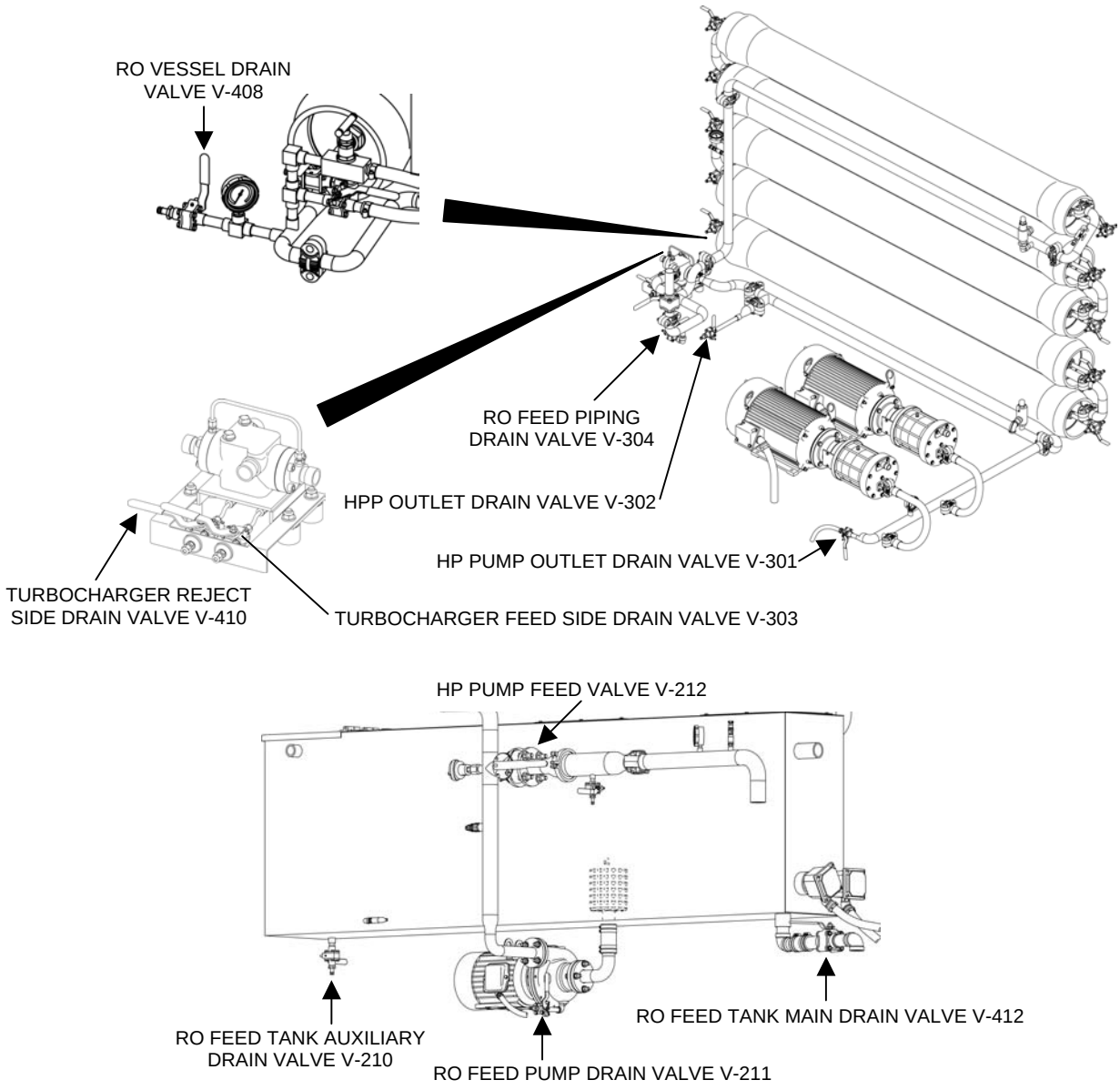

Figure 15. Valves to Operate at the End of RO Preservation for Storage.

7. End the RO Preservation in Preparation for Storage as follows:
    a. Set the SYSTEM MODE SWITCH to Standby.
    b. If using the cleaning waste storage tank, perform the following steps:
        1) Close valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 10 for valve location).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0025 00**
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2) Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
3) Disconnect Adaptor A-12 from the Adaptor A-16.
4) Direct the cleaning waste hose into an empty bucket, open Adaptor A-12 Valve V-705 and drain the contents of the hose into the bucket.
5) Open the top of the waste tank and empty the bucket into the waste tank. Then close the tank.

c. When drained, disconnect the cleaning waste hose from 4 x 2 Adaptor A-10.
d. Rinse the inside of the hose sections with water from the distribution system auxiliary hose.
e. Remove 4 x 2 Adaptor A-10 from the 4-in. x 5-ft. waste out hose and rinse.
f. Remove the 4-in. x 5-ft. waste out hose from the waste discharge of the TPWS and rinse.
g. Remove the product utility hose from the RO feed tank.

PREPARATION FOR STORAGE

Perform the Preparation for Storage procedures as described in WP 0031, Preparation for Storage – Army Unit or as described in WP 0032, Preparation for Storage – Marine Corps Unit.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS MICRO-FILTRATION SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

0026 00

INITIAL SETUP

Materials/Parts:

AC-120 Bisulfite (1) 12 oz. Packet (Box #4)
Measuring Bottle for Bisulfite (Box #4)
Chemical scoop (Box #4)
AC-210 Citric Acid, (1) 20 lb. bucket
AC-350 Caustic, (2) 1 Gallon Containers (Box #5)
Three 2-in. x 10 ft. Cleaning Waste Hoses
Adaptor A-10 (Box #1)
Adaptor A-12 (Box #1)
Cleaning Waste Storage Module if used

- One 1500 gallon cleaning waste storage tank
- Two adaptors A-16 (A-TWPS, Box #1)

One 2 in. x 50 ft. raw water discharge hose if cleaning waste storage module not used
Personal protective gear (Box #1)

- Two chemical aprons
- One face shield
- Two chemical gloves
- One dust mask

Personnel Required:

Two Operators/Crew

Equipment Condition:

Short Term Shutdown WP0017 has been performed, the TQG and Air Compressor are left on
All drain and vent valves closed as instructed in WP0018.
All product 3-way valves set to normal operating position as instructed in WP0018.
WP0024 must be completed prior to performing **MF Preservation in Preparation for Storage**.

GENERAL

MF preservation procedures are performed when the TWPS is placed in an extended shutdown (shut down longer than 54 hours during deployment) or when the TWPS is shut down in preparation for storage (stand down from deployment).

Preservation is necessary to ensure that biological growth does not become established on the MF fibers surfaces during the shutdown period. If they are not preserved and a biological film grows on the fibers, the TWPS will not meet performance requirements when placed back in operation. If the biological growth is severe enough, the MF modules will require extensive cleaning/soaking and may need to be replaced.

The caustic used for MF Caustic Detergent Cleaning is used as the preservative for the MF. For an extended shutdown, the caustic preservative solution is flushed through the MF module fibers once and discharged into a cleaning waste holding tank. For a shutdown in preparation for storage, residual caustic detergent cleaning solution left in the MF modules after the completion of the MF Caustic Detergent Clean procedure serves to preserve the fibers until the next time the TWPS is deployed.

The procedures covered in this work package include:

- MF Preservation Flush for Extended Shutdown
- MF Preservation in Preparation for Storage (WP0024 procedures must first be performed)

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0026 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

MF PRESERVATION FLUSH FOR EXTENDED SHUTDOWN

NOTE

This procedure is a part of the extended shutdown procedure (WP 0018). Follow the extended shutdown procedure and complete the preservation in sequence as instructed.

1. Make sure the cleaning waste storage tank is set up as follows (see Figure 1):
   a. Set up the Waste Tank within 30 feet of the TWPS waste out connection. Face the female tank connection toward the TWPS skid.
   b. If the terrain allows, set the tank at an elevation so that the top of the full tank will be below the bottom of the RO Feed Tank.
   c. Connect an A-16 Adaptor to both connections on the waste tank. Close shut-off valve V-706 on both of the A-16 adaptors.
   d. Be sure that the zipper on the waste tank is zipped closed.

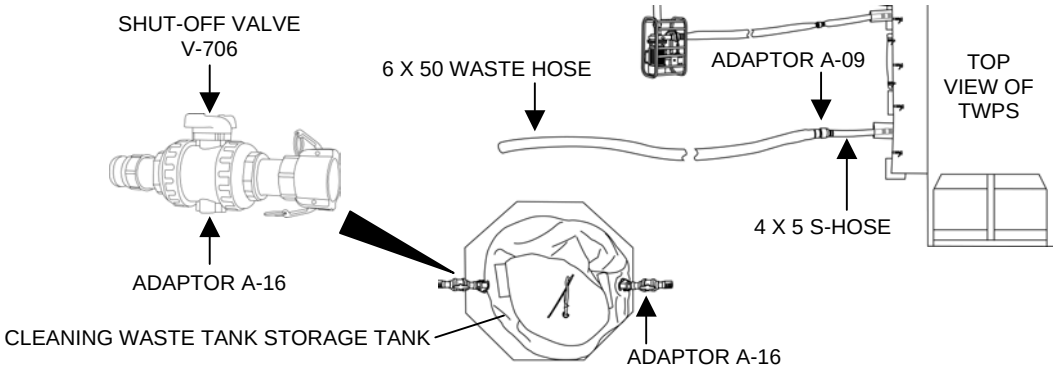

Figure 1. Cleaning Waste Storage Tank Set-Up.

2. Make sure the cleaning waste hoses are set up as follows (see Figure 2):
   a. Disconnect 4 x 6 in. Adaptor A-09 and the 6 in. red-banded waste out hose from the 4 in x 5 ft. waste outlet hose of the TWPS
   b. Check Adaptors A-10, A-12, and A-16 to make sure that there are gaskets inside the female ends and that the gaskets are in good condition to ensure leak-tight connections.
   c. Connect 4 x 2 in. Adaptor A-10 to the 4 in x 5 ft. waste outlet hose.
   d. If using the cleaning waste storage tank, set up the hoses as follows (see Figure 2):
      1) Connect a 2 in. x 10 ft., red-banded cleaning waste hose to Adaptor A-10.
      2) Connect one or two additional 2 in. x 10 ft., red-banded hoses as needed to reach the waste tank.
      3) Connect Adaptor A-12 to the end of the last hose.
      4) Connect Adaptor A-12 to the A-16 Adaptor on the waste tank with the female end exposed and **open** the valves on these two adaptors.
      5) Make sure Valve V-706 on the other Adaptor A-16 on the waste tank is **closed**.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0026 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

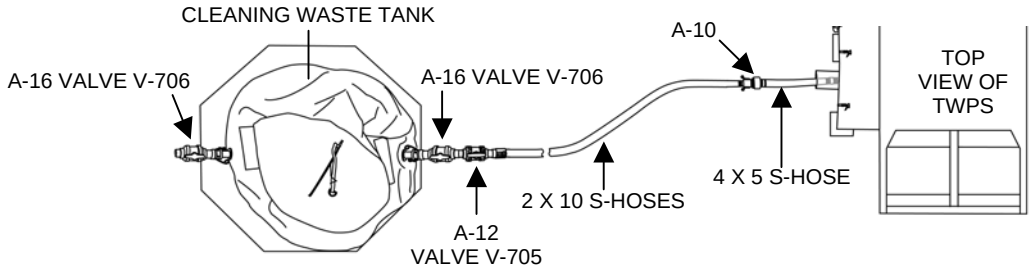

Figure 2. Cleaning Waste Hose Set-Up with the Cleaning Waste Tank.

e. If not using the cleaning waste tank, set up the cleaning waste hoses as follows (see Figure 3):
   1) Connect a 2 x 10, red-banded, cleaning waste suction hose to Adaptor A-10.
   2) Connect one 50-foot, green banded, raw water discharge hose to the 2 x10, red-banded cleaning waste hose.
   3) Connect one 2x10, red-banded, cleaning waste suction hose to the other end of the 50-foot hose.
   4) Connect Adaptor A-12 to the end of the second cleaning waste hose.
   5) **Open** Adaptor A-12 Valve V-705.
   6) Direct A-12 discharge into a depression in the ground away from the TWPS.

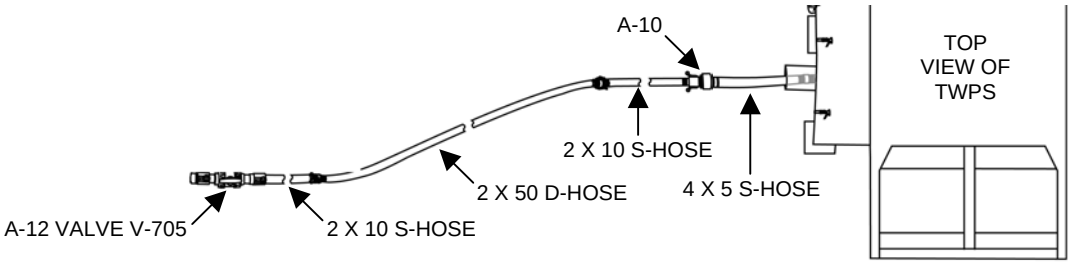

Figure 3. Cleaning Waste Hose Set-Up Without the Cleaning Waste Tank.

3. Put citric acid in the cleaning waste tank for neutralizing the cleaning solution when the solution is flushed into the tank as follows:

WARNING

Acid chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling citric acid. Avoid inhaling chemical fumes. If acid spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

   a. Make sure a bucket of water is placed near the cleaning waste tank to rinse any area of skin or clothing that comes in contact with citric acid.

b. Open the cleaning waste tank zipper.
c. Open an extra AC-210 Citric Acid bucket. Pour half of the contents (10 lbs.) into the cleaning waste tank. (After all of the cleaning waste has been discharged into the tank, the pH will be approximately 9).
d. Close the cleaning waste tank zipper.
e. Rinse the pitcher and chemical gloves in the bucket of water before removing the gloves.

4. Prepare water for MF preservation solution as follows (see Figure 4 for valve location):
   a. Make sure main RO Feed Tank Drain Valve V-412 is closed.
   b. Close MF Clean Feed Valve V-704.
   c. Open Clean Mixing Valve V-703.
   d. Close RO Clean Feed Valve V-701.
   e. Be sure HP Pump Inlet Valve V-212 is closed.
   f. Close Clean Return Valve V-702.

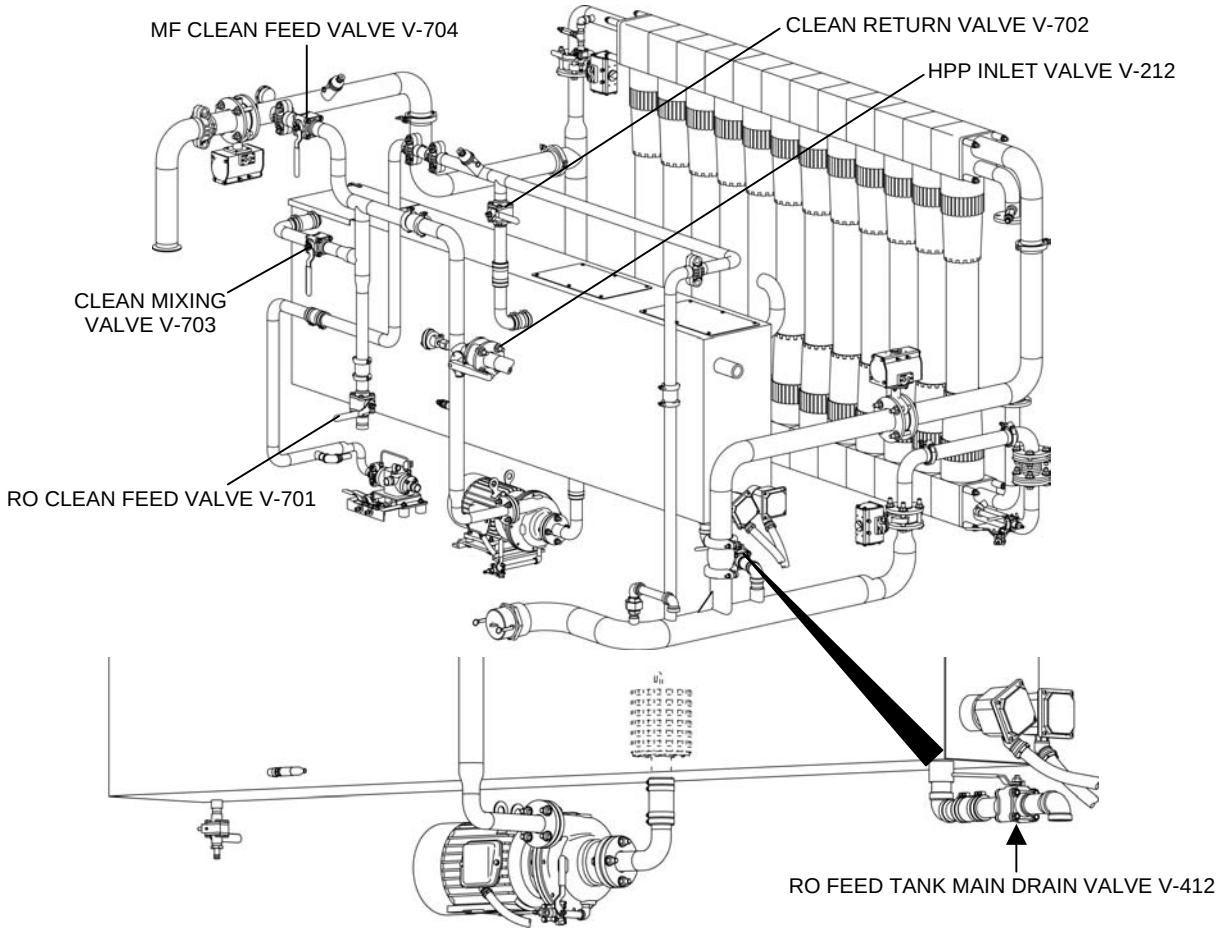

Figure 4. Valves for Preparing Water for MF Preservation Flush.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0026 00**
OPERATOR INSTRUCTIONS
MICRO-FILTRATION SYSTEM PRESERVATION – OPERATION UNDER USUAL CONDITIONS

g. Remove the 3-in. hose from the TWPS inlet connection and cap the inlet connection.
h. Using the distribution system auxiliary fill hose, fill the RO feed tank to about 3 in. above **the bottom** of the baffle plate.
i. Set the SYSTEM MODE SWITCH to RO CLEAN.

WARNING

Chemical dust. Wear a protective face shield, chemical gloves, and a dust mask when handling sodium bisulfite. Avoid inhaling chemical dust or fumes. Failure to observe this warning may result in mild irritation of the nose, throat, eyes, and skin.

CAUTION

Failure to add sodium bisulfite to the chlorinated product water that is used for MF preservation will result in MF membrane failure.

NOTE

If a bottle of bisulfite powder has not already been prepared, open one of the 12oz. sodium bisulfite packets and pour it into the bottle provided in the BII. The bisulfite powder will be used to neutralize the chlorine in the product water that is used for preparing the MF preservation solution.

j. Using the bottle of bisulfite, add one capful of sodium bisulfite to the RO feed tank while filling the tank to neutralize the chlorine in the product water.
k. Reset the RO Feed Tank Low Alarm.
l. Start the RO feed pump. This circulates solution through the RO feed pump and back into the RO feed tank through Clean Mixing Valve V-703 to provide mixing when caustic is added to the water. Silence any alarms.
m. Place a bucket of product water in the operator station for rinsing.

5. Prepare the caustic preservation solution as follows:

WARNING

Caustic chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling caustic solution. Contact with caustic will result in severe chemical burns. Keep water ready when handling. Avoid inhaling chemical fumes. If the caustic spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in severe irritation of the nose, throat, and eyes. Contact with skin will result in severe chemical burns if not immediately rinsed off.

a. Hook the RO feed tank cover open.
b. Take one AC-350 caustic container and remove the outer plastic bags.
c. Hold the container inside the RO feed tank and remove the cap. Rinse the cap in tank and set aside.
d. Hold the container near the water (**but not underwater**) to avoid splashing and slowly empty the container into the water.
e. When empty, rinse the container with water inside the tank (now it may be held under water) then reinstall the cap.

f. Immediately rinse the outside of the container in the bucket containing product water before discarding.
g. Repeat until two containers of caustic have been added to the water in the RO feed tank.
h. Close the RO feed tank cover.
i. Rinse the chemical gloves in the bucket containing product water before removing.
j. Rinse any areas where spills are noted.

NOTE

If the SYSTEM MODE SWITCH has not been set to STANDBY, nothing will happen when the MF Clean Switch is set to FILL/RECIRC.

6. Stop the RO feed pump.
7. Set the SYSTEM MODE SWITCH to STANDBY.
8. Set valves to flush the caustic preservation solution through the MF modules and out the waste hose into the cleaning waste storage tank as follows (see Figure 2 and Figure 4 for valve location):
    a. Open MF Clean Feed Valve V-704.
    b. Close Clean Mixing Valve V-703.
    c. If the cleaning waste tank is used, make sure valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank are **open** (see Figure 2 for valve location).
    d. Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is **closed**.
    e. If the waste tank is not used, **open** valve V-705 on Adaptor A-12 at the end of the waste hoses (see Figure 3).
9. Set the MF Clean switch to FILL/RECIRC
    a. After a 5 second delay, the RO feed pump comes on automatically.
    b. The MF goes through a fill cycle with water supplied by the RO feed pump from the RO feed tank.
    c. The RO feed pump remains on to flush the solution through the MF shell and out the cleaning waste hose until the RO feed tank empties.
    d. Silence the alarm.
    e. When the RO Feed Tank Level % indicator on the Operator Control Panel shows 0%, wait 15 seconds, then set the MF Clean switch to OFF. Wait 5 seconds and the RO feed pump will stop.

WARNING

Caustic chemical. Wear a protective face shield, chemical gloves, and a chemical apron when handling the drain valves, cleaning waste hoses, and adaptor. Keep water ready when handling. Failure to observe this warning may result in severe irritation of the nose, throat, and eyes. Contact with caustic will result in severe chemical burns if not immediately rinsed off.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0026 00**
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10. Drain the remaining caustic solution from the MF modules as follows:
    a. Set the SYSTEM MODE SWITCH to MF DRAIN.
    b. Air purges the caustic solution from the MF and out the waste hose.
    c. When complete (after about one minute), open MF drain valves V-203 and V-403 and drain into buckets.
    d. When water stops draining, disconnect each tube from its valve and hold the end up to drain residual water from the tube. Then reconnect the tube to its valve (see Figure 5).

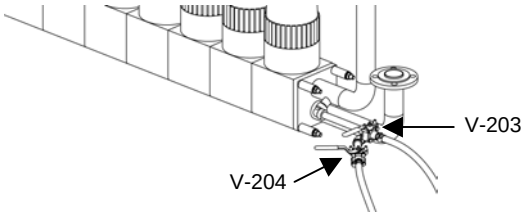

Figure 5. MF Drain Valves V-203 and V-403.

    e. Empty the buckets into the cleaning waste tank if in use. Then close the tank.
    f. Close the drains unless preparations are being made to move the TWPS.
    g. Set the SYSTEM MODE SWITCH to Standby.
11. Flush the RO feed tank with product water as follows (see Figure 6 for valve location):
    a. Open Main RO Feed Tank Drain Valve V-412.
    b. Flush the RO feed tank with product water from the distribution system auxiliary hose.
    c. While flushing the RO feed tank:
        1) Place the drain hose from RO Feed Pump Drain Valve V-211 in a bucket. Open the valve long enough for water from the RO feed tank to flow through and flush the pump. Close the valve.
        2) Place the drain hose from RO Feed Tank Auxiliary Drain Valve V-210 in a bucket. Open the valve long enough for water from the RO feed tank to flow through flush the valve. Close the valve.
        3) Place the drain hose from RO Feed Pipe Drain Valve V-304 in a bucket. Open the valve and drain water from the RO feed pipe into the bucket. Close the valve when draining is done.
        4) Stop flushing the RO feed tank with product water.
    d. Perform the following steps for each of the valves V-211, V-210, and V-304:
        1) Place the drain tube in a bucket.
        2) Disconnect the drain tube from its valve and hold the end up to drain residual water from the tube into the bucket.
        3) Reconnect the tube to its valve.
    e. Empty the bucket into the cleaning waste tank. Then close the waste tank.

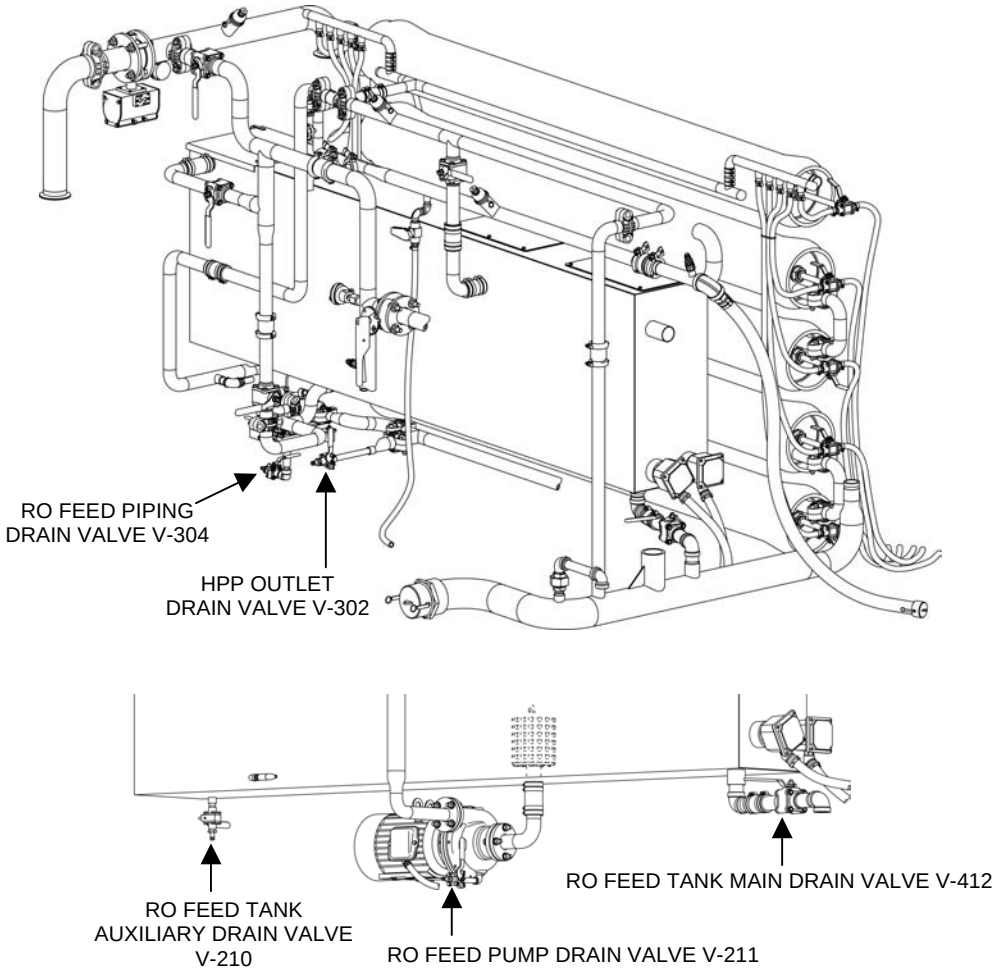

Figure 6. Valves to Flush RO Feed Tank After MF Preservation Flush.

12. End the MF Caustic Preservation Flush for Extended Shutdown as follows:
    a. If using the cleaning waste storage tank, perform the following steps:
        1) Close valves V-705 and V-706 on Adaptors A-12 and A-16 that are connected together on the cleaning waste tank (see Figure 2 for valve location).
        2) Make sure the A-16 adaptor valve V-706 on the other side of the waste tank is closed.
        3) Disconnect Adaptor A-12 from the Adaptor A-16.
        4) Direct the cleaning waste hose into an empty bucket, open Adaptor A-12 Valve V-705 and drain the contents of the hose into the bucket.
        5) Open the top of the waste tank and empty the bucket into the waste tank. Then close the tank.

b. If not using the cleaning waste tank, simply leave valve V-705 on Adaptor A-12 open (see Figure 3).
c. Disconnect the cleaning waste hose from 4 x 2 Adaptor A-10.
d. Rinse the inside of the hose sections and adaptors with product water from the distribution system auxiliary hose.
e. Remove Adaptor A-10 from the 4 x 5 waste out hose and rinse with product water from one of the distribution nozzles.
f. Remove the 4 x 5 waste out hose from the waste discharge of the TWPS and rinse with product water from the distribution system auxiliary hose.
g. This completes the MF Preservation Flush for Extended Shutdown.

13. Refer to WP 0020, Cleaning, Preservation, and Cleaning Waste Neutralization and Pump-Out, for the procedures to neutralize and dispose of the waste in the cleaning waste storage tank.

MF PRESERVATION IN PREPARATION FOR STORAGE

MF Preservation in Preparation for Storage has already been accomplished with the completion of the procedures that were performed for MF Cleaning with RO Acid Cleaning, WP0024. MF Cleaning with RO Acid Cleaning is performed whenever the TWPS is placed in a long-term term shutdown in preparation for storage. It should also be performed if the TWPS is to be shut down during deployment for longer than 54 hours and it is not certain how long the TWPS will be shut down before it is started up again.

The last steps of the MF Cleaning with RO Acid Cleaning procedure are MF Caustic Detergent Cleaning steps. At the end of the MF Caustic Detergent Cleaning, the caustic detergent cleaning solution is drained and then air-purged from the MF modules. The MF modules are NOT rinsed with product water. Residual caustic detergent cleaning solution left in the MF modules serves to preserve the fibers until the next time the TWPS is deployed.

As a consequence, when MF Cleaning with RO Acid Cleaning is performed on the TWPS in preparation for storage, no additional MF Preservation steps are required.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0027 00**
OPERATOR INSTRUCTIONS
OPERATION UNDER UNUSUAL CONDITIONS

INITIAL SETUP:

Personnel Required
Three Operator/Crew
Equipment Condition
(See the instructions for each unusual condition in this WP.)

GENERAL:

This work package contains instructions for operation under the following unusual conditions:

- Cold Weather Operation
  - Cold Weather Startup from Standby
  - Cold Weather Initial Startup or Startup with the System Fully Drained
  - Cold Weather Emergency Shutdown on Loss of Power
- NBC Water Purification Mission
- Equipment Decontamination After an NBC Water Purification Mission
  - Nuclear Decontamination
  - Chemical/Biological Decontamination
- NBC Survivability
- Low EMI Emissions Missions

COLD WEATHER OPERATION

Setup the TWPS for cold weather and observe cold weather operation procedures under the conditions listed in Table 1.

Table 1. Conditions for Cold Weather Operation Procedures.

Water Temperature (degrees F)	Air Temperature (degrees F)			
	Less than 15°F	15-20°F	20-25°F	Over 25°F
Less than 35°F	Yes	Yes	Yes	Yes
35-40°F	Yes	Yes	No	No
Over 40°F	Yes	No	No	No

Cold Weather Startup from Standby

Cold weather shutdown to standby (WP 0017) requires that the TQG and the diesel heater remain on. The TWPS equipment, therefore, remains warm and may be started following the normal **Startup from Standby without Draining** procedures (WP 0015). If the diesel-driven raw water pump P-1 (or the 9000 gallon extended distribution system diesel-driven pump P-8) is used, follow the procedures described in WP 0009 to warm and start the pump without freeze up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0027 00**
OPERATOR INSTRUCTIONS
OPERATION UNDER UNUSUAL CONDITIONS

Cold Weather Initial Startup or Startup with the System Fully Drained

This procedure covers startup with the TWPS fully drained and cold.

1. For **initial startup**, complete the procedures provided by WP 0009, Cold Weather Set-Up Instructions. These procedures bring the TWPS to the point of ready to begin raw water flow. The heating blankets have warmed the hoses. The diesel heater has warmed the TWPS to the minimum temperature of 600 degrees Fahrenheit. The air compressor has been started.
2. For **startup with the system fully drained** and cold, complete the following procedures.
    a. Establish electrical power (WP 0012)
    b. Set the Hose/Pump Heater switch to ON.
    c. Start the diesel fuel-fired heater as follows:
        1) Check the fuel supply gauge. Add fuel as needed.
        2) Make sure the power switch on the heater electrical panel is in the OFF position.
        3) If the remote thermostat is used, set the thermostat toggle switch on the heater electrical panel to the ON position. Then set the dial on the remote thermostat to 70 degrees Fahrenheit.
        4) If you are not using the remote thermostat, set the thermostat toggle switch on the heater electrical panel to the OFF position. This will cause the heater to operate continuously once it is started.
        5) Move the power switch on the heater electrical panel to the ON position. The heater should start up immediately (unless the remote thermostat is used and is set at a higher temperature than the surrounding air).
    d. Allow the heater to run for at least one hour, or longer if needed to reach a temperature of at least 60 degrees Fahrenheit. A temperature gauge is mounted on the frame between the High Pressure Pumps (see Figure 1). Do not continue until the temperature is at least 60 degrees.

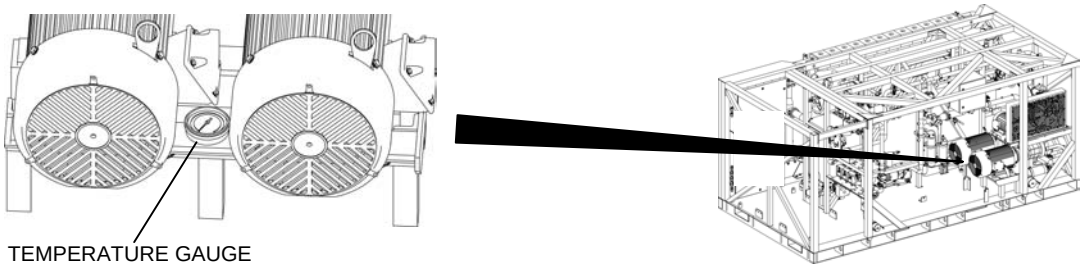

Figure 1. Temperature Gauge Between the High Pressure Pumps.

    e. After reaching 60 degrees Fahrenheit, check the air compressor oil. If it seems normal (and not syrupy), start the air compressor as described by WP0014. If the air compressor belt slips or screeches, stop the compressor and wait another 30 minutes for the compressor oil to warm further. If the oil is syrupy when checked, wait 30 minutes and check again.
    f. After air pressure is available, complete the Pre-Operational Diagnostic Self-Tests (WP 0013).
    g. Set the valves to start-up positions as described by WP0014, Table 1. Some drain valves may be frozen open. Remove the Heat Gun and extension cord from BII box #8. Plug it into the generator 110-volt outlet (do not plug into the TWPS PDP outlet). The heat gun can be used to thaw any valves that cannot be closed.

3. Heat-up the TWPS systems as follows (see Figure 2 for valve locations):
    a. Start the raw water pumps.
    b. When the MF feed tank is about one-third full, close Raw Water Flow Valve V-107 in Adaptor A-05 until only a small flow is discharged from the hose into the MF feed tank.
    c. Set the Mode Switch to MF FILL/HOLD. (If flow is not observed during the FILL/HOLD cycle, set the Mode Switch back to Standby and repeat the FILL/HOLD).
    d. When the FILL cycle is complete, set the Mode Switch to RUN and start the MF feed pump.
    e. When the RO Feed Tank Level reaches 20%, set the Tank Heater switch to AUTO 2.
    f. When the MF feed pump stops after filling the RO feed tank, set the Mode Switch to Standby for 10 seconds and then to RO Clean.
    g. Remove the 4-in. waste hose from the TWPS waste outlet. Install the cap on the outlet. (On the A-TWPS, the 4-in waste hose can be capped instead of the TWPS connection as long as the hose is brought inside the enclosure.)
    h. Close HP Pump Valve V-212.
    i. Open Clean Mixing Valve V-703.
    j. Reset to clear any alarms.
    k. Start the RO feed pump to mix the water as it is heated by the RO feed tank (electric immersion) heaters.
    l. When the water temperature reaches approximately 90 degrees Fahrenheit (as indicated on RO tank Temperature Indicator TI-201 at the left end of the tank), circulate warm water through the RO to remove ice from within the RO system before full startup as follows:
        1) Open Clean Return Valve V-702.
        2) Open HP Pump Inlet Valve V-212.
        3) Close Clean Mixing Valve V-703.
        4) Slightly open the HP Pump Drain Valve V-215 under the HP pumps. Direct the drain tube into a bucket and fill the bucket. Then close valve V-215. (The HP pump cases may leak slightly at the segments until warmed).
        5) Allow the water to circulate for at least 20 minutes or until the RO reject pipe feels warm. The tank level should initially drop to 60 to 70% and flow should be displayed on the reject flow meter. Note that some product water may be produced. Stop recirculation before the level drops below 20%.
        6) Stop the RO Feed Pump.
        7) Set the System Mode Switch to Standby.
    m. Circulate warm water through the MF to remove ice from within the MF system before full startup as follows:
        1) Open MF Cleaning Feed Valve V-704.
        2) Close HP Pump Inlet Valve V-212.
        3) Set the MF Clean Switch to FILL/RECIRC.
        4) After 15 minutes, set the MF Clean Switch to OFF.
    n. Stop the RO feed pump.
    o. Set the Tank Heater switch to OFF.
    p. Close MF Cleaning Feed Valve V-704.
    q. Close Clean Return Valve V-702.
    r. Remove the cap from the TWPS waste outlet and connect the 4-in., red-banded waste out hose.
    s. Open RO Feed Tank Main Drain Valve V-412 to drain the tank. Close the valve when the tank is drained.

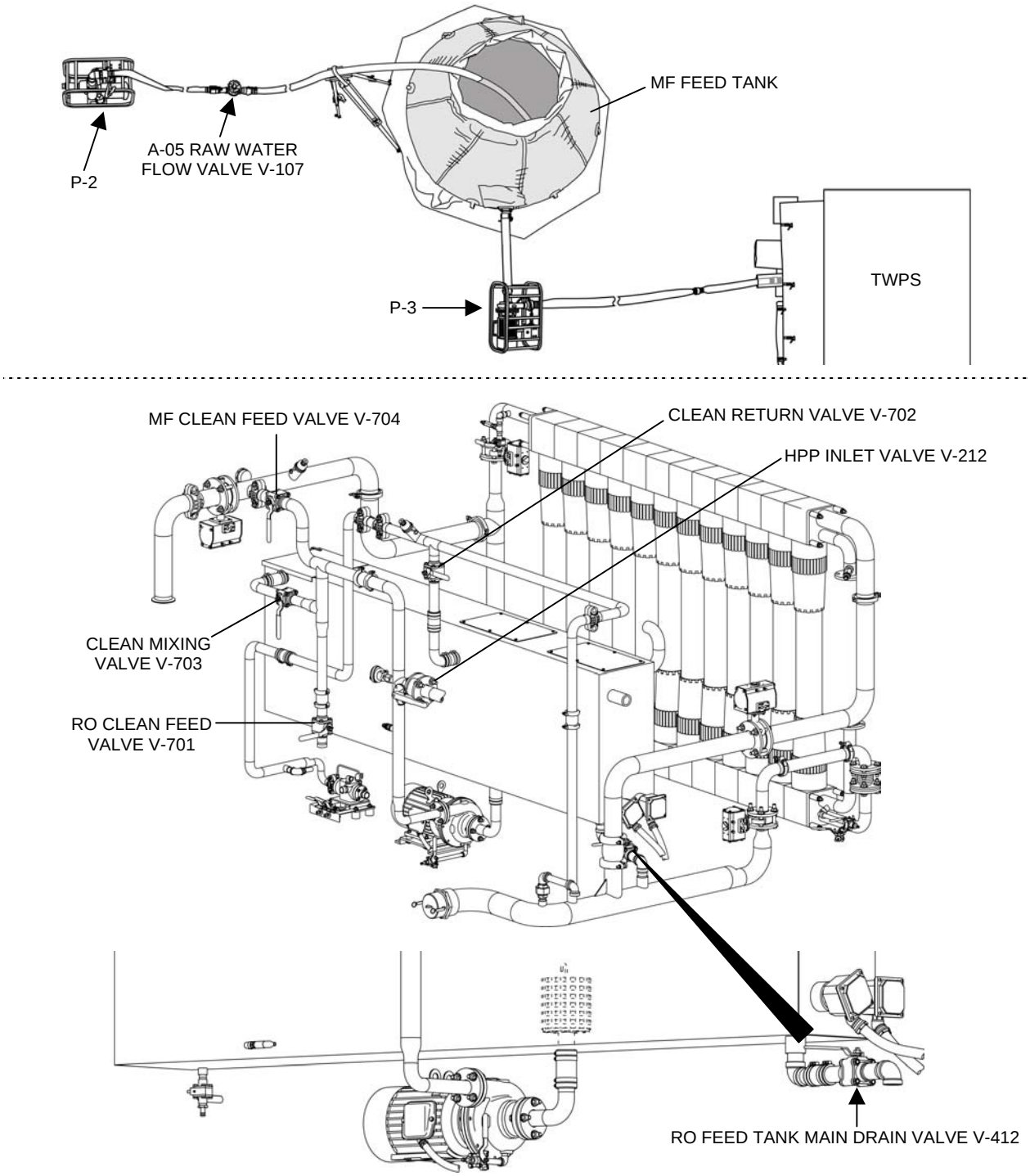

Figure 2. Valves Operated to Heat Up the TWPS Systems.

4. Continue with Initial Start-Up or Start-Up with the System Fully Drained (WP 0014)
5. After adjusting the product flow, check the TQG power meter.
    a. If 30 kW is available, set the Tank Heater switch to Auto 2.
    b. If less than 30 kW but at least 15 kW is available, set the Tank Heater switch to AUTO 1.
    c. If less than 15 kW is available, leave the heaters off.

NOTE

In very cold weather the MF modules may shrink and leak. If this happens, place the TWPS in Short Term Shutdown – Cold Weather Operation (refer to WP 0017). Then torque the 4 nuts at the top and 4 nuts at the bottom of one end of the MF assembly to 45 to 50 ft. lbs. (see Figure 3).

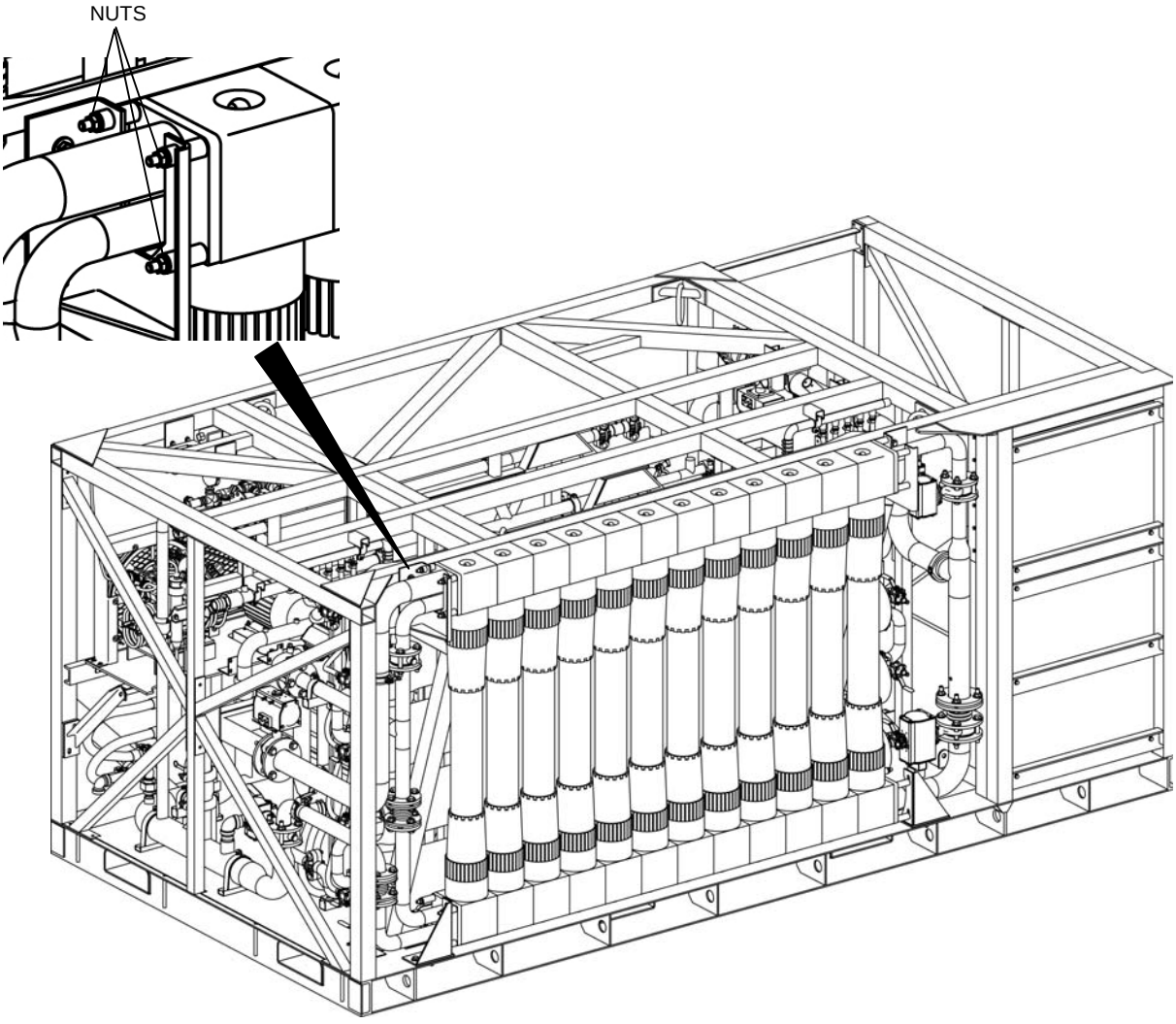

Figure 3. MF Assembly.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0027 00**
OPERATOR INSTRUCTIONS
OPERATION UNDER UNUSUAL CONDITIONS

Cold Weather Standby or Short Term Shutdown

Refer to WP 0017.

Cold Weather Emergency Shutdown on Loss of Power

1. Open all drain valves on the TWPS (see Table 2 and Figure 5 for valve location).

Table 2. TWPS Drain Valves.

✓	VALVE NAME AND NUMBER	POSITION
	Product RO Element 3-Way Valves, left end, V-502, 503, 506, 507, 510	Drain
	RO Vessel Drain Valve V-408	Open
	RO Feed Tank Auxiliary Drain Valve V-210	Open
	Turbocharger Reject Drain Valve V-410	Open
	Turbocharger Feed Drain Valve V-303	Open
	Strainer S-2 Vent /Sample Valve V-110	Open
	Strainer S-2 Drain Valve V-109	Open
	Feed Piping Drain Valve V-304	Open
	HP Pump Outlet Drain Valve V-302	Open
	Strainer S-4 Drain Valve V-213	Open
	RO Feed pump P-4 Drain Valve V-211	Open
	Coalescer CO1 Drain Shutoff Valve V-902	Open
	HP Pumps Case Drain Valve V-215	Open
	HP Pump P-5 and P-6 Inlet Drain Valve V-214	Open
	HP Pump P-5 and P-6 Outlet Drain Valve V-301	Open
	Air Compressor Intermediate Filter Drain Valve V-901	Open
	RO Feed Tank Main Drain Valve V-412	Open
	Product RO Element 3-Way Valves, right end, V-501, 504, 505, 508, 509	Drain
	MF Filtrate Sample/Drain Valve V-204	Open
	MF Filtrate Drain Valve V-203	Open
	MF Shell Drain Valve V-403	Open

NOTE

The Product RO Element 3-Way Valves are in the drain position when the middle pointer on the valve handle is pointing toward the RO Vessel (see Figure 4).

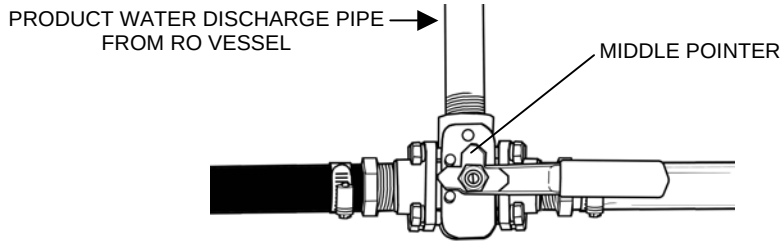

Figure 4. RO Element 3-Way Valve in the Drain Position.

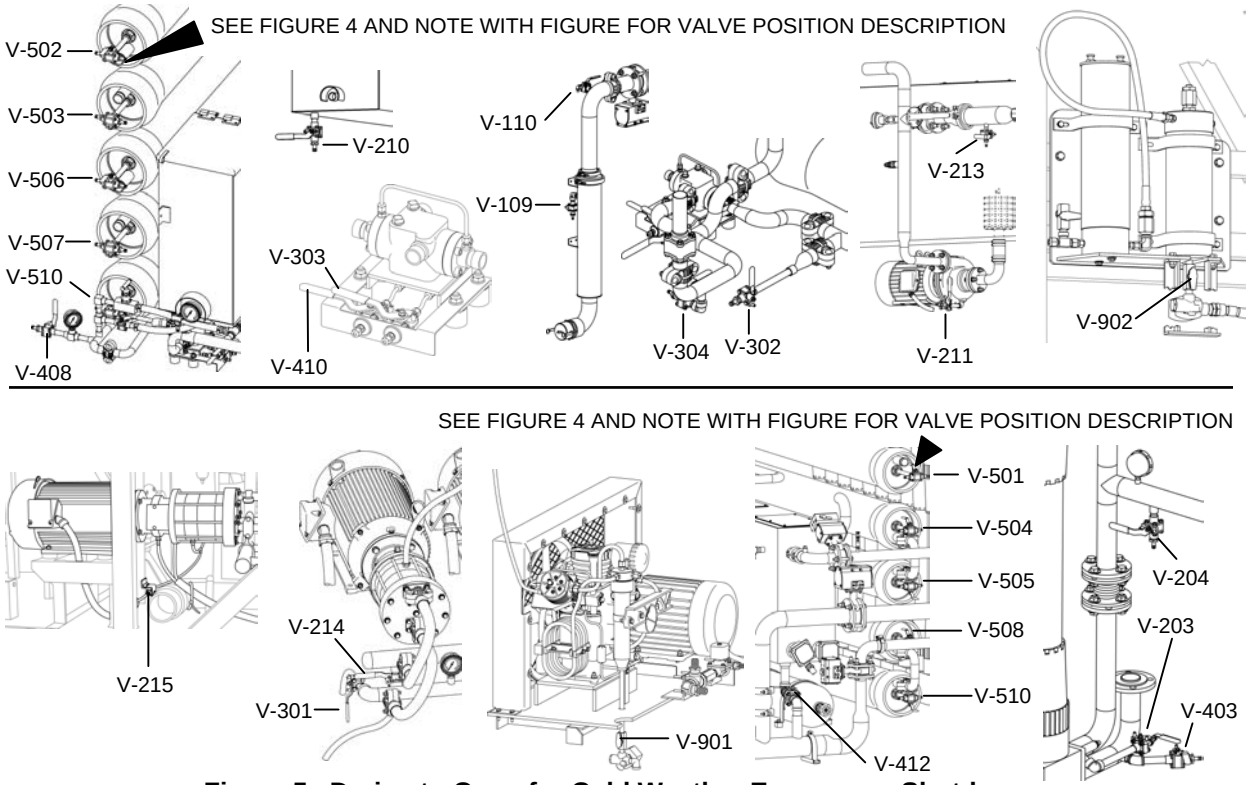

Figure 5. Drains to Open for Cold Weather Emergency Shutdown.

2. Connect the air hose to the air manifold and to RO Air Purge Valve V-913. Partly open the valve.
   a. When air is observed at drain valves V-302, V-303, V-304 or V-410, close these valves.
   b. When air is observed at drain valve V-408, shut off the air purge valve V-913.
   c. Open valves V-302, 303, 304 and 410.
3. Disconnect the HP Pump coolant return tubes from the RO Feed Tank (see Figure 6). Blow air into the tubes and out the pump drains using the auxiliary air gun (from the tool box). Reconnect hoses.

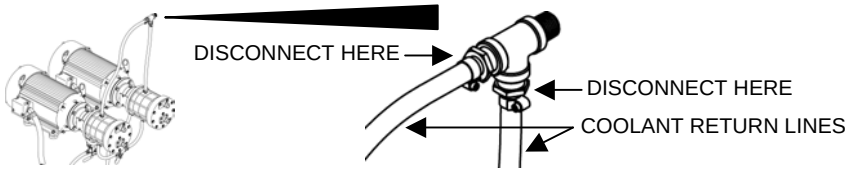

Figure 6. HP Pump Coolant Return Tubes at the RO Feed Tank.

4. Disconnect the raw water hoses and walk them out to quickly drain.
5. Open the raw water pump drains.
6. Pull the suction hose in and disconnect the sections.
7. Disconnect the MF Feed Pump hoses. Open the pump drain.
8. Disconnect the chemical pump discharge tubes at both ends and drain. Use the air hose if needed to blow them dry.
9. Disconnect the chemical pump suction tubes from the pump and from the foot valves. Be sure that they drain.

NBC DECONTAMINATION WATER PURIFICATION MISSION

Follow established doctrine for identifying the agents contaminating the raw water source and for product water quality release prior to distribution.

Single Pass NBC Filtration

The TWPS set up for a single pass through the NBC filter (WP 0010) will produce potable quality water from water contaminated with agents and concentrations as listed in Table 3.

Table 3. NBC Agents and Concentrations Treatable with Single Pass RO and NBC Filtration.

Agent	Concentration
VX, GD, GB, GA,	3 mg/l each
T-2 toxins	3 mg/l
Lewisite	3 mg/l
BZ	3 mg/l
Sulfur mustard	3 mg/l
Lindane	2 mg/l

The NBC filter will provide treatment with a wide margin of safety for 100 hours of water production at 25 gpm. The total amount of water that the filter can process is 150,000 gallons. Note the Hour Meter reading and the Product Totalizer reading at the beginning of the mission. The hour meter provides a backup in the event that the totalizer fails during the mission. When the NBC filter life has been spent, disconnect the hoses and allow it to drain. Cap the inlet and outlet connections. If the mission requires continued operation, a new filter and new filter media will be required. At the end of the mission, the filter or filters used are to remain in place for later disposal.

Double Pass NBC Filtration

The agents listed in Table 4 are not sufficiently removed by one TWPS with a single pass through the RO system and the NBC filter. Double pass reverse osmosis is required prior to the NBC filter.

Table 4. NBC Agents and Concentrations Requiring Double Pass RO and NBC Filtration.

Agent	Concentration	Acceptable Quantity
Cyanide	30 mg/L	2 mg/L
Arsenic	2 mg/L	0.02 mg/L
Radioactive iodide	167 micro-curies	0.05 micro-curies/L

Double pass NBC filtration may be accomplished by processing the water twice with one TWPS or by using two TWPS to provide product water to feed a third TWPS. When treating water contaminated with cyanide, the pH of the product water from the first pass is increased with caustic for use as feed water for the second pass.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0027 00**
OPERATOR INSTRUCTIONS
OPERATION UNDER UNUSUAL CONDITIONS

Double Pass NBC Filtration Using One TWPS

1. Wear appropriate protective gear as required.
2. Perform the first filtration pass as follows:
    a. Set up the unit for normal operation (WP 0007) except as noted below.
        1) Do not set up the NBC filter at this time. Set aside two product hoses (P02) to connect this filter when it is set up.
        2) MC-TWPS: Do not interconnect the two distribution tanks. Connect the product hose P02 (one or two hoses only) to only one of the two tanks. Connect the distribution pump to the discharge of the same tank. Physically mark this tank to identify it as “First Pass Product Water” (see Figure 7).

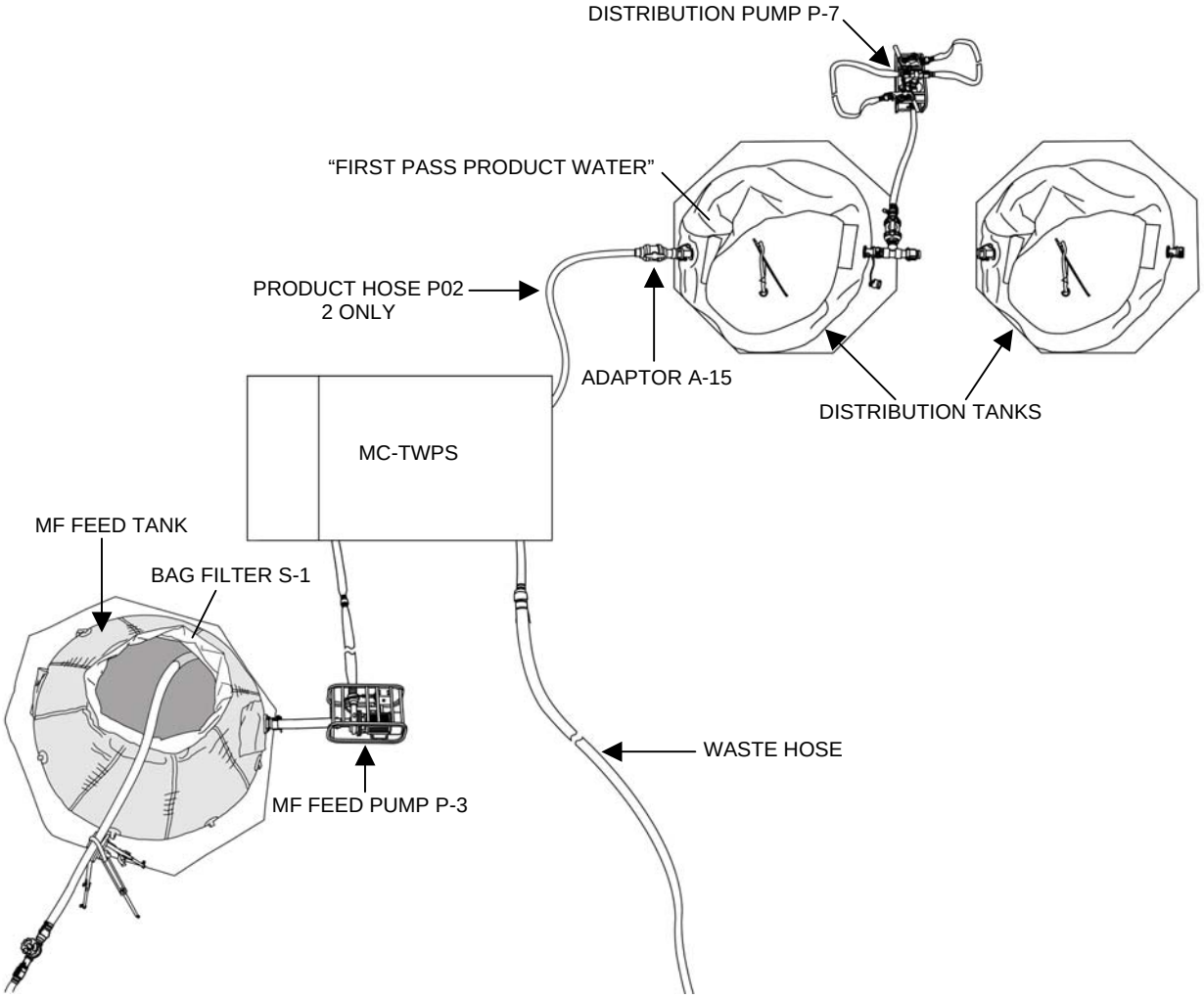

Figure 7. MC-TWPS First Pass Set-Up for Double Pass NBC Filtration Using One TWPS.

3) A-TWPS: Set up both the standard two-tank 6K distribution system and the three-tank 9K extended distribution system with their respective pumps. Connect the product hose P02 (one or two hoses only) to the 9K extended distribution system (see Figure 8).

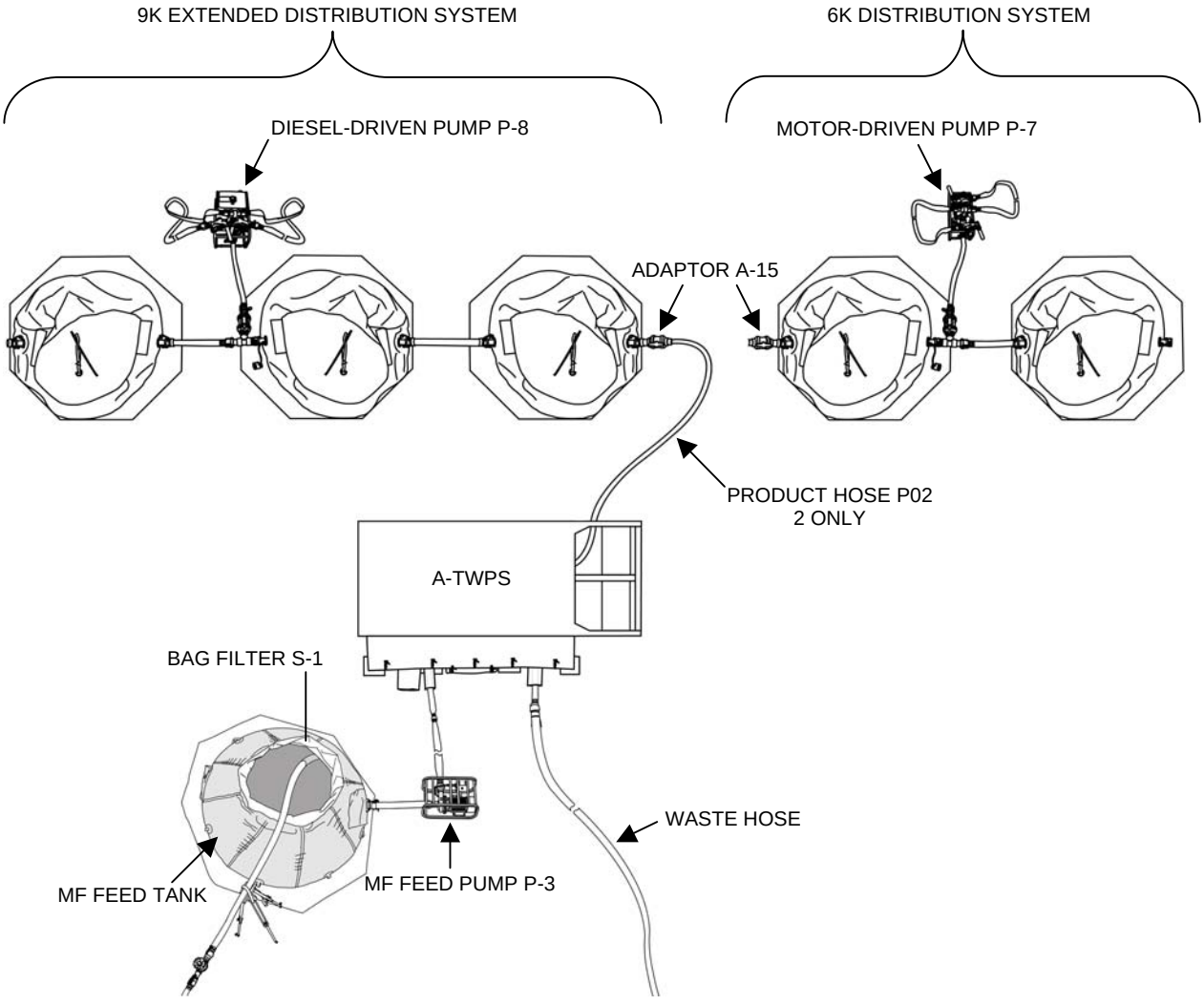

Figure 8. A-TWPS First Pass Set-Up for Double Pass NBC Filtration Using One TWPS.

b. Start up following the normal procedure (WP 0014) except do not set up the hypochlorite chemical system. Set the speed on the hypochlorite pump to OFF (fully counterclockwise). The first pass water is not chlorinated.

c. If treating water contaminated with cyanide, set up the hypochlorite chemical system after water production is established (with the product hose disconnected from the A-15 adaptor) as follows:
   1) Hypochlorite is not used. In its place, AC-350 caustic is used to increase the pH of the product water to a value of 10.5 to 11. This improves the rejection of the cyanide when the product water is treated in the second pass operation.
   2) Record the product water TDS and flow rate after start up.
   3) Calculate the amount of AC-350 caustic required in milliliters to be added when filling the chemical bucket:
      Factor A = Product TDS (in mg/L) x 0.141 + 9.8
      Amount = 2.97 x Factor A x Product Flow (gpm)
   4) Use the Bisulfite chemical bucket (blue cover) in place of the hypochlorite bucket. Fill the bucket with product water from the utility hose to the 4.5-gallon mark.
   5) Prime Chemical Pump CP-3 following the procedure for normal operation (WP 0014).
   6) Set the chemical pump speed dial to 70 and the stroke dial to 60.
   7) Wash out the 1000 ml measuring cup.

WARNING

Caustic chemical. Wear goggles, a protective face shield, chemical gloves, and a chemical apron when handling caustic solution. Contact with caustic will result in severe chemical burns. Keep water ready when handling. Avoid inhaling chemical fumes. If the caustic spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in severe irritation of the nose, throat, and eyes. Contact with skin will result in severe chemical burns if not immediately rinsed off.

   8) Put on the chemical apron, the goggles, the face shield and the chemical gloves. Open one container of AC-350 caustic and slowly pour out the calculated amount into the measuring cup.
   9) Slowly pour the measuring cup into the chemical bucket. Rinse the measuring cup in the chemical bucket and then in a bucket of clean water.
   10) Mix the caustic with the chemical mixing paddle.
   11) Check the product water pH (WP 0016). Adjust the stroke as needed to achieve a pH between 10.5 and 11.
   12) Connect the product hose to the A-15 adaptor to fill the distribution tank(s).

d. Continue to operate normally until the single MC-TWPS distribution tank or the three A-TWPS extended distribution tanks are filled.
e. Shut down to Standby with drain down (WP 0017).

3. Set up the MF tank for the second filtration pass as follows:
   a. Drain the MF Feed tank.
   b. Remove Bag Filter S-1 from the MF tank and set aside for later use or disposal.
   c. Rinse out the MF tank with “First Pass Product Water” from the distribution system.
   d. Set up the MF tank for normal operation, but do NOT install bag filter S-1 (WP 0007).
   e. Fill the MF Feed Tank ½ full with “First Pass Product Water” using a distribution nozzle.

4. Set up the NBC system for the second filtration pass as described in WP 0010 except as noted below:
    a. If caustic was injected, remove the CP-3 suction tube from the Bisulfite bucket used to hold the caustic. Set the bucket aside for later use when the TWPS is again used for first pass operation.
    b. The hypochlorite bucket and pump will be set up using “Second Pass Product Water” from the distribution system (WP 0014).
    c. Set the Speed dial on the antiscalant pump to OFF (fully counterclockwise).
    d. MC-TWPS: move the distribution hoses as follows (see Figure 9):
        1) Remove Adaptor A-15 with product hose P02 from the “First Pass Product Water” distribution tank and quickly cap the tank inlet.
        2) Remove adaptor A-15 and connect the product hose (P02) to the inlet at the top of the NBC tank. Up to three hoses may be used.

CAUTION

Do not connect the product hose to the 2nd distribution tank until verifying the product TDS and Chlorine.

        3) Connect one end of the product hose set aside earlier to the outlet at the bottom of the NBC tank. Place the other end near Adaptor A-15 on the 2nd distribution tank. If two hoses are required, use the second hose set aside earlier.
        4) Do not remove the distribution pump from the “First Pass Product Water” distribution tank.

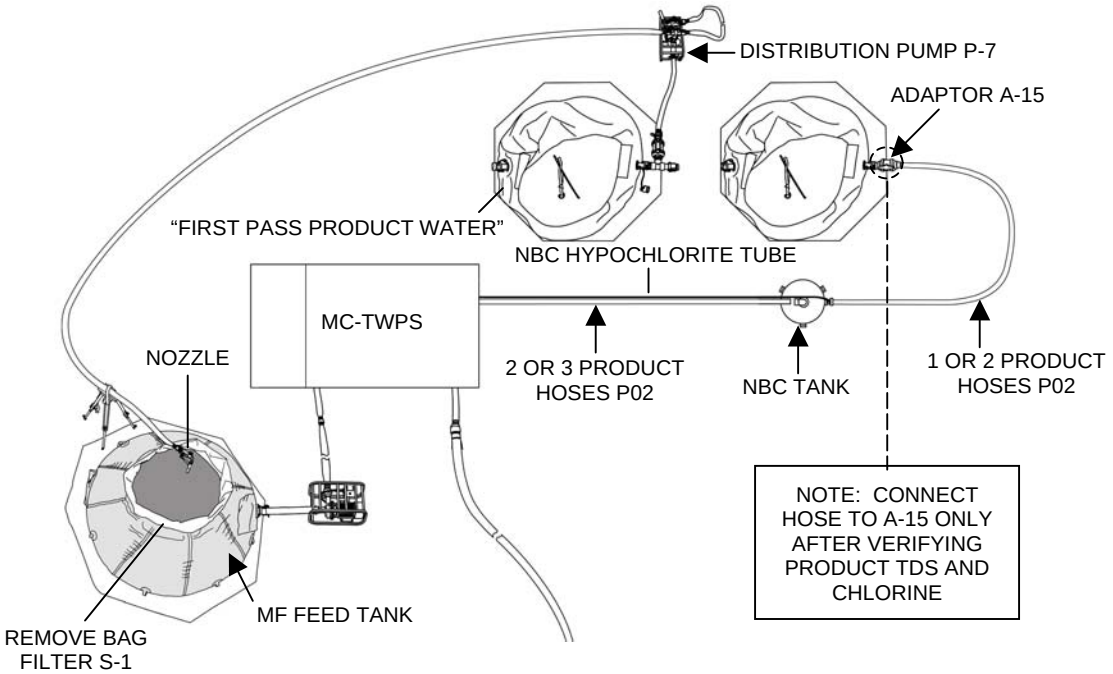

Figure 9. MC-TWPS Second Pass Set-Up for Double Pass NBC Filtration Using One TWPS.

e. A-TWPS: Move the distribution hoses as follows (see Figure 10):
   1) Close Adaptor A-15 on the 9K extended distribution system
   2) Remove the product hose from Adaptor A-15 on the 9k system.
   3) Connect the product hose to the inlet at the top of the NBC tank. Three hoses may be used if required.

CAUTION

Do not connect the product hose to the 2nd distribution tank until verifying the product TDS and Chlorine.

   4) Connect one end of a product hose set aside earlier to the outlet at the bottom of the NBC tank. Place the other end near Adaptor A-15 on the 6K standard distribution system. If two hoses are required, use the second hose set aside earlier.

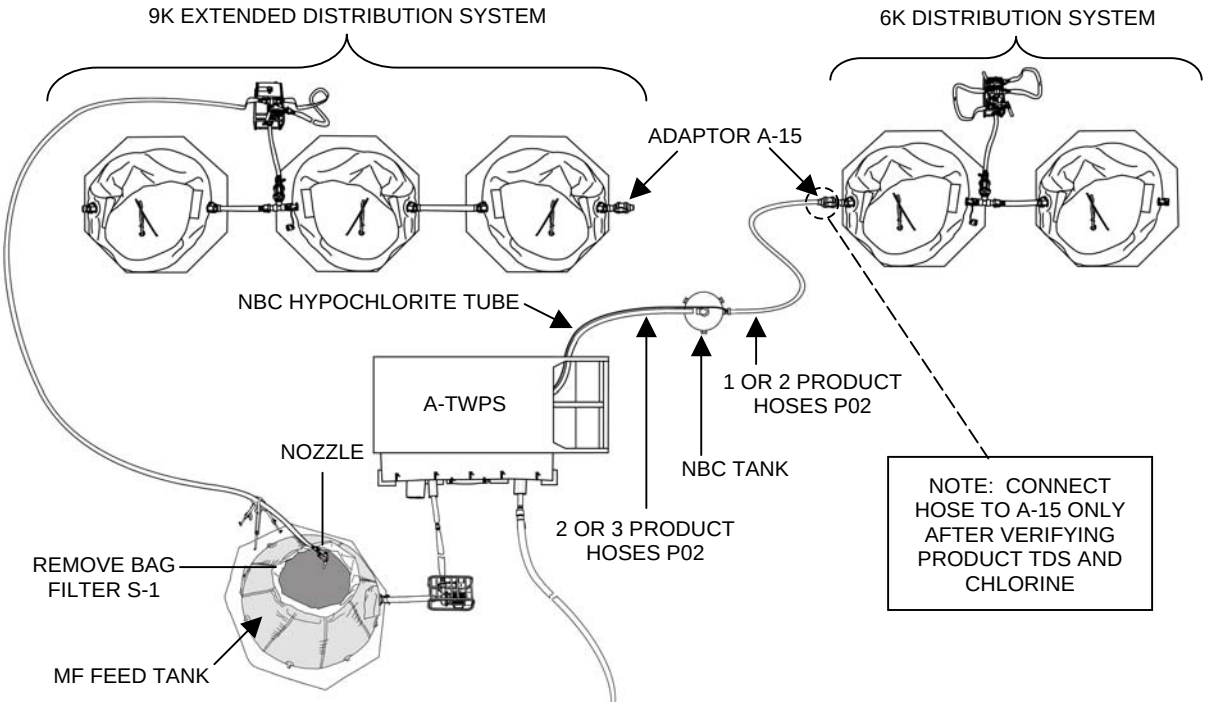

Figure 10. A-TWPS Second Pass Set-Up for Double Pass NBC Filtration Using One TWPS

5. Perform the second filtration pass as follows:
    a. Note the Total Product Water reading on the OCP.
    b. Continue with the normal initial start up and operation (WP 0014). Fully close HCV-401 and HCV-401A to maximize production rate. **Do not push Backwash Start**. The second filtration pass operation does not require backwashing. Omitting this step makes more product water available for use.
    c. Leave the antiscalant pump speed dial to OFF (fully counterclockwise).
    d. Batch the hypochlorite using 2nd pass product water.
    e. After measuring the product TDS and chlorine (WP 0017), connect the product water hose to Adaptor A-15 on the distribution tank.
    f. Using the distribution pump, keep the MF feed tank ½ to ¾ full with water from the "First Pass Product Water" distribution tank (MC-TWPS) or the 9k extended distribution system tanks (A-TWPS).
    g. When the last of the "First Pass Product Water" is put into the MF feed tank, allow the MF feed tank to be emptied by the MF Feed Pump. Keep the TWPS operating until it shuts down due to low RO Feed Tank level or low RO feed pressure.
6. Note the Total Product Water reading on the OCP at the end of the second filtration pass. Subtract the first reading from this reading to calculate the total water produced.
7. Repeat the double pass filtration procedures as long as the mission demand requires. Calculate the total water produced each time.
8. Replace the NBC filter when the total water produced by the second pass operation reaches 150,000 gallons.

Double Pass NBC Filtration Using Three TWPS

1. Wear appropriate protective gear as required.
2. Set up first two TWPS units for normal operation (WP 0007) except as noted below (see Figure 11):
    a. Set up only one two-tank 6k standard distribution system to be shared by the two units.
    b. Interconnect the two distribution tanks as for normal operation.
    c. Do not connect a distribution pump to the tanks discharge hose.
    d. Connect the product hose P02 and Adaptor A-15 from one TWPS unit to one of the distribution tanks.
    e. Connect the product hose P02 and Adaptor A-15 from the second TWPS unit to the other distribution tank.
    f. Do not set up the NBC tanks for the first two TWPS.
3. Set up the third TWPS unit for normal operation (WP 0007) except as noted below (see Figure 11):
    a. Unscrew the inlet coupling from the raw water pump for the third TWPS unit.
    b. Unscrew the inlet coupling from the distribution pump for one of the first two TWPS and install it on the raw water pump.
    c. Connect the raw water pump to the distribution system hose P04 for the first two units where the distribution pump would normally be connected.
4. Set up the NBC tank for the third TWPS (see Figure 11) (WP 0010).

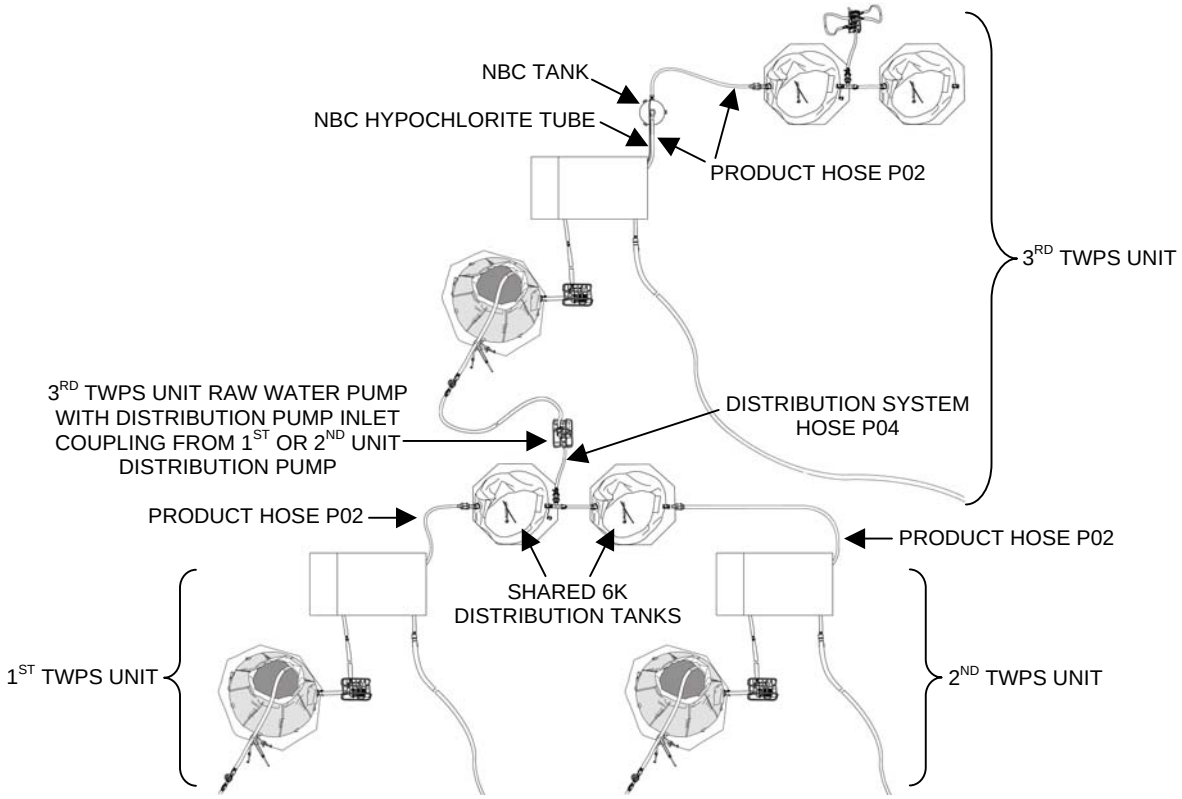

Figure 11. Double Pass NBC Filtration Set-Up Using Three TWPS Units.

5. Operate the first two TWPS units for the first filtration pass as follows:
    a. Unless treating water contaminated with cyanide, set the Speed dial on the hypochlorite pump to OFF (fully counterclockwise).
    b. If treating water contaminated with cyanide, set up the hypochlorite chemical system after water production is established (with the product hose disconnected from the A-15 adaptor) as follows:
        1) Hypochlorite is not used. In its place, AC-350 caustic is used to increase the pH of the product water to a value of 10.5 to 11. This improves the rejection of the cyanide when the product water is treated in the second pass operation.
        2) Record the product water TDS and flow rate after start up.
        3) Calculate the amount of AC-350 caustic required in milliliters to be added when filling the chemical bucket:
        Factor A = Product TDS (in mg/L) x 0.141 + 9.8
        Amount = 2.97 x Factor A x Product Flow (gpm)
        4) Use the Bisulfite chemical bucket (blue cover) in place of the hypochlorite bucket. Fill the bucket with product water from the utility hose to the 4.5-gallon mark.
        5) Prime Chemical Pump CP-3 following the procedure for normal operation (WP 0014).
        6) Set the Speed to 70 and the stroke to 60.

7) Wash out the 1000 ml measuring cup.

WARNING

Caustic chemical. Wear goggles, a protective face shield, chemical gloves, and a chemical apron when handling caustic solution. Contact with caustic will result in severe chemical burns. Keep water ready when handling. Avoid inhaling chemical fumes. If the caustic spills, immediately flush the area with water from the auxiliary hose. Failure to observe this warning may result in severe irritation of the nose, throat, and eyes. Contact with skin will result in severe chemical burns if not immediately rinsed off.

8) Put on the chemical apron, the goggles, the face shield and the chemical gloves. Open one container of AC-350 caustic and slowly pour out the calculated amount into the measuring cup.
9) Slowly pour the measuring cup into the chemical bucket. Rinse the measuring cup in the chemical bucket and then in a bucket of clean water.
10) Mix the caustic with the chemical mixing paddle.
11) Check the product water pH (WP 0016). Adjust the stroke as needed to achieve a pH between 10.5 and 11.
12) Connect the product hose to the A-15 adaptor to fill the distribution tank(s).

c. Continue with normal startup and operation. If possible, push the product flow to 29 to 30 gpm from each unit.

6. Operate the third TWPS unit for the second filtration pass as follows:
   a. Set the speed switch on the antiscalant pump to OFF (fully counterclockwise).
   b. Set up the hypochlorite pump for normal operation.
   c. Continue with normal startup and operation after the distribution tanks for the first two TWPS units are at least ¼ full. Fully close HCV-401 and HCV-401A to maximize production rate. **Do not push Backwash Start.** The second filtration pass operation does not require backwashing. Omitting this step makes more product water available for use.
   d. Leave the antiscalant pump speed switch set to OFF (fully counterclockwise).
   e. Replace the NBC filter when the total water produced by the third TWPS unit reaches 150,000 gallons.

At the end of the mission, the TWPS equipment must be decontaminated or replaced as instructed under **Equipment Decontamination After an NBC Water Purification Mission** below.

EQUIPMENT DECONTAMINATION AFTER AN NBC WATER PURIFICATION MISSION

At the conclusion of an NBC water purification mission, the TWPS must be decontaminated before moving. There are different procedures for nuclear decontamination and chemical/biological decontamination. If nuclear contamination is present together with chemical and/or biological contamination, use the chemical/biological decontamination procedures.

Nuclear Decontamination

1. Shutdown to standby.
2. Flush the MF System as follows:
    a. Clean the MF feed strainer and re-install.
    b. Empty the MF feed tank. Remove the bag strainer and set aside for disposal.
    c. Fill the MF feed tank with product water.
    d. Set the MF Clean Switch to BACKWASH.
    e. Complete four backwashes with product water.
    f. Set the MF Clean Switch to OFF.
3. Flush the RO System as follows:
    a. Set the product hose to discharge on the ground.
    b. Use the distribution nozzles to keep the MF feed tank full of product water.
    c. Start up normally. Do not initiate the backwash.
    d. Continue operation for 10 minutes. Shutdown to standby.
4. Drain the TWPS as follows:
    a. Set the Mode Switch to MF DRAIN.
    b. When the drain is complete, set the Mode Switch to STANDBY and then back to MF DRAIN for a second drain.
    c. Open RO Vessel Drain Valve V-408.
    d. Connect the auxiliary air hose to the air system connector and then to RO Air Purge Valve V-913. Partially open V-913 and leave open until air begins to discharge from RO Vessel Drain Valve V-408.
    e. Open all drains (see Table 2 and Figure 5 for valve location).
5. Remove the MF elements as follows:
    a. Remove the MF elements including the filtrate cups and O-rings (see WP 0040).
    b. Set aside for later disposal by a decontamination team.
6. Flush the Raw Water System as follows:
    a. Reset the raw water suction hoses to draw from the MF feed tank.
    b. Keep the MF feed tank full with product water from the distribution nozzles.
    c. Connect all of the hoses and pump(s) that were originally deployed.
    d. Set the discharge hoses to discharge back to the raw water source.
    e. Start the pump(s).
    f. Fully open Raw Water Flow Control Valve V-107 (see Figure 2 for valve location).
    g. Flush for approximately 10 minutes.
7. Preparation for Movement: Follow normal procedures.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0027 00**
OPERATOR INSTRUCTIONS
OPERATION UNDER UNUSUAL CONDITIONS

Chemical/Biological Decontamination

WARNING

Chemical hazard. When handling the chemicals and the decontamination solution mixture, wear the protective goggles, face mask, apron and gloves. Always keep one or two chemical buckets filled with product water and ready to use. Direct contact with the decontamination solution will cause skin burns and may cause serious eye damage.

Hazardous chemical dust and/or fumes. Wear the protective face shield, chemical gloves, and dust mask when handling calcium hypochlorite. Avoid inhaling chemical dust or fumes. Hypochlorite will give off chlorine vapor, which will burn your nose, throat and lungs if breathed directly. Keep your head away from the top of the bucket while filling. Inhalation of calcium hypochlorite dust may cause severe chemical burns. Direct contact with the eyes may cause severe eye damage.

1. Shutdown to standby.
2. Decontaminate the MF System as follows:
    a. Follow the procedure for **MF Caustic Detergent Cleaning** in WP 0021 with the changes stated below.
    b. After adding the AC-350 caustic, slowly add 15 lbs. of calcium hypochlorite.
    c. Extend the soak to 4-hours.
    d. Complete following the normal cleaning procedure.
    e. Set the MF feed tank aside for disposal.
    f. Decontaminate MF Feed Strainer S-2 as follows:
        1) During the extended soak, vent the MF strainer (V-110 and V-109) and then remove the strainer and place it in the RO feed tank.
        2) Leave the strainer in the tank until after the rinsing is complete. When filling the tank, be sure to rinse the strainer.
        3) Remove the strainer from the tank, rinse and remove any remaining dirt.
    g. Decontaminate the MF Feed Strainer S-2 body as follows:
        1) After removing the strainer, disconnect the raw water hose from the TWPS raw water inlet and install the cap on the inlet.
        2) Using the raw water pump priming pitcher, collect decontamination solution through the RO Feed Tank Auxiliary Drain Valve V-210 and drain tube (see Table 2 and Figure 5 for valve location).
        3) Pour the solution into the strainer body. Repeat until the strainer body is full.
        4) At the end of the soak, drain the filter into a chemical bucket and pour back into the RO feed tank.
3. Decontaminate the RO System as follows:
    a. Follow the procedure for **RO Detergent Cleaning** in WP 0023 with the changes stated below.
    b. After adding the detergent, add 4 gallons of caustic following the procedure described for **MF Caustic Detergent Cleaning** in WP 0021.

c. After adding the caustic, slowly add 15 lbs of calcium hypochlorite.
d. To establish circulation, leave RO Clean Feed Valve V-701 closed and open HP Pump Shutoff Valve V-212 to circulate the solution through the entire system (see Figure 2 for valve location).
e. Continue circulation for 4-hours.
f. Complete following the normal cleaning procedure.
g. Perform a product water flush of the system (Short Term Shutdown, WP 0017).

4. Decontaminate the raw water pump(s) as follows:
   a. During the extended soak, move the raw water pump(s) to the TWPS.
   b. Install the plug(s) in the inlet connection(s).
   c. Using the raw water pump priming pitcher, collect decontamination solution from the RO Feed Tank Auxiliary Drain Valve V-210 and drain tube (see Table 2 and Figure 5 for valve location).
   d. Pour the solution into the pump(s). Repeat until the pump(s) is (are) full.
   e. At the end of the soak, drain the pump(s) into a chemical bucket and pour back into the RO feed tank
   f. Flush the pump(s) with product water from a distribution nozzle.
5. Remove the MF and RO elements as follows:

WARNING

Chemical burn hazard. Wear the protective goggles, face shield, apron and gloves. The residual caustic and chlorine will cause skin burns and may cause serious eye damage if direct contact occurs.

   a. Fill the chemical buckets with product water for rinsing gloves and any skin areas that may come in contact with decontamination solution.
   b. Remove the MF elements, cups and O-rings. Flush with product water and set aside for disposal.
   c. Flush the MF element center tubes and the heads with product water before re-installing the center tubes.
   d. Remove the RO elements, flush the outside with product water and set aside for disposal.
6. Remove all the hoses and adaptors that were deployed and set them aside for disposal.

NBC SURVIVABILITY

The CAC cover is supplied to provide equipment survival from an NBC agent attack. The doctrine assumes that a warning of a possible NBC agent attack is provided. Install the cover as described in WP 0010, Other Set-Ups – Operation Under Unusual Conditions.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0027 00**
OPERATOR INSTRUCTIONS
OPERATION UNDER UNUSUAL CONDITIONS

LOW EMI EMISSIONS MISSIONS

If the mission requires low EMI emissions, pull out the conductivity transmitter ON/OFF switch on the instrument/solenoid panel and move it down to the OFF position. Move the switch to the ON position only as needed to collect conductivity data, then move the switch back to the OFF position. (See Figure 12)

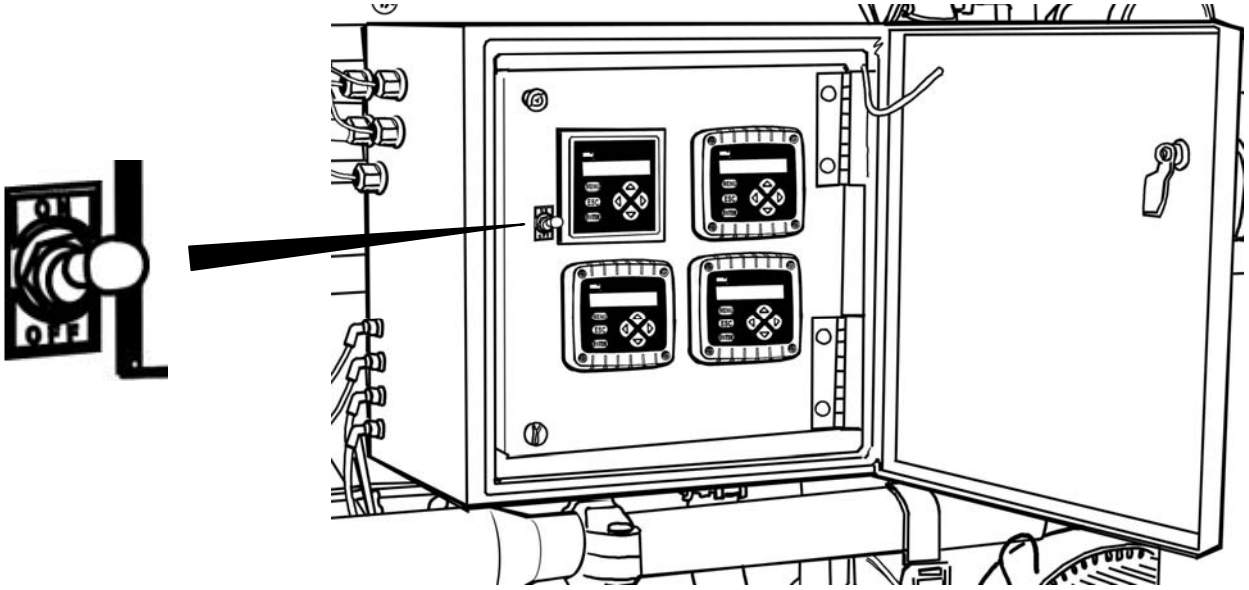

Figure 12. Conductivity Transmitter ON/OFF Switch.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS PREPARATION FOR MOVEMENT – ARMY UNIT

0028 00

INITIAL SETUP:

Reference:
TM 10-5430-237-12&P
Personnel Required:
Three Operator/Crew
Equipment Condition:
TWPS set up and operating or shut down

GENERAL

This work package provides instructions for preparing and packing out the A-TWPS for movement from one deployed location to another, including short storage periods (up to 30 days) between deployments. Refer to WP 0031 for packout procedures if the unit if it will be in storage for more than 30 days.

UNIT SHUTDOWN AND PRESERVATION

Before starting equipment/component disassembly and packout, the A-TWPS must be shut down, flushed and drained, and the power source must be secured. Preservation of the Micro-Filtration (MF) and Reverse Osmosis (RO) elements may also be necessary depending on the expected length of the shutdown.

1. Refer to WP 0017 and WP 0018 for shutdown and preservation requirements and procedures.
2. Disconnect the power and ground cables from the Tactical Quiet Generator (TQG) as follows:

WARNING

High voltage electrical hazard. High voltage is produced when the generator set is in operation. Make sure that the Tactical Quiet Generator has been properly shut down before attempting to disconnect the power or ground cable from the TQG. Failure to observe this warning could result in injury or death from electrical shock.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

NOTE
Refer to TM 5-6115-545-12 for generator operation.

a. Disconnect the TWPS power cable leads from the generator lugs labeled L1, L2, and L3.
b. Disconnect the TWPS power cable white lead from the generator Neutral lug and the green lead from the generator Ground lug.
c. Tuck the TWPS power cable end inside the TWPS frame.
d. Disconnect the ground cable from the generator Ground lug.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – ARMY UNIT

PREPARATION FOR PACKOUT

Prepare the A-TWPS for packout as described in the following steps. These steps can generally be performed at the same time and in any convenient order. Depending on the specific operating configuration and environmental conditions, some steps will not be necessary.

3. Sort by length and lay out the following straps that will be used to secure various components:
   - Six 12-in. hook and loop straps (4 of 6 should already be on the NBC Hypochlorite tubing)
   - Ten 18-in, hook and loop straps
   - Ten 36-in. hook and loop straps
   - Ten 48-in. hook and loop straps
   - Twelve 10-ft. ratchet straps (2 of the 12 should already be around the NBC tank)
   - Six 20-ft. ratchet straps
4. If the heating blankets were used, sort by length and lay out the following heating blanket hook and loop straps that were stored in a separate BII box when the blankets were installed:
   - Two 18-in. hook and loop straps
   - Eleven 36-in. hook and loop straps
   - Twelve 48-in. hook and loop straps
5. Sort by length and lay out the following discharge hose straps that were stored in a separate BII box when the hoses were installed. (The hose straps are brown and have a carrying loop.)
   - Ten 25-in. straps
   - Two 12-in. straps
   - One 36-in strap

NOTE

All product water hoses have caps and plugs that should be installed on the end of the hoses during packout to keep the product hoses clean.

For easy identification, all system hoses are coded with colored bands at each end as follows:

- **Ocean Intake Structure System (OISS) – yellow**
- **Raw Water – green**
- **Product Water – blue**
- **Cleaning and Waste - red**

6. Remove the raw water, MF feed, and product water distribution pump insulated covers if used.
7. Disconnect all hose and adaptor heating blanket and pump heating collar power cables and remove the blankets and collars if used.
8. Tightly roll up the heating blankets as follows:
   a. Lay out the blanket with the air vents facing up. Open the air vents (see Figure 1).
   b. Starting at the end opposite the power cable, double the blanket over as shown and roll it up as tightly as possible.
   c. At the power cable end, make sure the cable is rolled up inside the blanket.

NOTE

Be sure the blankets are rolled up as tightly as possible so they will all fit in their designated packout locations.

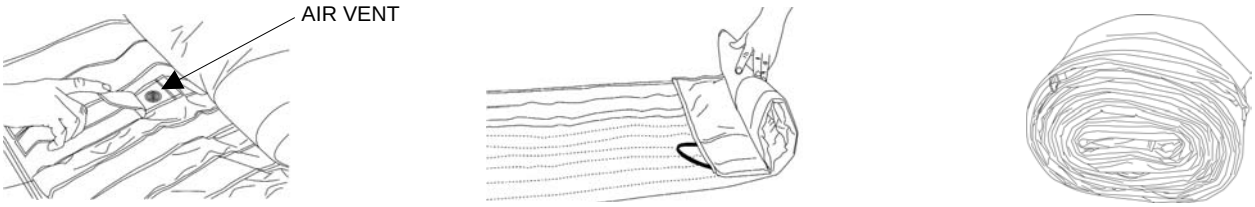

Figure 1. Rolling Up the Hose Heating Blankets.

d. Secure each rolled-up blanket with a hook and loop strap as indicated in the table below:

Table 1. Straps to Secure Heating Blankets.

Heating Blanket Stencil	Hook and Loop Strap(s) to Use
A02	18-in.
F01-1	48-in.
F01-2	48-in.
F03-1	48-in + 36-in.
F03-2	48-in + 36-in.
F07	48-in + 18-in.

Heating Blanket Stencil	Hook and Loop Strap(s) to Use
F12	48-in.
P02	36-in + 36-in.
P03-1	36-in.
P03-2	36-in.
P04	36-in.
P05	48-in.

9. Disconnect the raw water, MF feed, and product water distribution hoses and adaptors. Allow them to drain.
10. Install the dust covers and caps on the product water distribution hoses. (Note: dust covers and caps are only provided for the product water hoses. The covers and caps are stored in BII Box #3 when the hoses are in use).
11. Set the hoses and adaptor aside.
12. Install dust caps on the TWPS raw water inlet, product water discharge hose, and waste outlet.
13. Remove the cap from the end of each distribution discharge (collapsible) hose, tightly roll up the discharge hoses and secure each with one brown hose strap as indicated in the table below, then reinstall the caps on the ends of the hoses.

Table 2. Straps to Secure Discharge Hoses.

Hose	Hose Qty.	Strap
F02 2-in x 6-ft.	1	12-in.
F03 2-in x 50-ft.	4	25-in.
F07 3-in. x 10-ft.	2	25-in.

Hose	Hose Qty.	Strap
P05 2-in. x 65-ft.	4	25-in.
P06 5/8-in. x 50-ft.	1	12-in.
R05 6-in. x 50-ft.	1	36-in.

14. Retrieve the anchor assembly and/or OISS. Disassemble the OISS and set the parts aside.
15. Open the drain valves on the raw water, MF feed, and product water distribution pumps and drain the pump casings. Close the valves after all the water has drained. Install the dust caps and covers on the pump inlet and outlet connections.
16. Disconnect the motor-driven pump power cables at both ends and install the dust covers on the cable connectors. Tightly coil the cables and set them aside.
17. Install the dust caps on all pump skid junction box receptacles.

18. Close the fuel cock on the diesel pump fuel tank, disconnect the fuel supply and return quick disconnect couplings.

CAUTION

Potential cause of fuel pump and injection valve failure. Do not leave the fuel lines for the diesel engine and fuel tank disconnected. Failure to observe this caution may allow sand and dirt to enter the fuel system and result in fuel pump and injection valve failure.

19. Couple the two tank fuel lines together and the two diesel engine fuel lines together.
20. Remove the fuel tank.
21. Remove the screen filter from the fuel filler port and drain the fuel from the tank into a fuel can.
22. Ventilate the fuel tank as follows (see Figure 2).
    a. Connect the quick-disconnect air hose (BII Box #8) to the quick-disconnect fitting in Air System Section 1.
    b. Connect the air blowgun (air nozzle, Operator's Tool Kit) to the other end of the air hose.
    c. Blow air into the fuel filler port to ventilate the fuel tank.
    d. Reinstall the screen filter and the fuel cap.

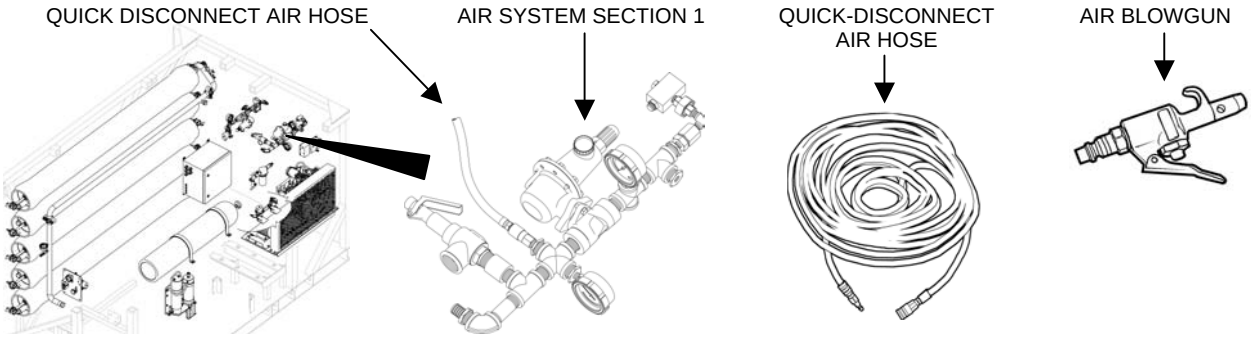

Figure 2. Quick-Disconnect Air Hose Connections.

23. Remove the suction and return tubing from the chemical buckets. Dispose of the contents of the buckets in accordance with local instructions, then set the buckets and lids aside.
24. After completely draining the 3000-gallon product water distribution tanks, roll up the tanks, place one tank repair kit on each tank, and wrap the tank ground cloth around the tank. Refer to TM 10-5430-237-12&P. Then wrap two 48-in. hook and loop straps around each tank for additional support to keep the tanks rolled up.
25. After completely draining the 1000-gallon MF feed tank, pack up the tank, a repair kit, and the ground cloth similar to the procedures for the product water distribution tanks. Wrap two 36-in. hook and loop straps around the tank for additional support to keep the tank rolled up.
26. Neutralize and dispose of the waste in the cleaning waste tank (see WP 0026 01).
27. Pack the 1500-gallon cleaning waste tank with its repair kit and ground cloth similar to the procedures for the product distribution tanks. Wrap two 36-in. hook and loop straps around the tank for additional support to help keep the tank rolled up.

28. Turn off the diesel-fired heater and allow it to cool. After the diesel-fired heater has cooled, drain and ventilate the fuel tank as follows (see Figure 2):
    a. Remove the drain plug from the bottom of the fuel tank and drain the fuel into a fuel can.
    b. Remove the fuel cap from the fuel tank.
    c. Connect the quick-disconnect air hose (BII Box #8) to the quick-disconnect fitting in Air System Section 1.
    d. Connect the air blowgun (air nozzle, Operator's Tool Kit) to the other end of the air hose.
    e. Blow air into the diesel-fired heater fuel filler port to ventilate the fuel tank.
    f. Clean the drain plug threads, apply antiseizing tape to the threads and reinstall the drain plug into the bottom of the fuel tank.
    g. Reinstall the fuel cap.
29. Disassemble the heating ducts, plenums, and registers and set them aside.
30. Disconnect the ground wire from the generator and ground rod. Coil the wire and set it aside.
31. Retrieve the ground rod. Disassemble the rod and the slide hammer, then reinstall the washers and nuts onto the slide hammer rod.
32. Empty the fuel can into the generator (TQG) fuel tank.
33. Remove the fabric wall and fold it up as follows (see Figure 3):
    a. Lay the wall out flat, with the white inner side facing up (Step 1).
    b. From both ends, fold the wall in toward the middle about halfway (Step 2).
    c. Fold the ends in again so they meet in the middle (Step 3).
    d. Fold the wall in half, then in half again (Steps 4 and 5).

Figure 3. Folding Up the Fabric Wall.

34. Fold the CAC (NBC contamination avoidance cover) as follows if it was opened, such as if it were used as a tarp:
    a. Lay the CAC out flat (1).
    b. From both ends, fold the long sides into the middle (2).
    c. Fold the long sides on top of each other (3).
    d. From both ends, fold the short sides into the middle (4).
    e. Fold the short sides on top of each other (5).

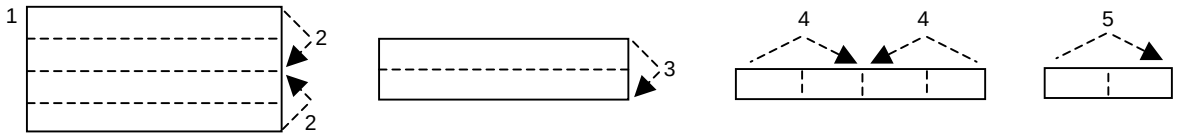

Figure 4. Folding Up the CAC.

PACKOUT

Basic Issue Items Packout

Referring to the illustrations and tables on the following pages, pack out the tool box, the six numbered BII boxes, the two BII buckets, and the manuals storage box and set them aside.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – ARMY UNIT

Operator's Tool Kit

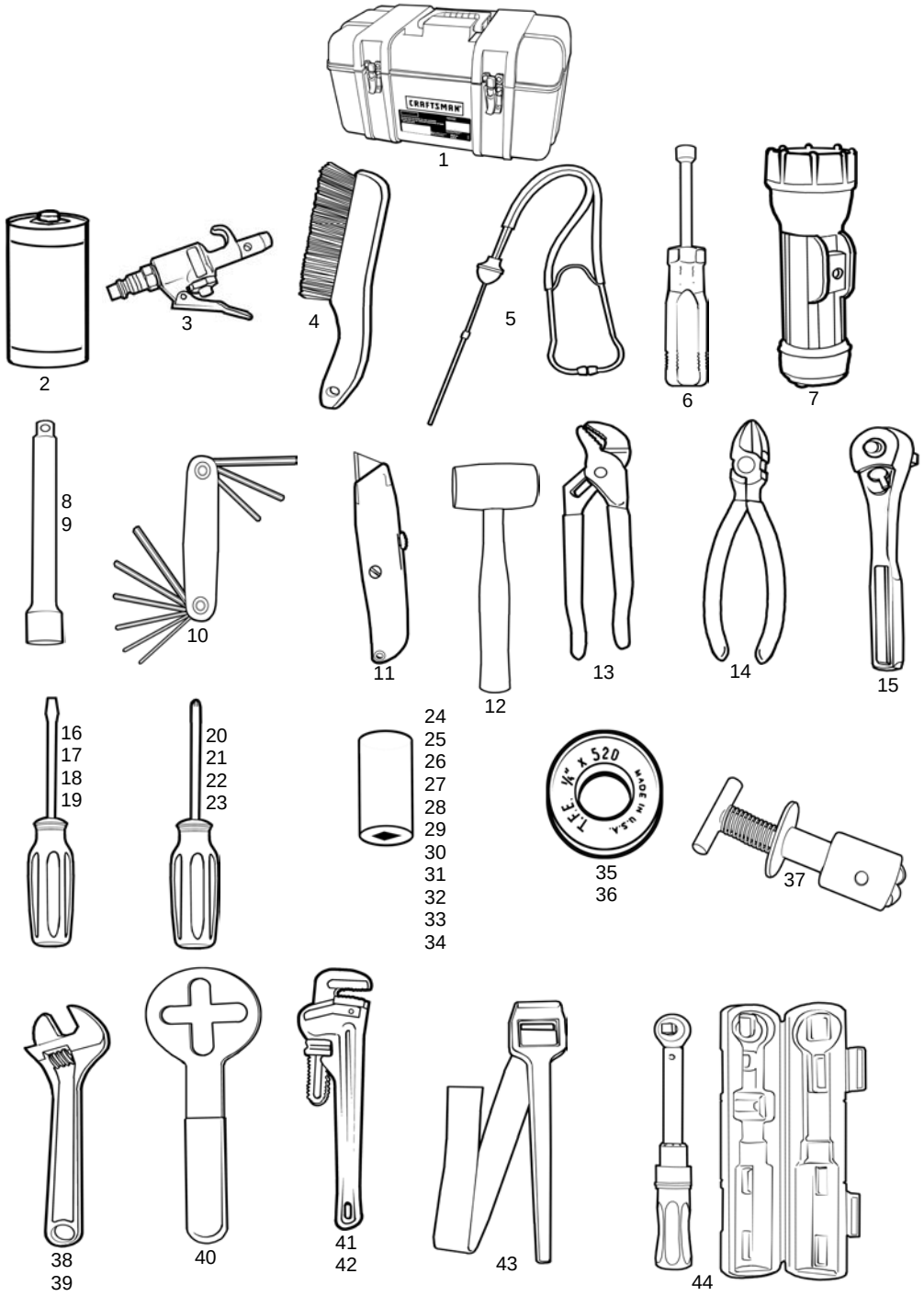

Table 3. Operator's Tool Kit.

No.	Item Name	Qty
1	Tool Box	1
2	Battery, D-Size, Package of 6	1
3	Blowgun Assy	1
4	Brush, Plater's	1
5	Detector, Mf Leak	1
6	Driver, Nut, 5/16"	1
7	Flashlight, D-Size	1
8	Extender, Socket, 3"	1
9	Extender, Socket, 6"	1
10	Key Set, Hex, Foldup Set	1
11	Knife, Utility	1
12	Mallet, Rubber, Wood Handle	1
13	Pliers, Channel Lock, 9.5"	1
14	Pliers, Diagonal	1
15	Ratchet, 3/8"	1
16	Screwdriver, Flat Blade	1
17	Screwdriver, Flat Blade	1
18	Screwdriver, Flat Blade	1
19	Screwdriver, Flat Blade	1
20	Screwdriver, Phillips Blade	1
21	Screwdriver, Phillips Blade	1
22	Screwdriver, Phillips Blade	1
23	Screwdriver, Phillips Blade	1
24	Socket, 1/2"	1
25	Socket, 11/16"	1
26	Socket, 13/16"	1
27	Socket, 15/16"	1
28	Socket, 3/4"	1
29	Socket, 3/8"	1
30	Socket, 5/8"	1
31	Socket, 7/16"	1
32	Socket, 7/8"	1
33	Socket, 9/16"	1
34	Socket, Spark Plug, 5/8"	1
35	Tape, Antiseizing, 1/2" Wide	1
36	Tape, Antiseizing, 1/4" Wide	1
37	Tool, Mf Filter Bypass	1
38	Wrench, Adjustable, 10"	1
39	Wrench, Adjustable, 8"	1
40	Wrench, Air Compressor Purification Chamber	1
41	Wrench, Pipe, 12"	1
42	Wrench, Pipe, 15"-18"	1
43	Wrench, Strap, 1"-5" Pipe	1
44	Wrench, Torque, With Case	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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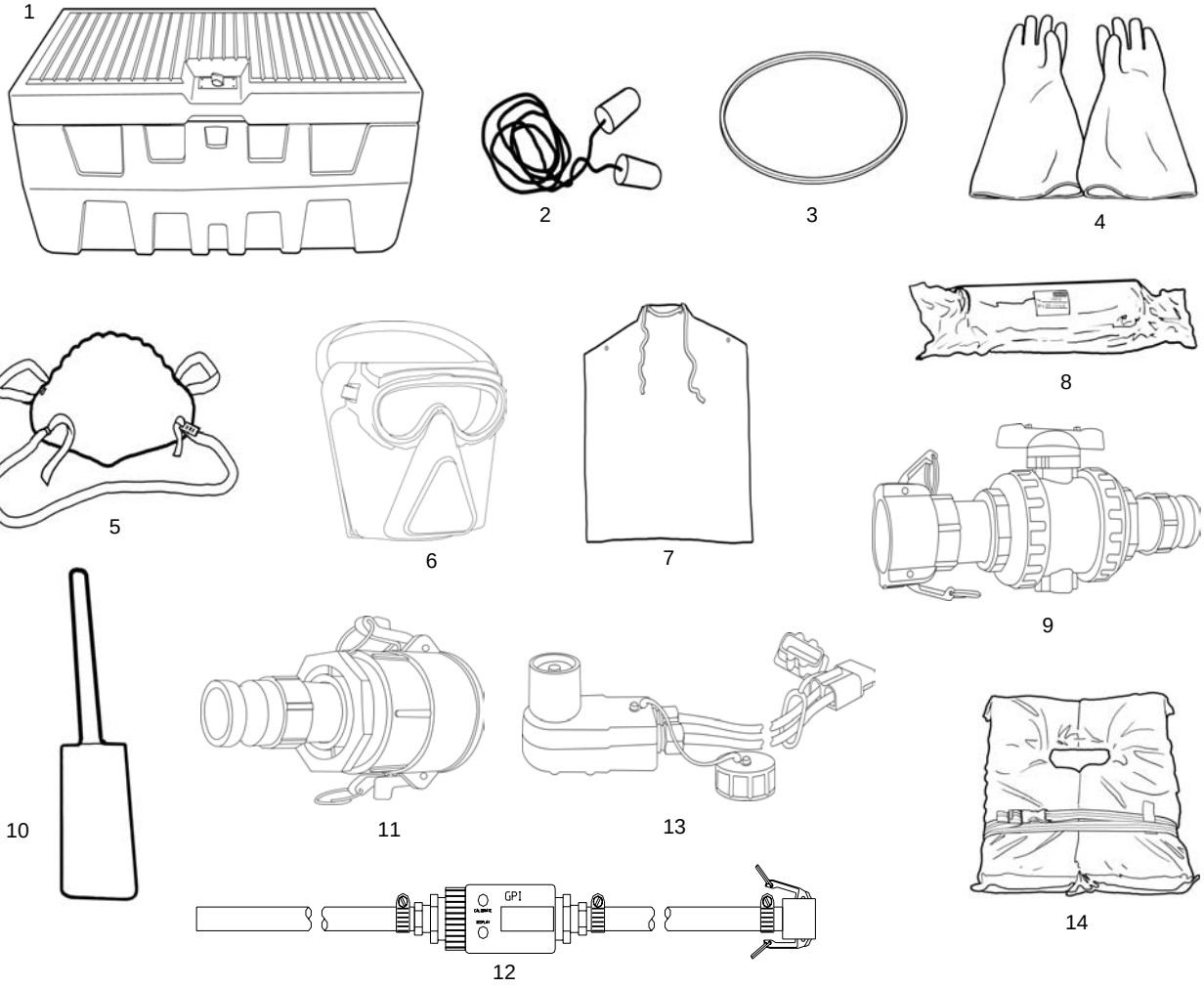
PREPARATION FOR MOVEMENT – ARMY UNIT

BII Box #1



TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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PREPARATION FOR MOVEMENT – ARMY UNIT

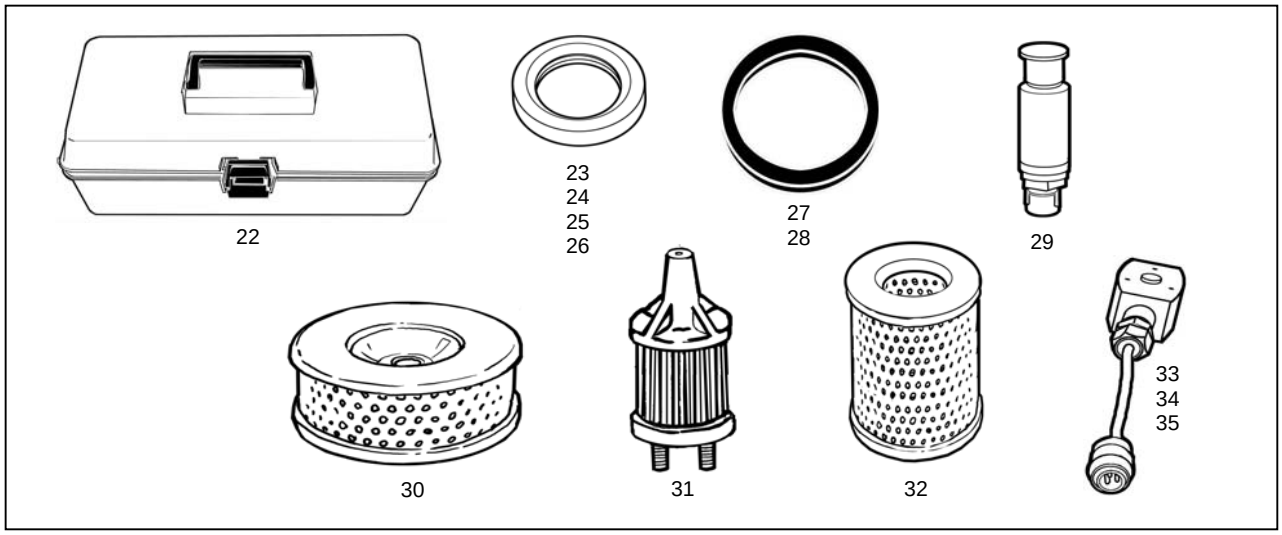

Table 4. BII Box #1.

No.	Item Name	Qty
1	Box	1
2	Earplugs	10
3	Belt, Air Compressor	1
4	Gloves, Chemical	2
5	Respirator, Particulate	4
6	Shield, Face, Chemical	1
7	Apron, Chemical	2
8	Purification Cartridge, Air Compressor	1
9	Adaptor A-12	1
10	Paddle, Stirring	1
11	Adaptor A-10	1
12	Flowmeter Assembly	1
13	Starting Cable, Diesel Engine, 24 Volt DC	1
14	Vest, Flotation	1
15	Gasket, C&G, 1"	1
16	Gasket, C&G, 1-1/2"	2
17	Gasket, C&G, 2"	12
18	Gasket, C&G, 3"	10

No.	Item Name	Qty
19	Gasket, C&G, 4"	1
20	Gasket, C&G, 6"	1
21	Rupture Disk DV 1.0 in.75# Burst and Storage Box	1
22	Box	1
23	Gasket, Grooved Coupling, 1"	2
24	Gasket, Grooved Coupling, 1.5"	5
25	Gasket, Grooved Coupling, 2.0"	2
26	Gasket, Grooved Coupling, 3.0"	1
27	Gasket, Sanitary, 4"	1
28	Gasket, Sanitary, 6"	1
29	Pressure Transmitter, PT-201	1
30	Filter, Air, Diesel	1
31	Filter, Fuel, Diesel	1
32	Inlet Air Filter, Air Compressor	1
33	Spare Solenoid Assembly	1
34	Spare Solenoid Assembly	1
35	Spare Solenoid Assembly	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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PREPARATION FOR MOVEMENT – ARMY UNIT

BII Box #2

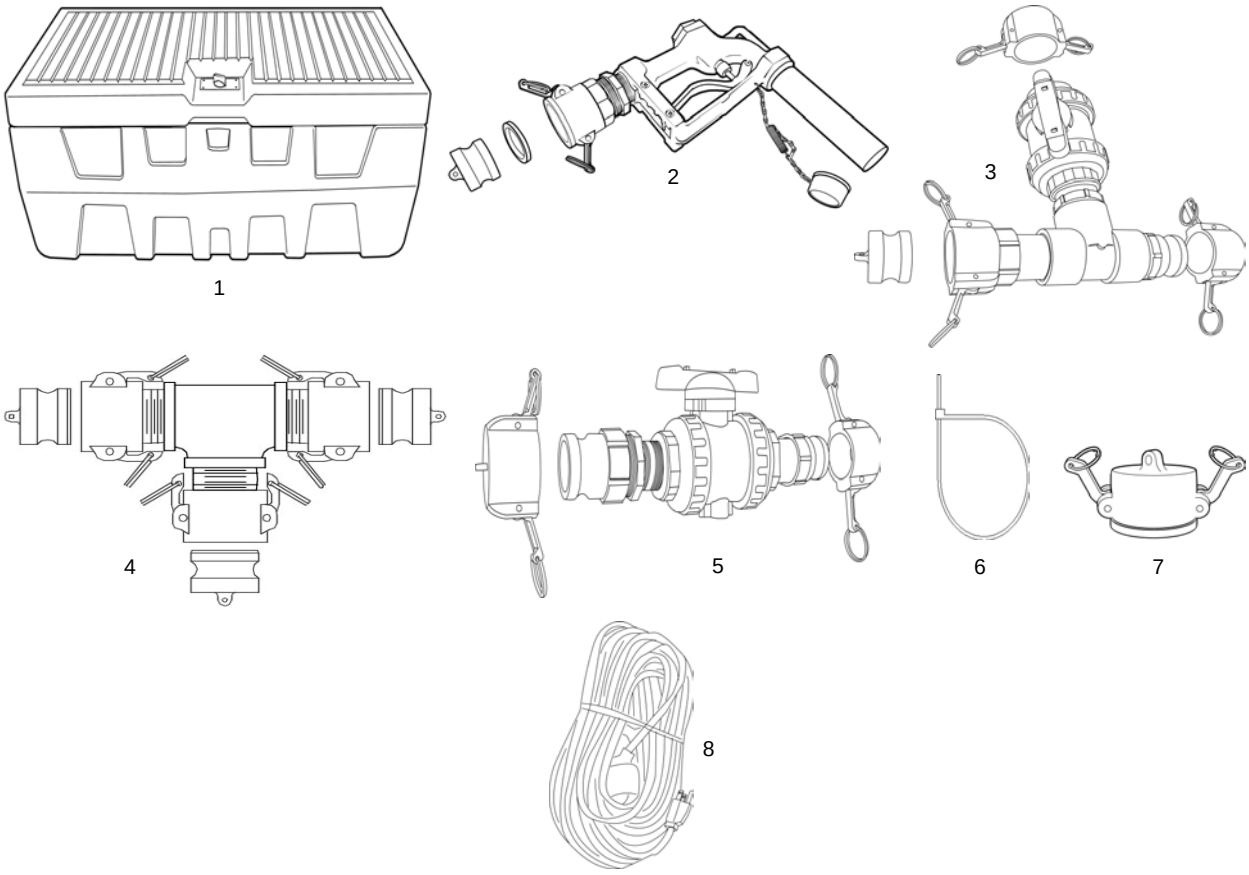
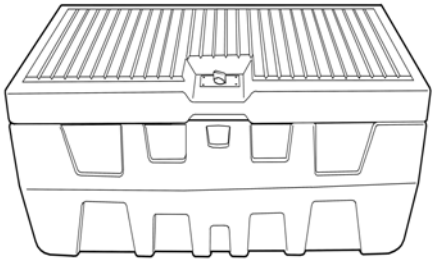


Table 5. BII Box #2.

No.	Item Name	Qty
1	Box	1
2	Nozzle Assembly	4
3	Adaptor A-07 (9K System)	1
4	Adaptor A-08 (9K System)	1
5	Adaptor A-15 (9K System)	1
6	Wire Ties	100
7	Dust Cap	1
8	Extension Cord, 100 ft.	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – ARMY UNIT

BII Box #3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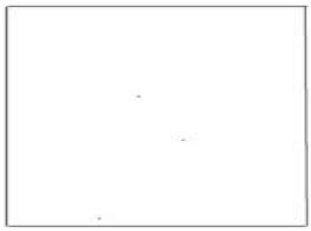
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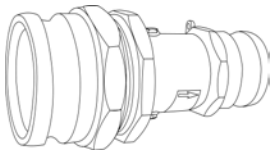
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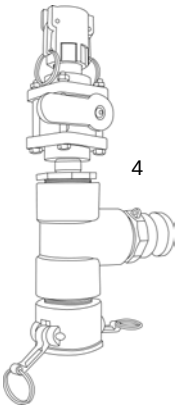
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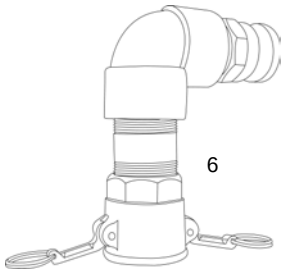
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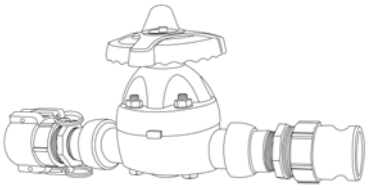
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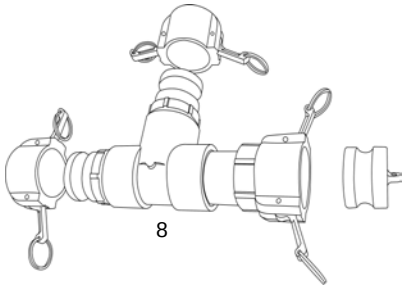
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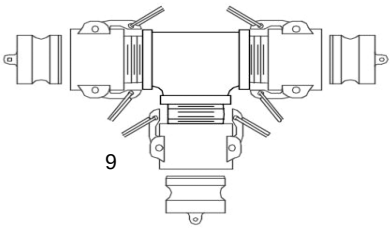
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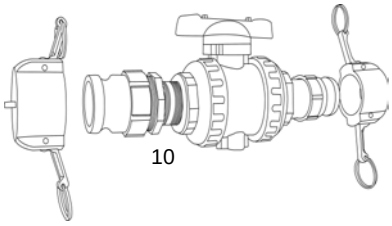
Table 6. BII Box #3.

No.	Item Name	Qty
1	Box	1
2	Pad, fuel absorbent	1
3	Adaptor A-01	1
4	Adaptor A-02	1
5	Adaptor A-03	1
6	Adaptor A-04	1
7	Adaptor A-05	1
8	Adaptor A-07	1
9	Adaptor A-08	1
10	Adaptor A-15	1
11	Hose Assembly F-06	2
12	Plug, Hose, 3”	1
13	Strainer, MF Feed Tank	1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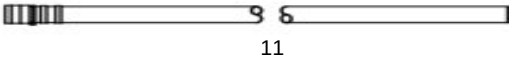
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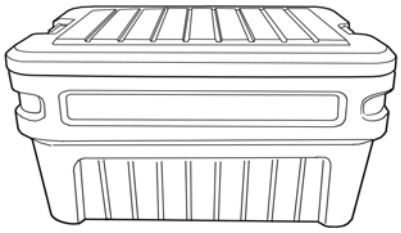
TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – ARMY UNIT

BII Box #4



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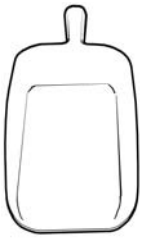

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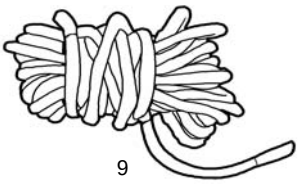

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Table 7. BII Box #4.

No.	Item Name	Qty
1	Box	1
2	Large Scoop	1
3	Measuring Bottle	1
4	Measuring Cup, 1000 ml	1
5	High PH Detergent	4
6	Bisulfite, 10 oz. Packets	1
7	Antiscalant	2
8	Strainer, MF Feed Tank	2
9	Rope, Strainer	1

BII Box #5

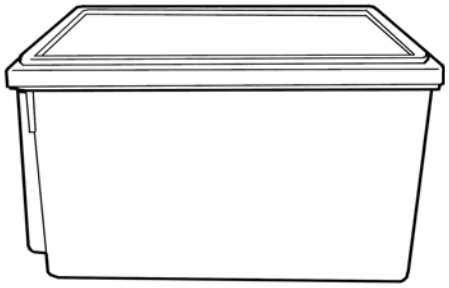

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Table 8. BII Box #5.

No.	Item Name	Qty
1	Box	1
2	Sodium Hydroxide	4

BII Bucket #6

1

2

3

4

5

6

Table 9. BII Bucket #6.

No.	Item Name	Qty
1	Bucket	1
2	Funnel	1
3	Corrosion Preventive Compound	1
4	Oil, SAE 10W-30, 1 qt	1
5	Oil, Air Compressor, 1 qt	1
6	Silicon Lubricant	1

BII Bucket #7

1

2

Table 10. BII Bucket #7.

No.	Item Name	Qty
1	Bucket	1
2	Container, Chlorine, 10 - 4 oz. Packets	1

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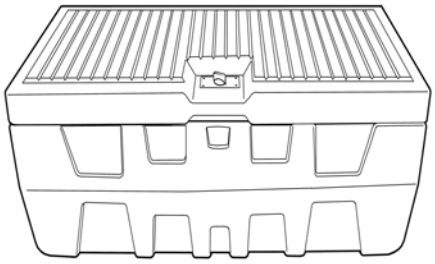
BII Box #8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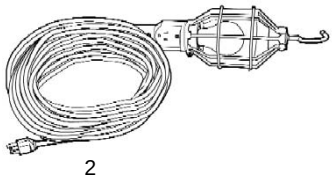
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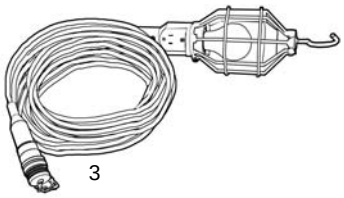
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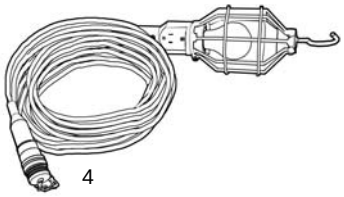
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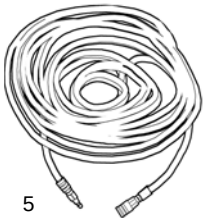
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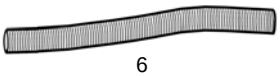
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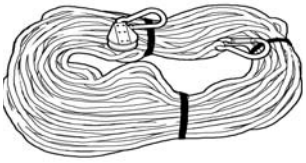
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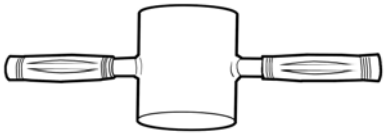
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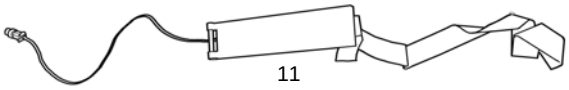
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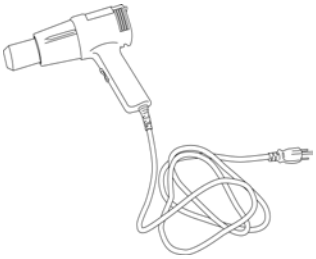
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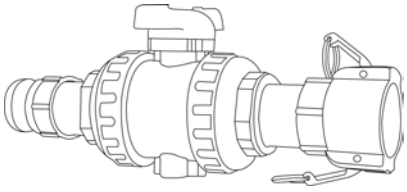
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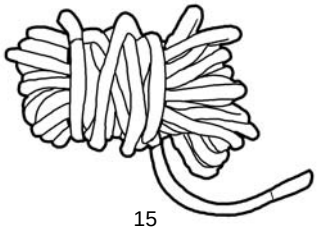
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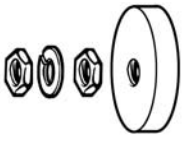
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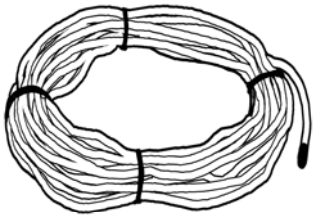
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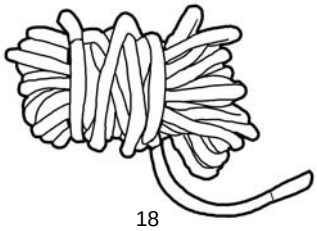
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Table 11. BII Box #8.

No.	Item Name	Qty
1	Box	1
2	Light, Trouble	1
3	Light, Work	1
4	Light, Blackout	1
5	Hose, Auxiliary Air	1
6	Hose, Diesel Engine Exhaust Extension	2
7	Spout, Fuel Can	1
8	Rope Assembly, Anchor	1
9	Hammer, Slip, Ground Rod	1
10	Wire, Ground, 25 ft.	1
11	Heating Collar, Pump, Strap-On	3
12	Tool, MF Filter C-Spanner	1
13	Heat Gun	1
14	Adaptor A-16	3
15	Rope, Raw Water Hose Tie-off	1
16	Hardware, Ground Rod - Hammer	1
17	Rope, Chemical Cover, 60 ft.	3
18	Rope, F-04 Hose	1
19	Cord, 100-ft., Extension	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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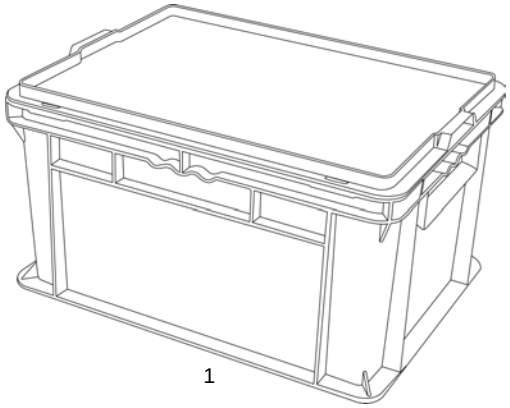
PREPARATION FOR MOVEMENT – ARMY UNIT

Manuals Storage Box



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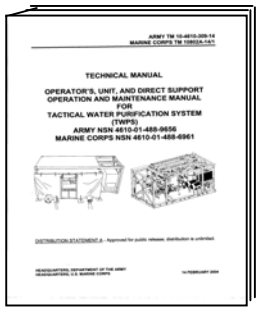

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Table 12. Manuals Storage Box.

No.	Item Name	Qty
1	Box, Storage, Manuals	1
2	TWPS Operation and Maintenance Manual (two volumes)	1
3	TWPS RPSTL	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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Left End Packout

1. Coil the bisulfite pump discharge, suction, and return tubing together and strap them to the TWPS frame behind the pump using a 12-in. hook and loop strap.
2. Coil the antiscalant and hypochlorite suction and return tubing together and strap them to the TWPS frame behind the pump using a 12-in. hook and loop strap.
3. Pack the ground rod sections and the slide hammer rod in the storage brackets at the left front corner of the skid and secure them with an 18-in. hook and loop strap (see Figure 5).

NOTE
The hammer section of the slide hammer will be packed out in BII Box #8.

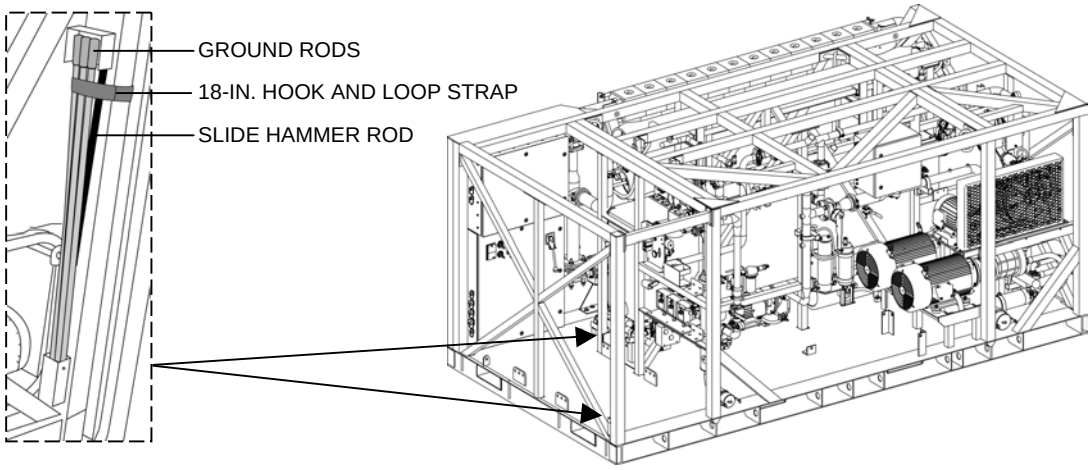

Figure 5. Ground Rod and Slide Hammer Rod Storage.

4. Store the protractor (level) in the protractor (level) storage box on the cross support beam at the left side of the Power Distribution Panel (see Figure 6).

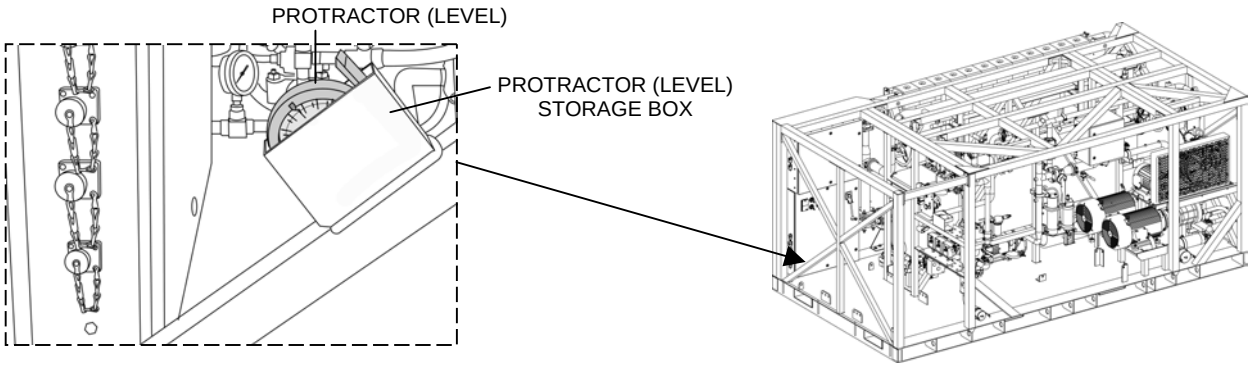

Figure 6. Level Storage.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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PREPARATION FOR MOVEMENT – ARMY UNIT

Ocean Intake Structure System (OISS) Packout

The components of the OISS, except the 2x2x3 tee assembly, are packed out lengthwise on top of the skid frame. These items are shown in Figure 7.

WARNING

Be extremely careful when packing out items on top of the frame. Do not allow hose ends or any other items to bump the RO vessels, which are easily damaged. If anything bumps an RO vessel, the vessel MUST be inspected and/or replaced before putting the A-TWPS into operation. Failure to observe this warning can result in severe personal injury or death from catastrophic vessel failure when the vessels are pressurized during startup.

1. From the rear of the skid, pack the OISS components in the following order:
    a. Wellpoint assemblies (4).
    b. Riser assemblies (5). Place the tees and elbows at the Operator Station end of the skid. Orient the riser assembly tees and elbows at the Operator Station end of the TWPS. Make sure they don't stick down and interfere with the Operator Control Panel door.
    c. Hoses (6 yellow-banded). Position the hoses toward the Operator Station end of the frame.
2. Group the assemblies and hoses together as compactly as possible and strap them down using two 10-ft. ratchet straps (see Figure 7).
    a. Secure one end of both straps to the TWPS frame in front of the hoses and assemblies.
    b. Cross the straps over the hoses and assemblies and hook the other ends to the spacers at the ends of the MF filter assemblies.
    c. Tighten the straps using the ratchets

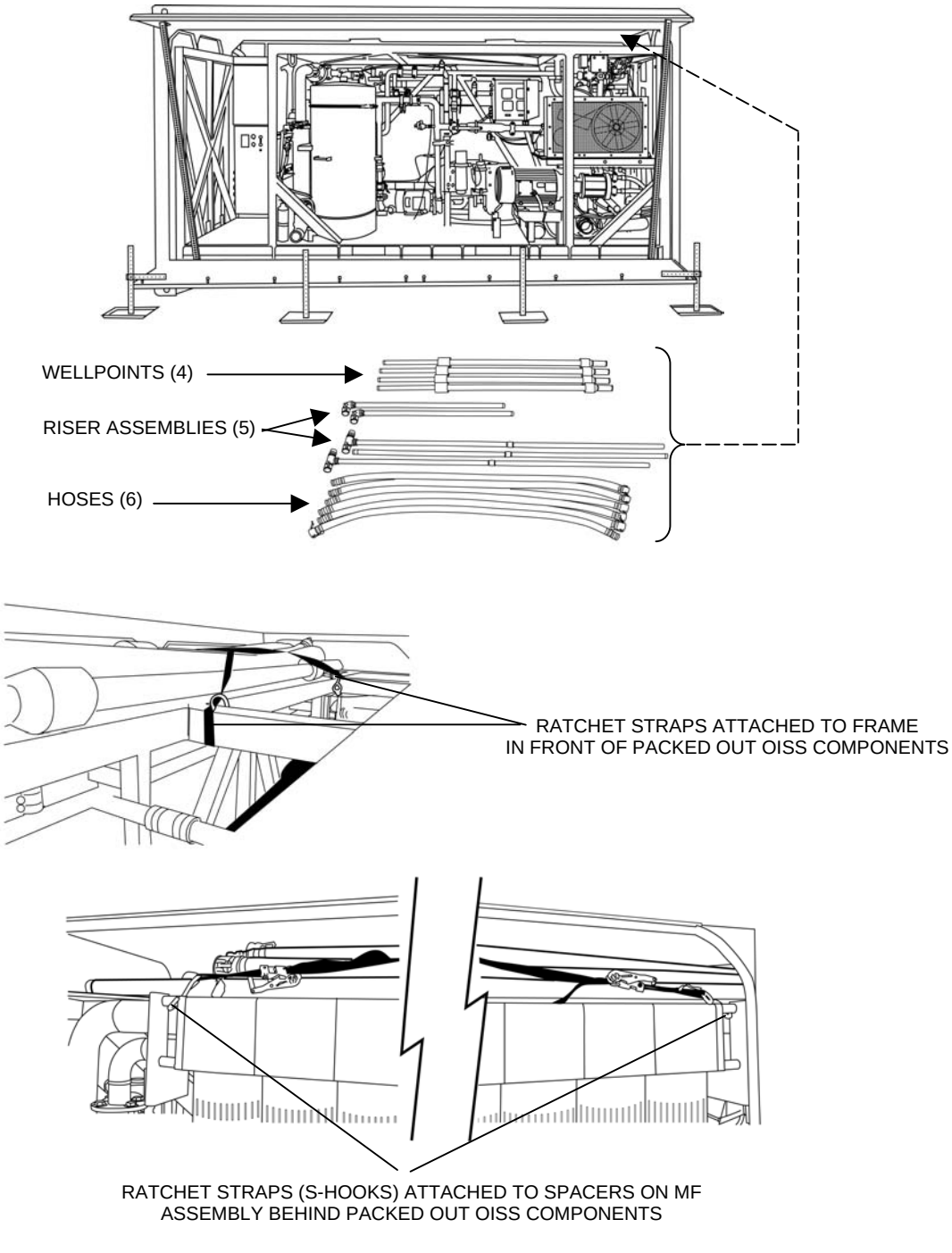

Figure 7. OISS Component Packout.

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Suction Hose Packout

All of the raw water, waste, and distribution suction hoses are packed out lengthwise on top of the skid frame, in front of the OISS components. These items are shown in Figure 8.

1. Secure the long section of two 10-ft.ratchet straps to the frame just in front of the OISS components and lay the straps back over the OISS components within reach from the ends of the frame.
2. Pack the suction hoses in the following order:
    - 3 in. x 10 ft., (green-banded) raw water hoses - 13 each.
    - 2 in. x 10-ft., (green-banded) raw water hose - 1 each. Place on top of the 3-in. hoses.
    - 2 in. x 10 ft., (red-banded) waste hoses - 3 each. Place on top of the 3-in. hoses.
    - 1½-in. x 10 ft., (blue-banded) product water hoses - 4 each. Place on top of the 3-in. hoses.
    - 2 in. x 5 ft., (blue-banded) product water hoses - 5 each. Place on top of the 3-in. hoses.
    - 4 in. x 5 ft., (red-banded) waste hose. Place on top of 3-in. hoses.
    - 3-in. x 3-ft., (green-banded) raw water hose. Place on top of the 3-in. hoses.
3. Bring the two straps over the suction hoses and secure them to the frame (see Figure 8).

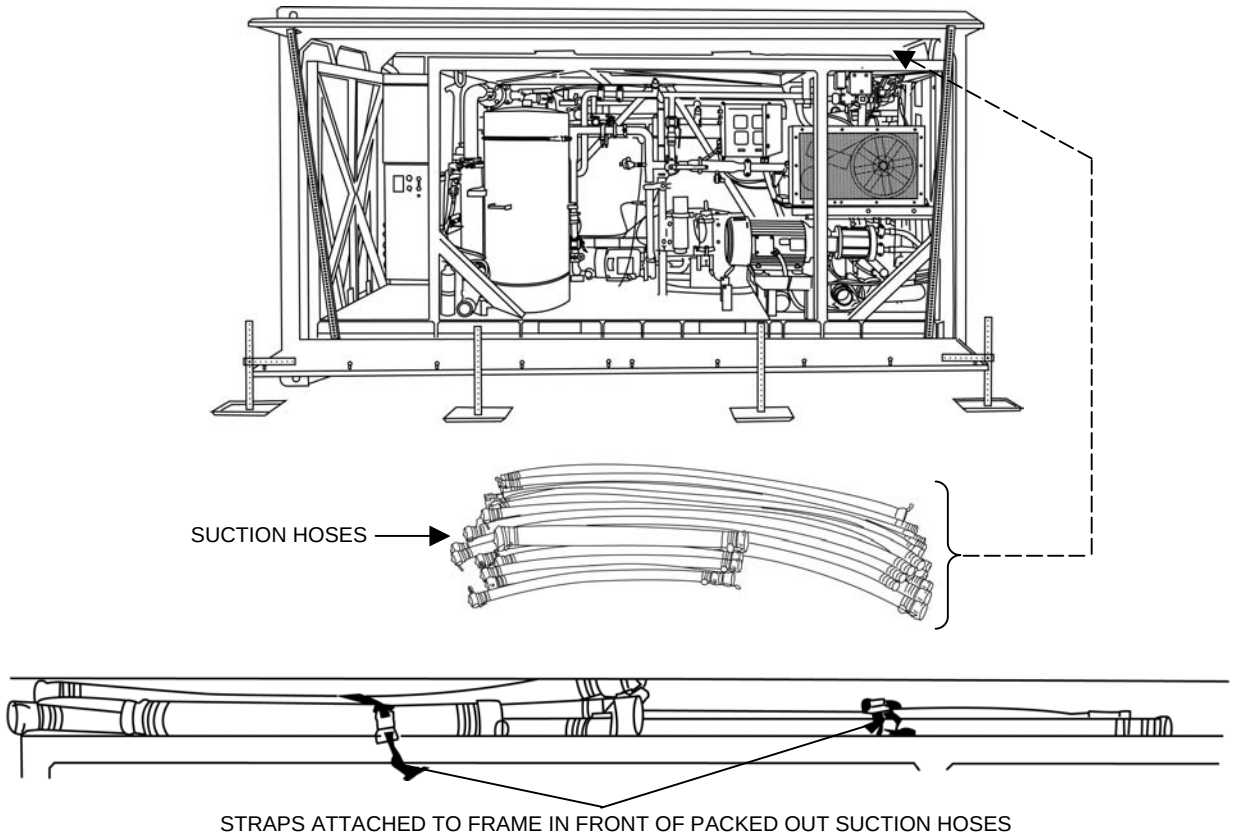

Figure 8. Suction Hose Packout.

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Heating Duct Packout

Pack the three heating ducts as follows (see Figure 9):

1. Slide the small diameter duct inside one of the large ducts.
2. Place both large ducts on top of the RO feed tank. Insert one from the operator station end of the frame and the other from the generator end.

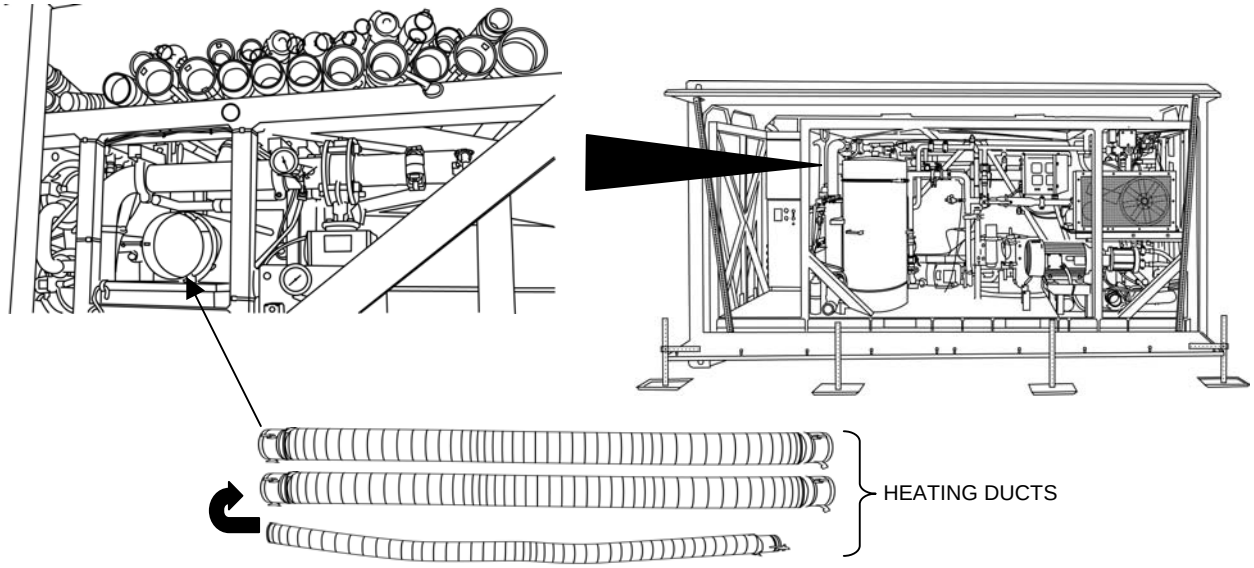

Figure 9. Heating Duct Packout.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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PREPARATION FOR MOVEMENT – ARMY UNIT

Operator Station Packout

1. Place the TWPS Technical Manuals and the Repair Parts and Special Tools List (RPSTL) Manual in the manuals storage box and put the cover on the box.
2. Set the manuals storage box under the chemical injection pumps next to the fire extinguisher (see Figure 10).
3. Place one of the Chemical Injection System buckets inside another one. Place BII bucket # 7 (chlorine bucket) inside the two buckets.
4. Place BII bucket #6 (lubricants bucket) inside the third Chemical Injection System bucket.
5. Place BII box #5 on the floor, to the left side of the Power Distribution Panel, then place the buckets beside it (see Figure 10).
6. Place the three chemical injection bucket colored lids on top of the buckets.

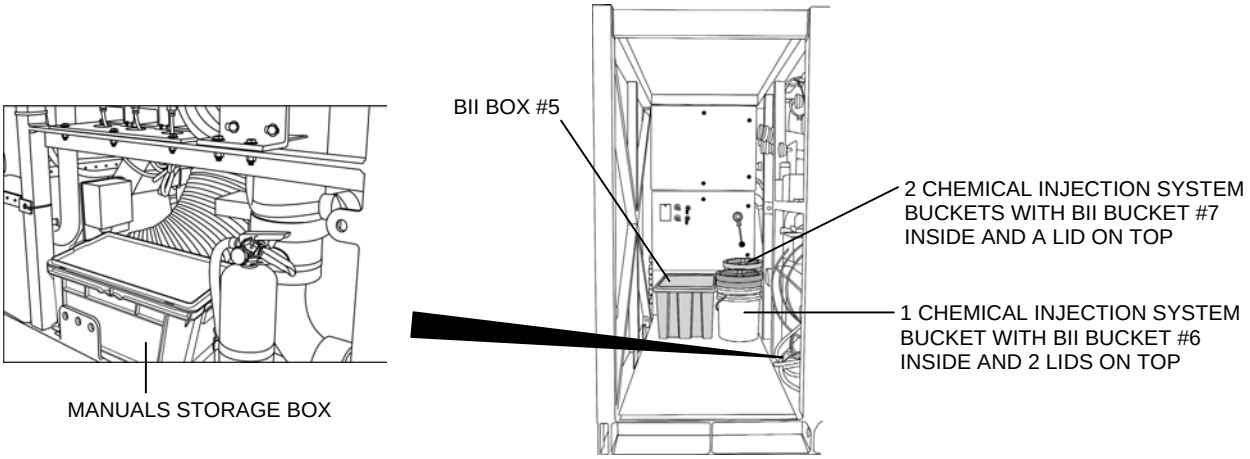

Figure 10. Operator Station Packout 1.

7. Place BII Box #4 in front of the buckets and BII Box #5 (see Figure 11).

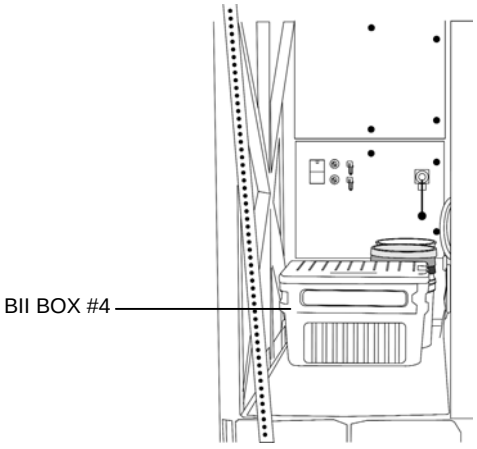

Figure 11. Operator Station Packout 2.

8. Stack the following items on top of BII box #5 and the buckets (see Figure 12):
    - 50-ft. hose heating blankets (2 each)
    - 41-ft. hose heating blanket (1 each)
    - 21-ft. hose heating blanket (1 each)
    - 66-ft. hose heating blanket (1 each)
    - 11-ft. hose heating blankets (3 each)
    - 6-ft. hose heating blanket (2 each)
    - motor-driven pump skid covers (3 each)

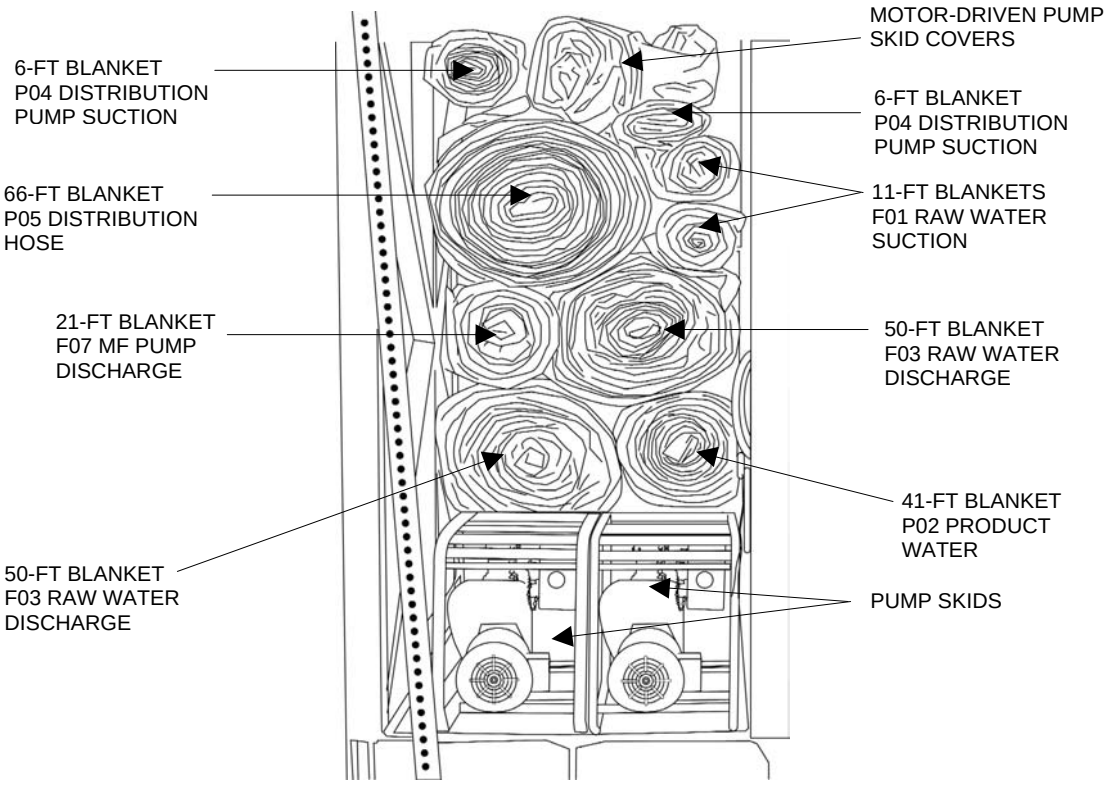

Figure 12. Operator Station Packout 3

WARNING

Two person lift. Two people are required to safely move the pump skids. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

9. Install the fire extinguisher in its bracket on the S-2 strainer.
10. Place the motor-driven pump skids side by side in front of BII Box #4 with the motors facing out (see Figure 12).

11. Install the two long pump skid retaining rods and secure them with the retaining pins (see Figure 13).

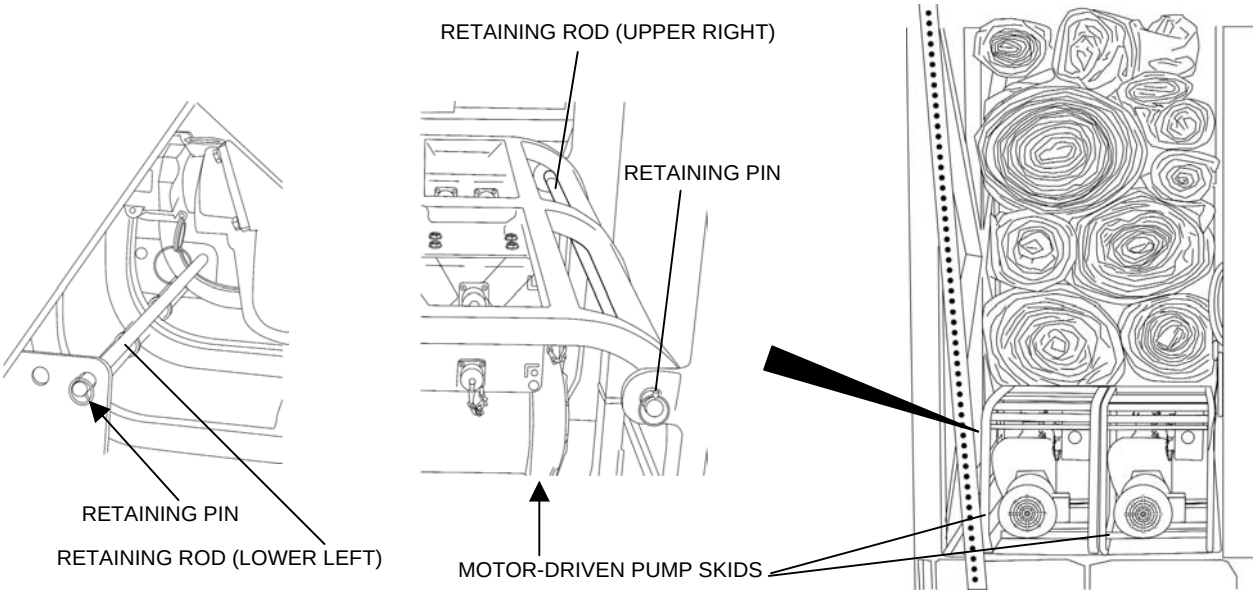

Figure 13. Pump Skid Retaining Rods.

12. Stack the following items on top of the BII box (see Figure 14)
    - 66-ft. hose heating blanket (2 each)
    - diesel engine-driven pump skid covers (2 each)
    - Adaptor A02 heating blanket (not shown – pack between pump skid cover and TWPS frame)
    - 6-ft. hose heating blanket

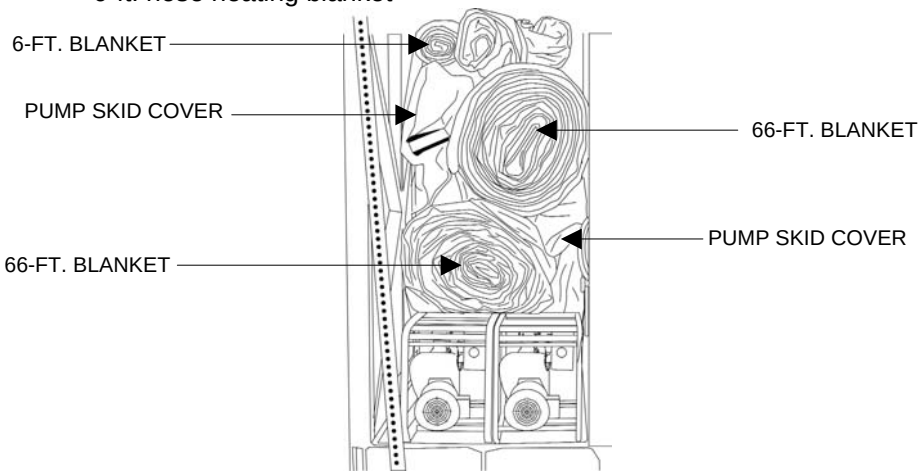

Figure 14. Operator Station Packout 4.

13. Place the pump priming pitcher inside one of the pump skids and secure it with an 18-in. hook and loop strap (see Figure 15).
14. Attach the long end of a 10-ft. ratchet strap to the TWPS frame above the feed flow control panel and temporarily lay it out of the way on top of the packed out heating blankets.
15. Place the following items on top of the pump skids (see Figure 15):
    - The remaining four BII boxes
    - Water Quality Analysis Set: Purification (WQAS-P)
    - Operator's tool box
    - Main ventilation plenum
    - 1000-gallon MF feed tank
    - 6 ft. hose heating blanket
    - Floating inlet strainer
16. Retrieve the 10-ft ratchet strap from on top of the heating blankets, route it around the 1000-gallon MF feed tank and 6-ft hose heating blanket. Attach the strap to the TWPS frame and tighten (see Figure 15).

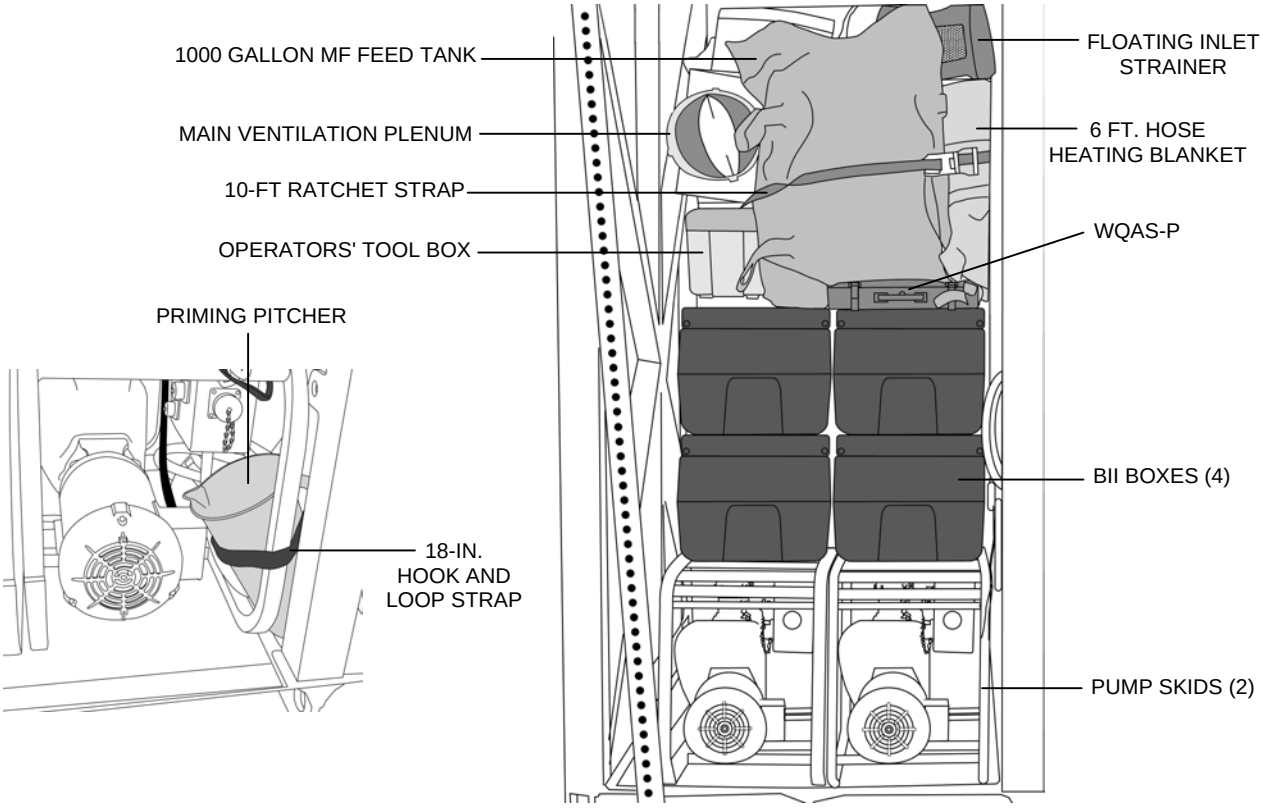

Figure 15. Operator Station Packout 5.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0028 00**
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PREPARATION FOR MOVEMENT – ARMY UNIT

Equipment Area Packout

1. Make sure the NBC tank is secured to Strainer S-2 with two 10-ft. ratchet straps.
2. Coil the product utility hose and the Strainer S-4 hoses together and secure them to the TWPS using an 18-in. hook and loop strap (see Figure 16 for hose location).

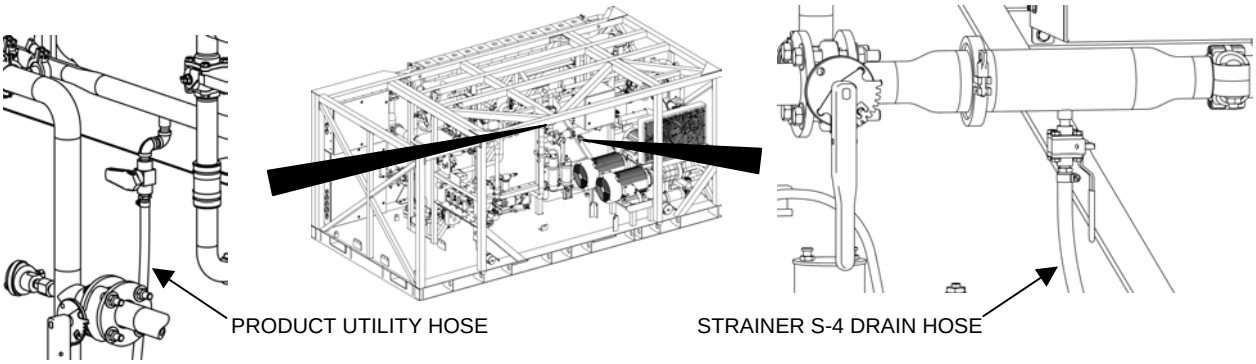


Figure 16. Product Utility Hose and Strainer S-4 Drain Hose.

3. Place the anchor flat on the floor behind the NBC tank. Slide it underneath the piping next to the turbocharger (see Figure 17).
4. Place the 5-gallon fuel can behind the NBC tank.

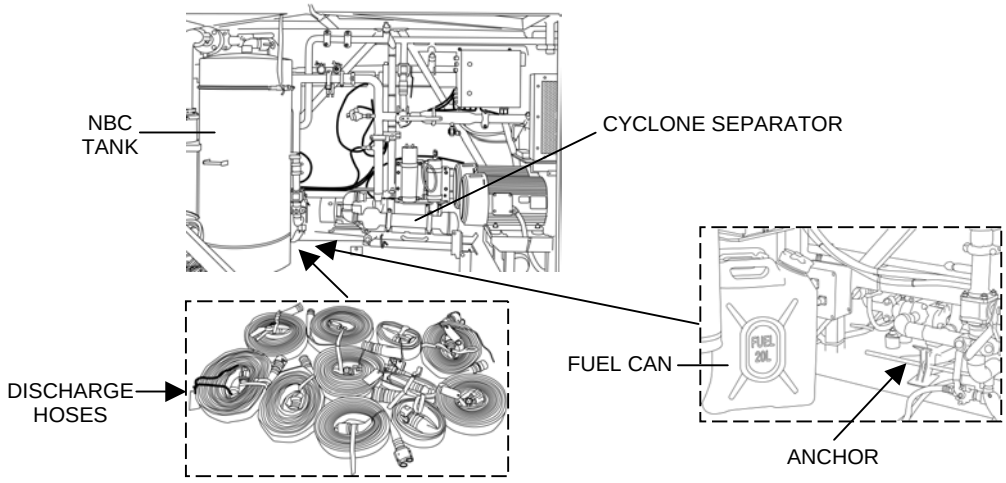


Figure 17. Anchor, Fuel Can, Cyclone, Collar, and Hose Packout.

WARNING

Two person lift. Two people are required to safely move the cyclone separator assembly. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

5. Place the cyclone separator unit on the floor with the separator facing up (see Figure 17). Slide it back and to the right as far as possible.

CAUTION

When packing the items in the following step, be careful not to damage the tubing, wires, or sensors mounted behind the NBC tank.

6. Place as many of the following hoses as you can behind the NBC tank (see Figure 17):
   - 2-in x 50-ft. discharge hose (1 each)
   - 3-in x 10-ft. discharge hoses (2 each)
   - 2-in x 50-ft. discharge hoses (4 each)
   - 2-in x 65-ft. discharge hose (4 each)
7. Place additional discharge hoses in front of the RO feed tank and to the left of the cyclone separator assembly (see Figure 18).

WARNING

Three person lift. Three people are required to safely move the MF pump skid. Use your legs, not your back. Failure to observe this warning may result in back injury.

8. Move the MF pump skid onto the TWPS skid (see Figure 18).
9. Position the pump end inside the mounting brackets and install the retaining rod.
10. Place Adaptor A-09 inside the MF pump skid.
11. Place the bisulfite and citric acid chemical buckets between the MF pump skid and the NBC tank.

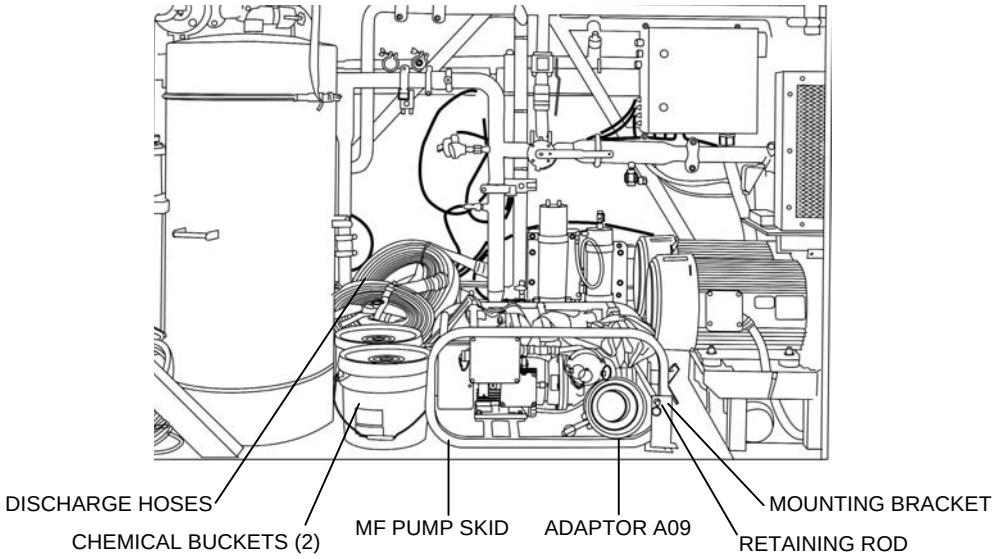


Figure 18. Equipment Area Packout 2.

12. Place any remaining discharge hoses on top of the chemical buckets and cyclone separator.

13. Hang the right hot air plenum in the deployment straps (see Figure 19).
14. Pack the following items in the order listed (see Figure 19):
    - 3000-gallon distribution tank
    - 3000-gallon distribution tank
    - 1500-gallon cleaning waste tank
    - Tripod assembly
    - 5/8-in. x 50-ft. auxiliary hose assembly P06
    - Motor-driven pump power cables
15. Attach a 10-ft. ratchet strap from the TWPS frame, over the 1500-gallon tank to the HPP frame.
16. Attach a 10-ft. ratchet strap from the upper left TWPS frame to the HHP frame.
17. Attach a 10-ft. ratchet strap from the TWPS frame near the chemical pumps, over the 3000-gallon tanks, to the TWPS frame above the compressor.
18. Pack the following items in the open spaces under the high pressure pumps:
    - Ice intake strainer attached to adaptor A-13
    - Adaptor A-11
    - Ice auger and handle (secure to the HPP support frame with 18-in. hook and loop strap).
    - OISS tee (secure to the HPP pump support frame with two 36-in. hook and loop straps: one through the straight part of the tee and one around the tee female connector).
    - Operator station entry overhead support beam.

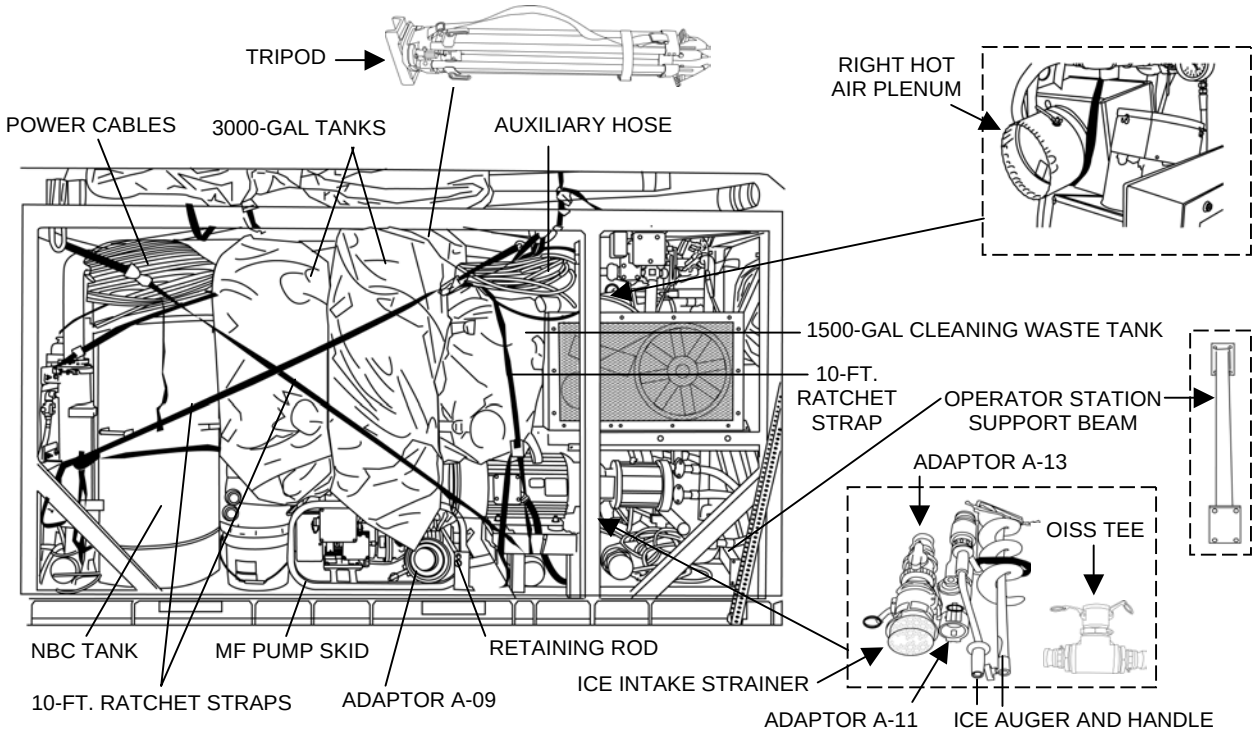


Figure 19. Equipment Area Packout 3.

19. At the rear of the skid, secure the RO element pusher to the horizontal pipe to the left of the MF filters using two 18-in. hook and loop straps (see Figure 20).

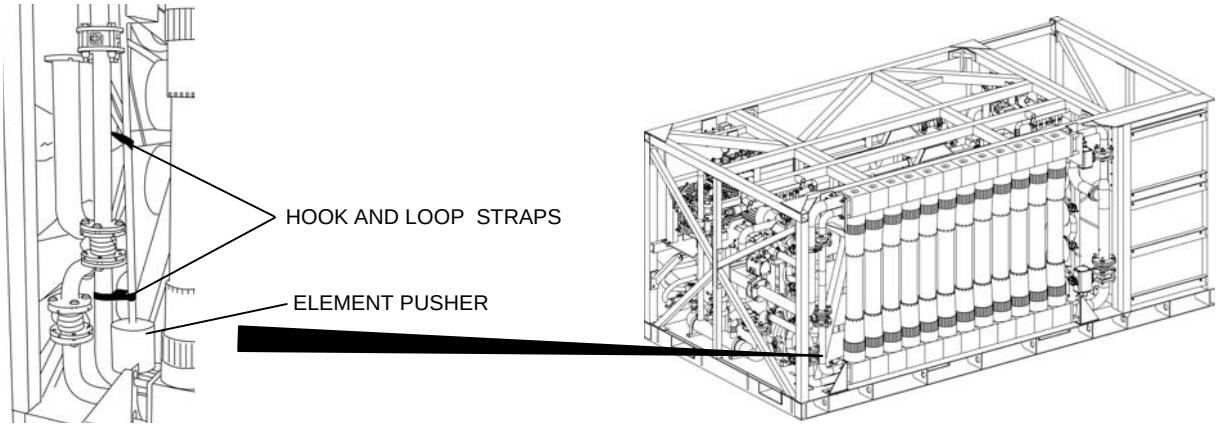


Figure 20. Filtrate Drain/Sample Hose and RO Element Pusher Packout.

Generator Area Packout

1. Raise and secure the bail bar as follows:
   a. Connect the cable to the bail bar.
   b. Turn the winch crank handle to raise the bail bar.

NOTE

Installing the two large bolts, lockwashers, and nuts at the bottom of the bail bar first helps align the holes for the other bolts and makes the other bolts easier to install.

   c. Install the two large bolts, lock washers, and nuts that secure the bottom of the bail bar to the flat rack (see Figure 21).

WARNING

A minimum of 6 bolts in the front of top horizontal beam of the flat rack and a minimum of 3 bolts in the underside of the top horizontal beam are required in order to safely lift the flat rack by the bail bar. Failure to observe this warning may result in equipment damage and severe injury or death.

CAUTION

The middle and upper bail bar bolts must be installed in their proper locations to ensure that the bail bar is properly secured. There are three different length bolts that are used. The longest of the three is used with washers and nuts to secure the bail bar to the diagonal beam of the flat rack. The other two shorter bolts thread into rivet nuts, which are threaded inserts that are welded in the top horizontal beam of the flat rack.

d. Separate the three different size bolts that are used to secure the middle of the bail bar to the diagonal beam of the flat rack and the top of the bail bar to the top horizontal flat rack beam (see Figure 21).
e. Loosely secure the top part of the bail bar to the front of the top horizontal flat rack beam using the seven short bolts with their lock washers and flat washers. Do NOT tighten yet.
f. Loosely secure the top part of the bail bar to the underside of the top horizontal flat rack beam using the four longer bolts with their lock washers and flat washers. Do NOT tighten yet.
g. Secure the middle of the bail bar to the diagonal flat rack beams using the four longest bolts with eight flat washers, four lock washers, and four nuts.
h. Tighten all 15 bolts. Torque to 250 in-lbs.

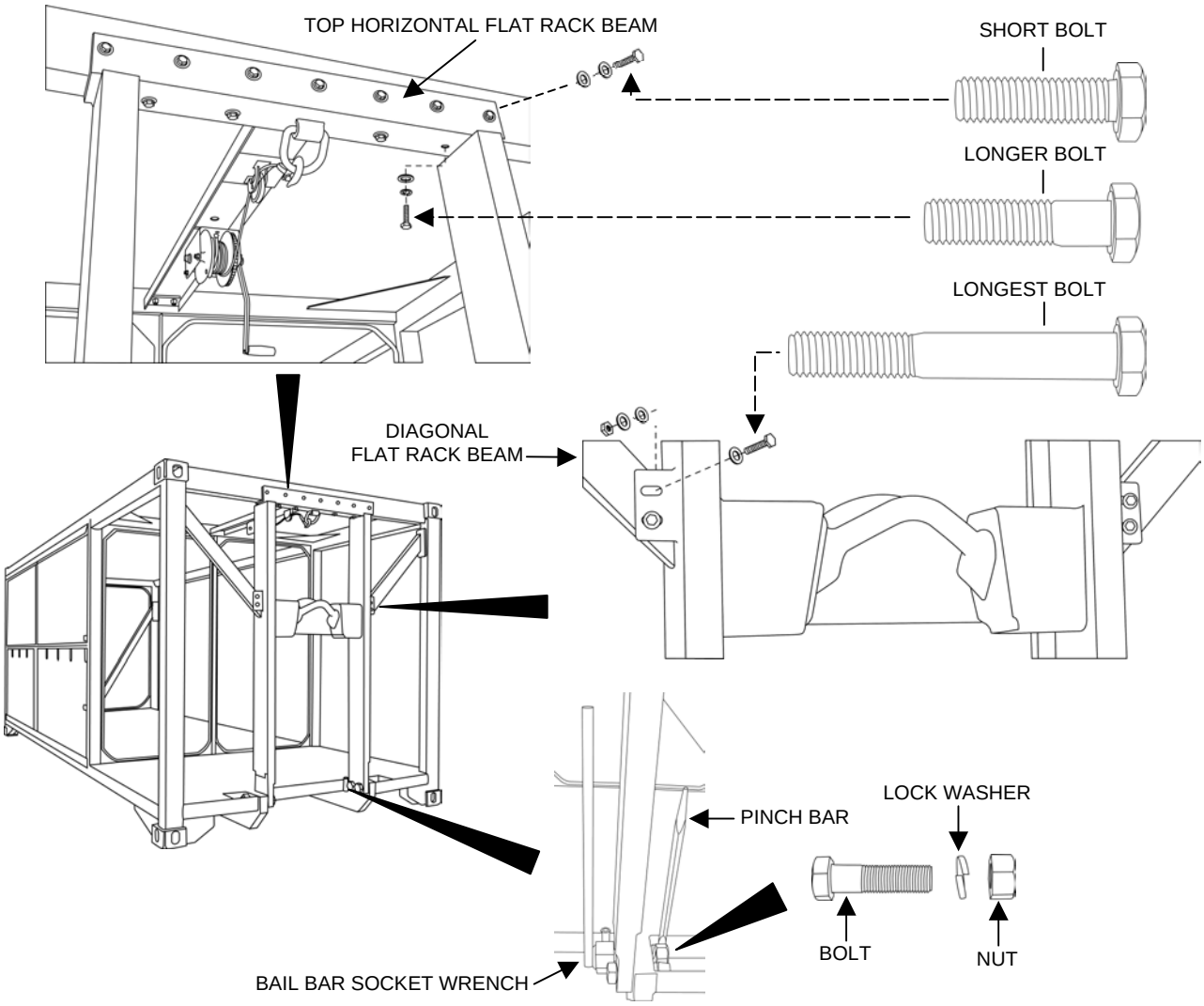


Figure 21. Correct Bail Bar Bolt Installation Locations.

WARNING

Two person lift. Two people are required to safely move the flat rack panels. Lift with your legs, not your back. Failure to observe this warning may result in personal injury.

2. Install flat rack panel #5 on the back of the TPWS and panels #6 and #7 at the generator end and latch them in place (see Figure 22).

WARNING

Three person lift. Three people are required to safely move the diesel pump skids and the diesel-fired heater. Use your legs, not your back. Failure to observe this warning may result in back injury.

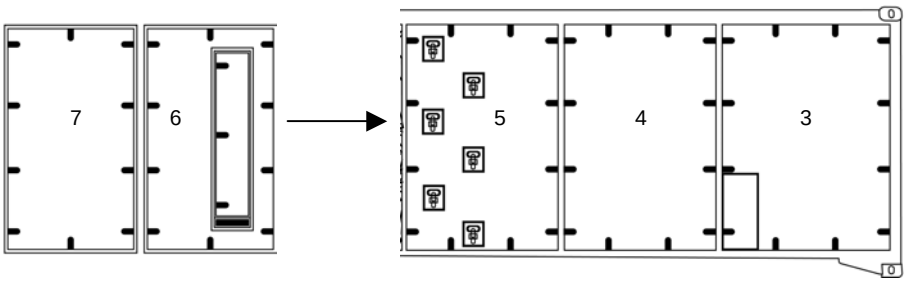


Figure 22. Flat Rack Panel #5, #6, and #7 Installation.

3. Pack the two diesel pump skids (with the fuel tank assemblies removed) and the diesel-fired heater next to the generator (see Figure 23).
4. Strap the pinch bar to the front diesel pump skid using two 18-in. hook and loop straps (see Figure 23).
5. Strap the bail bar socket wrench to the top of the front diesel pump skid using two 18-in. hook and loop straps (see Figure 23).
6. Pack a 3000-gallon tank behind the diesel pump skids (see Figure 24).
7. Attach the short end of a 20-ft. ratchet strap to each of the four tie-down rings at the rear of the generator and lay the straps out of the way.
8. Run a 10-ft. ratchet strap from the front left tie-down ring, through both pump skid frames, and over the 3000-gallon tank to the corresponding ring at the rear.
9. Run a second 10-ft. strap from the next tie-down ring to the right, through the lower part of the heater frame, and over the 3000 gallon-tank to the corresponding ring at the rear.

10. From the front, pack the following items as shown (see Figure 23):
    - 66-ft. hose heating blanket P05
    - Fuel tank assembly (for one of the diesel-driven pumps)
    - 50.5-ft. hose heating blankets F03-1 and F03-2

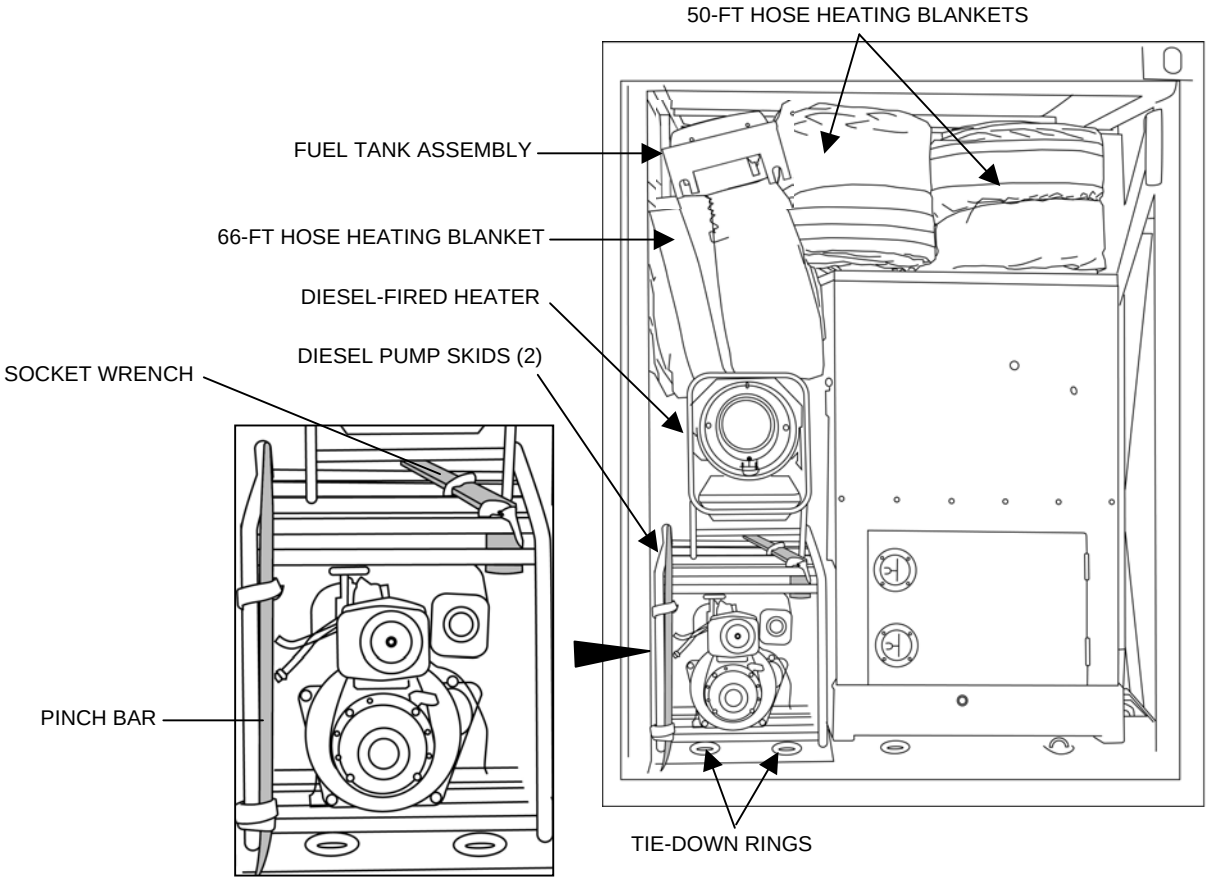


Figure 23. Generator Area Packout 1.

WARNING

Fall hazard. Make sure that flat rack rear panel #5 is fully latched in place before using the folding steps to climb onto the roof. Failure to observe this warning could result in personal injury.

11. From the rear and top, pack the following items beside and on top of the generator (see Figure 24):
    - Pump platforms (5 each directly on top of the TQG)
    - 3000-gallon distribution tanks (3 each)
    - 6-in x 50-ft. waste outlet hose
    - Fuel tank assemblies (for one of the diesel-driven pumps)
    - Diesel-fired heater inlet and outlet ducts
    - Return air connector assembly
    - Fabric wall
    - Chemical agent cover

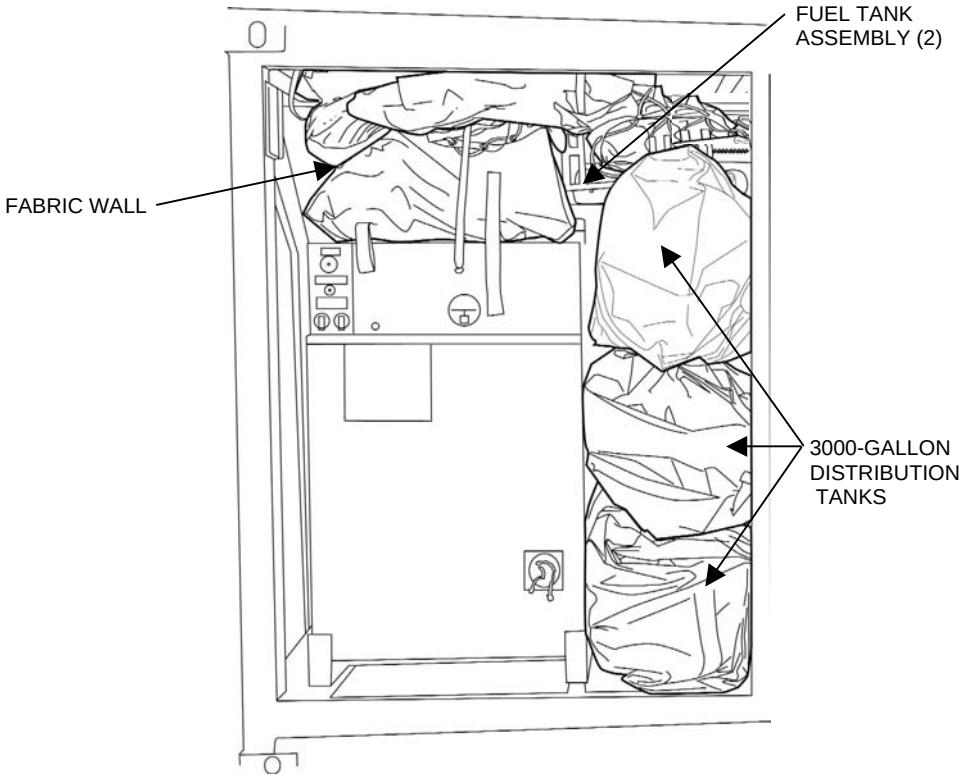
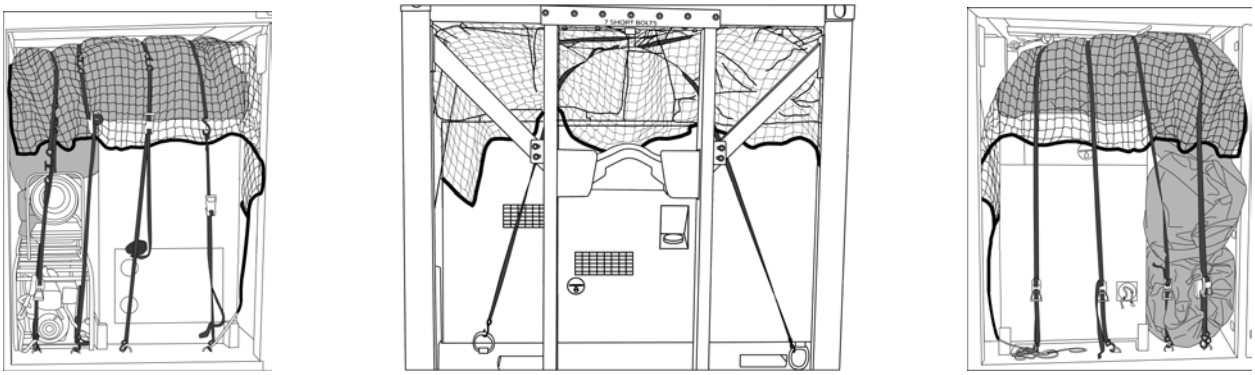


Figure 24. Generator Area Packout 2.

12. Place the cargo net over the items in the generator area and tie it in place (see Figure 25).
13. At the front of the flat rack, attach the long section of a 20-ft. ratchet strap to each of the four tie-down rings. Run the straps over the cargo net and connect them to the four short strap sections positioned earlier on the rings at the back of the flat rack generator area.
14. Attach a 20-ft. ratchet strap to each of the two rings on the side of the generator. Run these straps diagonally across the top of the cargo net to the inside tie-down rings at the front and rear of the flat rack.



FRONT VIEW SIDE VIEW REAR VIEW

Figure 25. Cargo Net and Strap Placement.

Flat Rack Closure

1. Inspect the entire deployment area to make sure no items have been overlooked. Inspect the skid to be sure all the packout straps are tight and all retaining rods and pins are in place.

WARNING

Potential for head and eye injury. Make sure that two people are holding up the hinged top panel before removing the retaining pins from the top panel supports. Failure to observe this warning could result in the top panel falling down suddenly, resulting in head injury or the possibility of a top panel latch causing eye injury.

2. While two people hold up the hinged top panel, the third person removes the retaining pins from the top panel supports (see Figure 26).
3. Carefully lower the top panel and latch it shut. Insert and secure the two retaining pins to an accessible part of the supports.

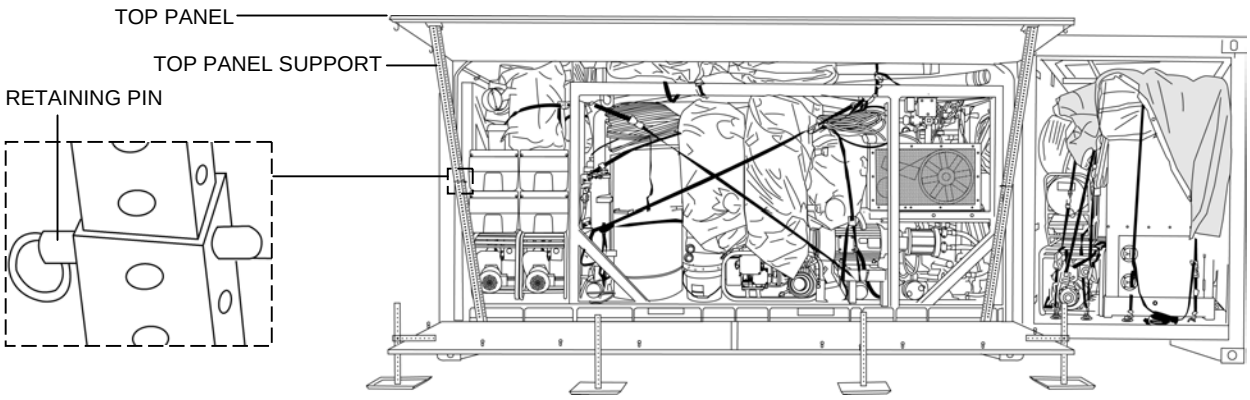


Figure 26. Flat Rack Hinged Top Panel Closure.

4. Pack out the deck support assemblies as follows (see Figure 27):
   a. With another person lifting the deck a few inches, remove the retaining pins and slide the support assemblies out of the brackets on the deck. Lower the deck to the ground.
   b. Remove the retaining pins and separate the two sections of each deck support assembly.
   c. Pin two of the horizontal sections together and insert them into each of the two middle brackets on the deck. Secure them in place with the remaining two retaining pins.

NOTE

Do not use the brackets mounted on the ends of the deck to store the horizontal sections. If you do, the deck won't close.

   d. Pack the four pad sections of the support assemblies on the edge of the skid at floor level.

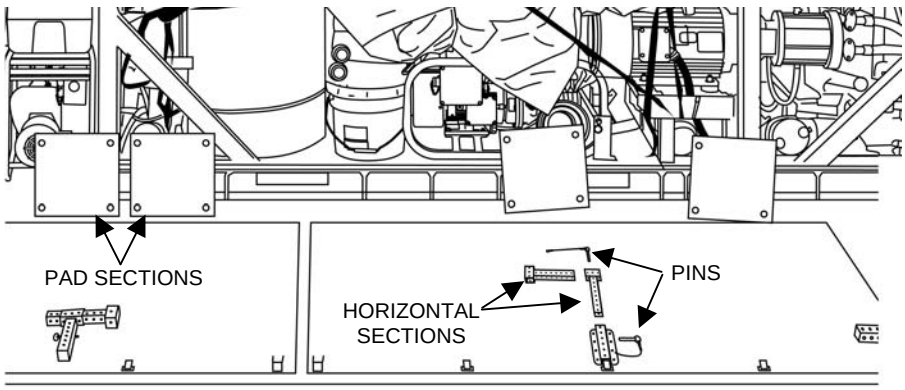


Figure 27. Deck Support Assembly Packout.

5. Raise the deck and latch it shut.
6. Install the remaining flat rack panels (side #1 and #2 and rear #3 and #4) and latch them shut (see Figure 28).
7. Attach the product water door shipping cover over the opening below the product water door.

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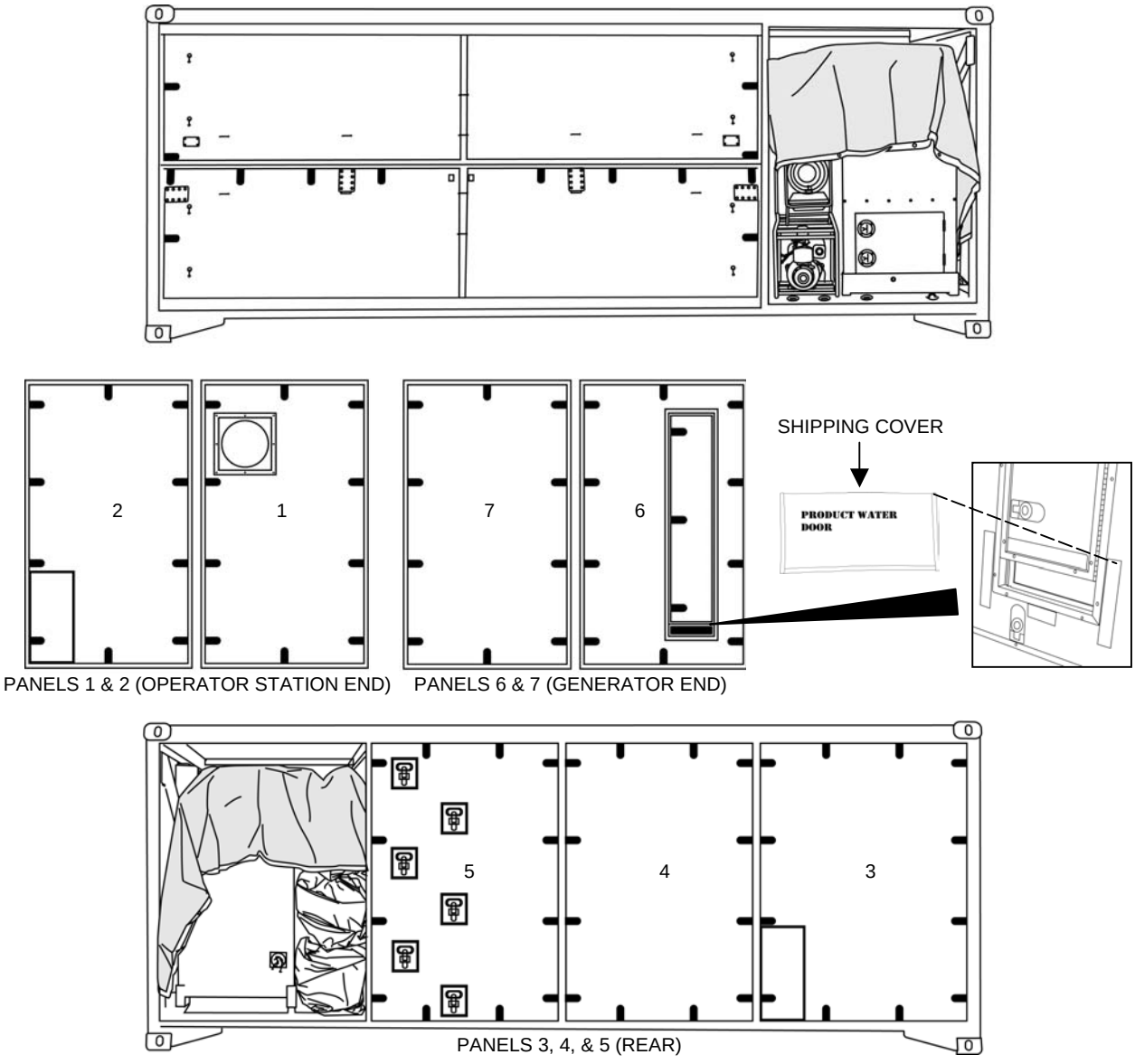

Figure 28. Flat Rack Panel Installation.

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Preparing to Load the A-TPWS on a PLS Trailer

If the A-TWPS is to be loaded onto a PLS Trailer, rollers are installed on the flat rack so that the A-TWPS can be rolled onto the trailer. After the A-TWPS has been loaded onto the PLS truck, install the flat rack rollers as follows:

1. Remove both rollers from their storage brackets at the bail bar end of the flat rack as follows (see Figure 29):
    a. Remove the retaining pins.
    b. Pull out the roller axle.
    c. Lift the roller out of the storage bracket.
2. Install both rollers in their in-use brackets at the operator station end of the flat rack as follows (see Figure 29):
    a. Position the roller in the in-use bracket.
    b. Slide the roller axle through the bracket and roller.
    c. Insert a retaining pin in both ends of the axle.

Once the rollers are installed, the A-TWPS can be lifted by the bail bar using the arm on the PLS truck and rolled onto an attached PLS trailer.

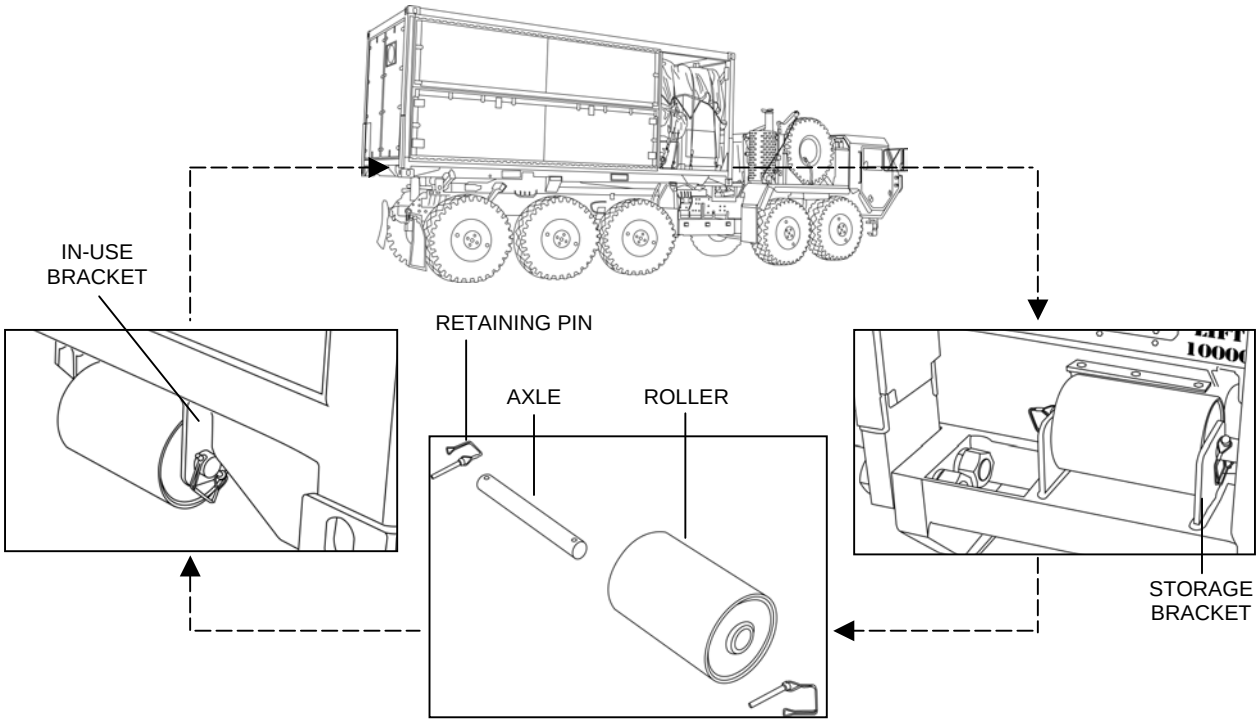

Figure 29. Flat Rack Roller Installation.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

0029 00

INITIAL SETUP:

Reference:
TM 10-5430-237-12&P
Personnel Required:
Three Operator/Crew
Equipment Condition:
MC-TWPS set up and operating or shut down

GENERAL

This work package provides instructions for packing out the MC-TWPS for movement from one deployed location to another, including short storage periods (up to 30 days) between deployments. Refer to WP 0032 for the procedures to pack out the unit if it will be in storage for more than 30 days.

UNIT SHUTDOWN AND PRESERVATION

Before starting equipment/component disassembly and packout, the MC-TWPS must be shut down, flushed and drained, and the power source must be secured and disconnected. Preservation of the Micro-Filtration (MF) and Reverse Osmosis (RO) elements may also be required based on the expected length of the shutdown.

1. Refer to WP 0017 and WP 0018 for shutdown and preservation requirements and procedures.
2. Disconnect the power and ground cables from the Tactical Quiet Generator (TQG) as follows:

WARNING

High voltage electrical hazard. High voltage is produced when the generator set is in operation. Make sure that the Tactical Quiet Generator has been properly shut down before attempting to disconnect the power or ground cable from the TQG. Failure to observe this warning could result in injury or death from electrical shock.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before making or capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

NOTE
Refer to TM 5-6115-545-12 for generator operation.

a. Disconnect the TWPS power cable leads from the generator lugs labeled L1, L2, and L3.
b. Disconnect the TWPS power cable white lead from the generator Neutral lug and the green lead from the generator Ground lug.
c. Tuck the TWPS power cable end inside the TWPS frame.
d. Disconnect the ground cable from the generator Ground lug.

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EXTENDED CAPABILITY MODULES

Depending on tactical and environmental conditions, and the layout of the deployment site, various extended capability modules may be in use. These include:

- Cold Weather Module
- Supplemental Cleaning Waste Storage Module
- Ocean Intake Structure System Module
- NBC Water Treatment Module
- NBC Survivability Module

The components of these modules are packed out and transported in their own containers. Before starting MC-TWPS packout, remove and pack out the extended capability module components using the procedures in WP 0030, Preparation for Movement – Marine Corps Extended Capability Modules.

PREPARATION FOR PACKOUT

Prepare the MC-TWPS for packout as described in the following steps, which can generally be performed at the same time and in any convenient order.

1. Sort by length and lay out the following straps that will be used to secure various components:
   - Six 12-in. hook and loop straps (4 of the 6 should already be on the NBC Hypochlorite tubing)
   - Ten 18-in, hook and loop straps
   - Three 36-in. hook and loop straps
   - Four 48-in. hook and loop straps
   - Ten 10-ft. ratchet straps (2 of the 9 should already be around the NBC tank)
2. Sort by length and lay out the following discharge hose straps that were stored in a separate BII box when the hoses were installed. (The hose straps are brown and have a carrying loop.)
   - Eight 25-in. straps
   - Two 12-in. straps
   - One 36-in strap

NOTE

All product water hoses have caps and plugs that should be installed on the end of the hoses during packout to keep the product hoses clean. The covers and caps are stored in BII Box #3 when the hoses are in use.

For easy identification, all hoses are coded with colored bands at each end as follows:

- **Ocean Intake Structure System (OISS) - yellow**
- **Raw Water – green**
- **Product Water – blue**
- **Cleaning and Waste – red**

3. Disconnect the raw water, MF feed, and product water distribution hoses and adaptors. Allow them to drain.
4. Install the dust covers and caps on the product water distribution hoses.

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5. Set the hoses and adaptors aside.
6. Install dust caps on the TWPS raw water inlet, product water discharge hose, and waste outlet.
7. Remove the cap from the end of each distribution discharge (collapsible) hose, tightly roll up the discharge hoses and secure each with one brown hose strap as indicated in the table below, then reinstall the caps on the ends of the hoses.

Hose	Hose Qty.	Strap
F02 2-in x 6-ft.	1	12-in.
F03 2-in x 50-ft.	4	25-in.
F07 3-in. x 10-ft.	2	25-in.

Hose	Hose Qty.	Strap
P05 2-in. x 65-ft.	2	25-in.
P06 5/8-in. x 50-ft.	1	12-in.
R05 6-in. x 50-ft.	1	36-in.

8. Retrieve the anchor assembly.
9. Open the drain valves on the raw water, MF feed, and product water distribution pumps and drain the pump casings. Close the valves after all the water has drained. Install the dust caps and covers on the pump inlet and outlet connections.
10. Disconnect the motor-driven pump power cables at both ends and install the dust covers on the cable connectors. Tightly coil the cables and set them aside.
11. Install the dust caps on all pump skid junction box receptacles.
12. Close the fuel cock on the diesel pump fuel tank, disconnect the fuel supply and return quick disconnect couplings.

CAUTION

Potential cause of fuel pump and injection valve failure. Do not leave the fuel lines for the diesel engine and fuel tank disconnected. Failure to observe this caution may allow sand and dirt to enter the fuel system and result in fuel pump and injection valve failure.

13. Couple the two tank fuel lines together and the two diesel engine fuel lines together.
14. Remove the fuel tank.
15. Remove the screen filter from the fuel filler port and drain the fuel from the tank into a fuel can.

16. Ventilate the fuel tank as follows (see Figure 1).
    a. Connect the quick-disconnect air hose (BII Box #8) to the quick-disconnect fitting in Air System Section 1.
    b. Connect the air blowgun (air nozzle, Operator's Tool Kit) to the other end of the air hose.
    c. Blow air into the fuel filler port to ventilate the fuel tank.
    d. Reinstall the screen filter and the fuel cap.

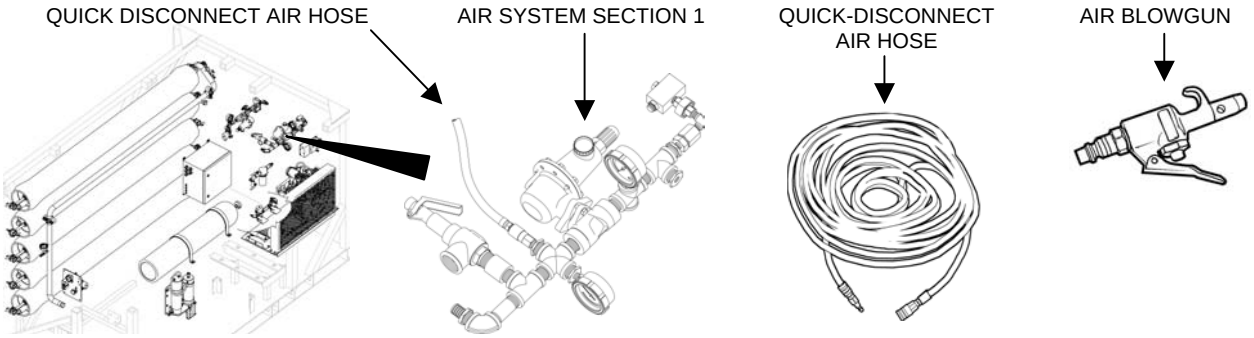

Figure 1. Quick-Disconnect Air Hose Connections.

17. Remove the suction and return tubing from the chemical buckets. Dispose of the contents of the buckets in accordance with local instructions, then set the buckets and lids aside.
18. After completely draining the 3000-gallon product water distribution tanks, roll up the tanks, place one tank repair kit on each tank, and wrap the tank ground cloth around the tank. Refer to TM 10-5430-237-12&P. Then wrap two 48-in. hook and loop straps around both distribution tanks for additional support to keep the both tanks rolled up.
19. After completely draining the 1000-gallon MF feed tank, pack up the tank, a repair kit, and the ground cloth similar to the procedures for the product water distribution tanks. Wrap two 36-in. hook and loop straps around the tank for additional support to keep the tank rolled up.
20. Disconnect the ground wire from the generator and ground rod. Coil the wire and set it aside.
21. Retrieve the ground rod. Disassemble the rod and the slide hammer, then reinstall the washers and nuts onto the slide hammer rod.
22. Empty the fuel can into the generator (TQG) fuel tank.

PACKOUT

Basic Issue Items Packout

Referring to the illustrations and tables on the following pages, pack out the tool box, the five numbered BII boxes, the two buckets, and the manuals storage box and set them aside.

NOTE

There is no BII Box #2. It is used only with the Army version of the TWPS.

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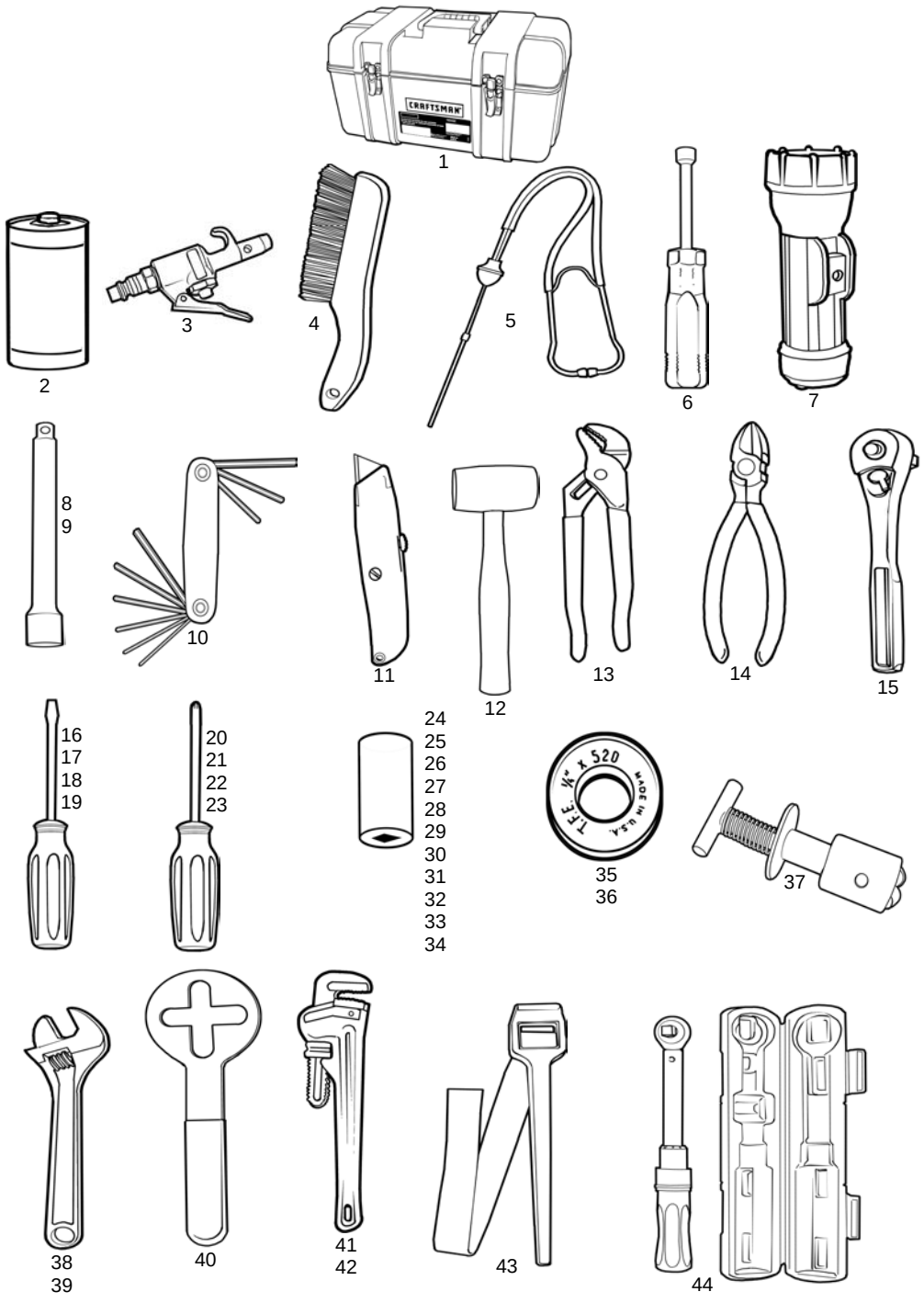
PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

Operator's Tool Kit



TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

Table 1. Operator's Tool Kit.

No.	Item Name	Qty
1	Tool Box	1
2	Battery, D-Size, Package of 6	1
3	Blowgun Assy	1
4	Brush, Plater's	1
5	Detector, Mf Leak	1
6	Driver, Nut, 5/16"	1
7	Flashlight, D-Size	1
8	Extender, Socket, 3"	1
9	Extender, Socket, 6"	1
10	Key Set, Hex, Foldup Set	1
11	Knife, Utility	1
12	Mallet, Rubber, Wood Handle	1
13	Pliers, Channel Lock, 9.5"	1
14	Pliers, Diagonal	1
15	Ratchet, 3/8"	1
16	Screwdriver, Flat Blade	1
17	Screwdriver, Flat Blade	1
18	Screwdriver, Flat Blade	1
19	Screwdriver, Flat Blade	1
20	Screwdriver, Phillips Blade	1
21	Screwdriver, Phillips Blade	1
22	Screwdriver, Phillips Blade	1
23	Screwdriver, Phillips Blade	1
24	Socket, 1/2"	1
25	Socket, 11/16"	1
26	Socket, 13/16"	1
27	Socket, 15/16"	1
28	Socket, 3/4"	1
29	Socket, 3/8"	1
30	Socket, 5/8"	1
31	Socket, 7/16"	1
32	Socket, 7/8"	1
33	Socket, 9/16"	1
34	Socket, Spark Plug, 5/8"	1
35	Tape, Antiseizing, 1/2" Wide	1
36	Tape, Antiseizing, 1/4" Wide	1
37	Tool, Mf Filter Bypass	1
38	Wrench, Adjustable, 10"	1
39	Wrench, Adjustable, 8"	1
40	Wrench, Air Compressor Purification Chamber	1
41	Wrench, Pipe, 12"	1
42	Wrench, Pipe, 15"-18"	1
43	Wrench, Strap, 1"-5" Pipe	1
44	Wrench, Torque, With Case	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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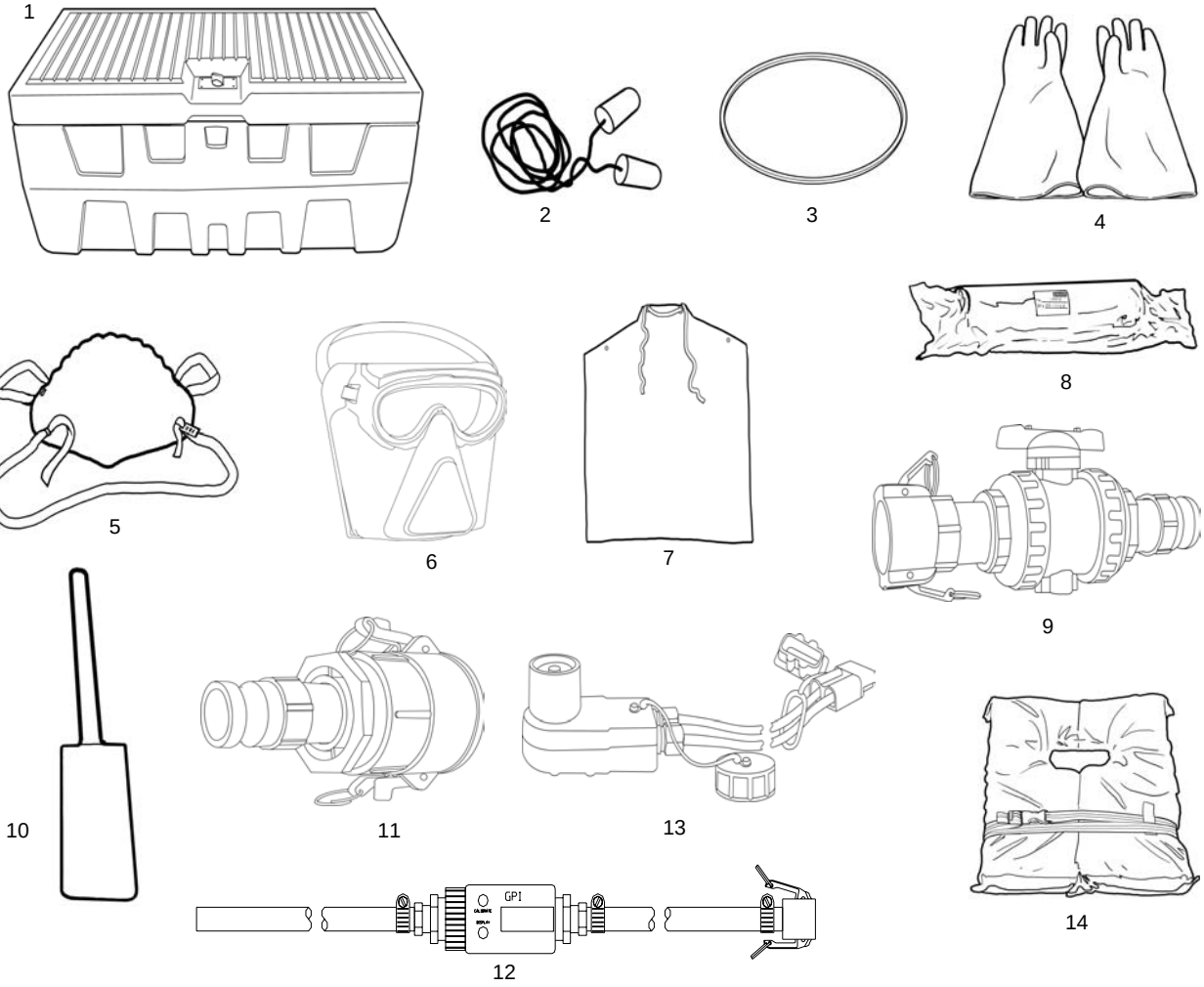
BII Box #1



TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

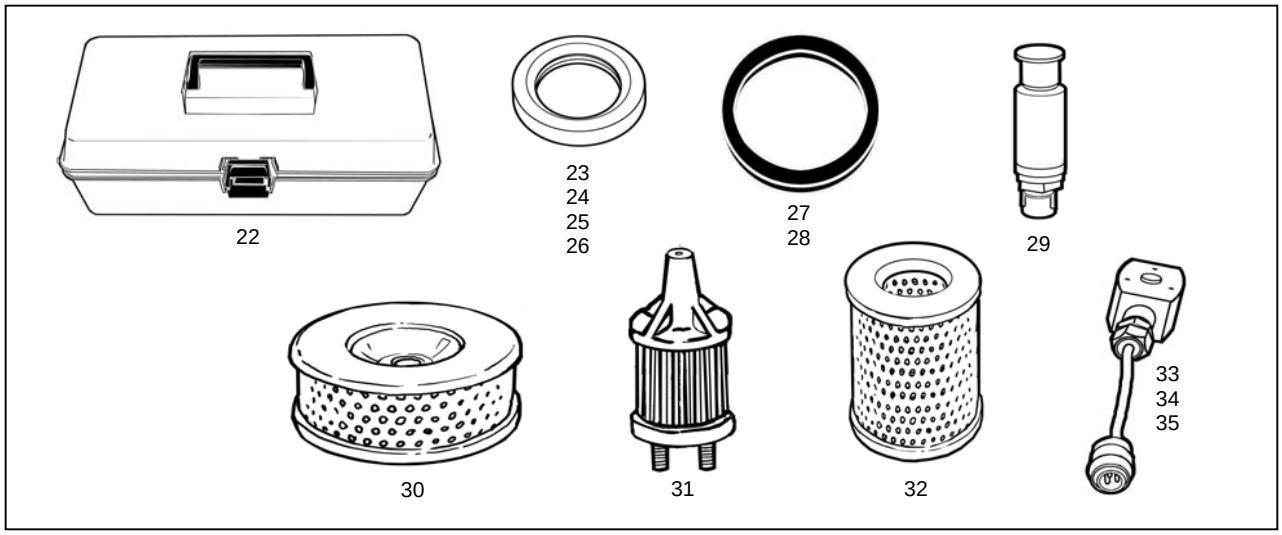

Table 2. BII Box #1.

No.	Item Name	Qty
1	Box	1
2	Earplugs	10
3	Belt, Air Compressor	1
4	Gloves, Chemical	2
5	Respirator, Particulate	4
6	Shield, Face, Chemical	1
7	Apron, Chemical	2
8	Purification Cartridge, Air Compressor	1
9	Adaptor A-12	1
10	Paddle, Stirring	1
11	Adaptor A-10	1
12	Flowmeter Assembly	1
13	Starting Cable, Diesel Engine, 24 Volt DC	1
14	Vest, Flotation	1
15	Gasket, C&G, 1"	1
16	Gasket, C&G, 1-1/2"	2
17	Gasket, C&G, 2"	12
18	Gasket, C&G, 3"	10

No.	Item Name	Qty
19	Gasket, C&G, 4"	1
20	Gasket, C&G, 6"	1
21	Rupture Disk DV 1.0 in.75# Burst and Storage Box	1
22	Box	1
23	Gasket, Grooved Coupling, 1"	2
24	Gasket, Grooved Coupling, 1.5"	5
25	Gasket, Grooved Coupling, 2.0"	2
26	Gasket, Grooved Coupling, 3.0"	1
27	Gasket, Sanitary, 4"	1
28	Gasket, Sanitary, 6"	1
29	Pressure Transmitter, PT-201	1
30	Filter, Air, Diesel	1
31	Filter, Fuel, Diesel	1
32	Inlet Air Filter, Air Compressor	1
33	Spare Solenoid Assembly	1
34	Spare Solenoid Assembly	1
35	Spare Solenoid Assembly	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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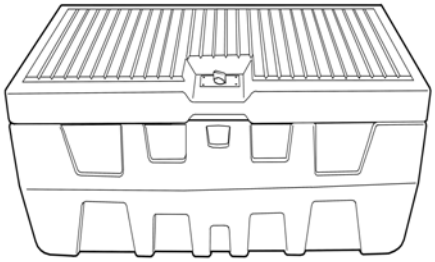
BII Box #3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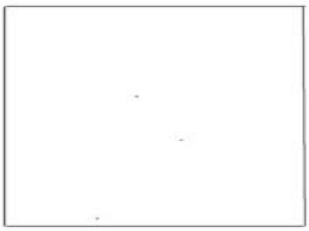
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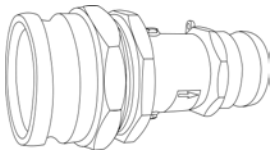
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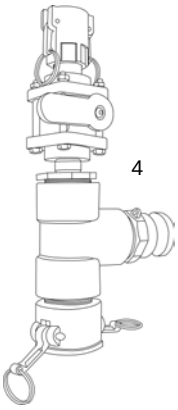
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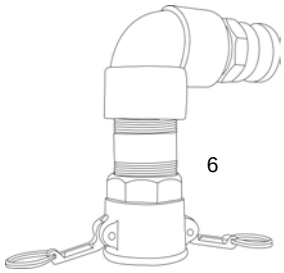
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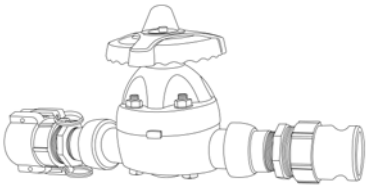
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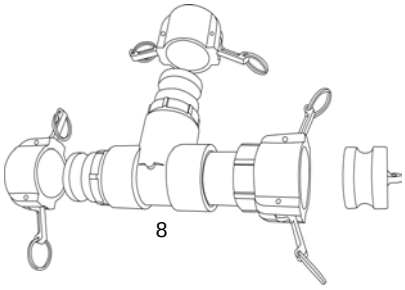
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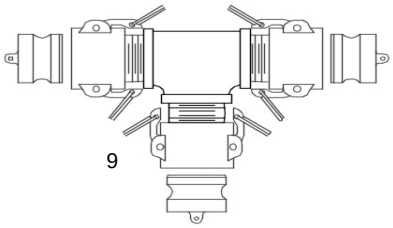
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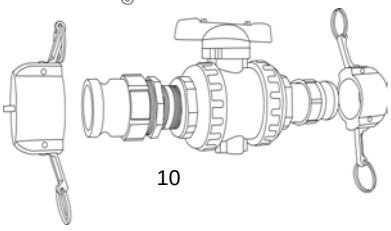
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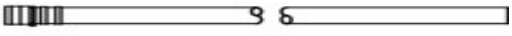
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Table 3. BII Box #3.

No.	Item Name	Qty
1	Box	1
2	Pad, fuel absorbent	1
3	Adaptor A-01	1
4	Adaptor A-02	1
5	Adaptor A-03	1
6	Adaptor A-04	1
7	Adaptor A-05	1
8	Adaptor A-07	1
9	Adaptor A-08	1
10	Adaptor A-15	1
11	Hose Assembly F-06	2
12	Plug, Hose, 3”	1
13	Strainer, MF Feed Tank	1

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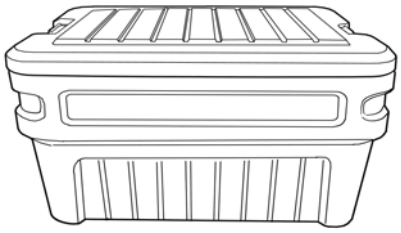
BII Box #4



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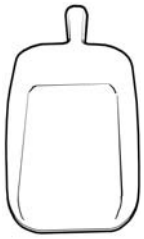

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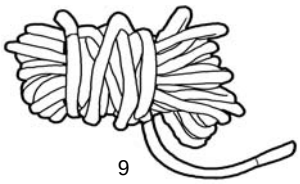

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Table 4. BII Box #4.

No.	Item Name	Qty
1	Box	1
2	Large Scoop	1
3	Measuring Bottle	1
4	Measuring Cup, 1000 ml	1
5	High PH Detergent	4
6	Bisulfite, 10 oz. Packets	1
7	Antiscalant	2
8	Strainer, MF Feed Tank	2
9	Rope, Strainer	1

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BII Box #5

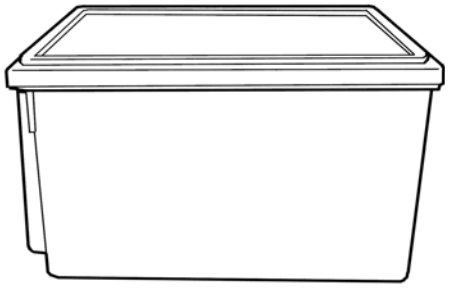

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Table 5. BII Box #5.

No.	Item Name	Qty
1	Box	1
2	Sodium Hydroxide	4

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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BII Bucket #6

1

2

3

4

5

6

Table 6. BII Bucket #6.

No.	Item Name	Qty
1	Bucket	1
2	Funnel	1
3	Corrosion Preventive Compound	1
4	Oil, SAE 10W-30, 1 qt	1
5	Oil, Air Compressor, 1 qt	1
6	Silicon Lubricant	1

BII Bucket #7

1

2

Table 7. BII Bucket #7.

No.	Item Name	Qty
1	Bucket	1
2	Container, Chlorine, 10 - 4 oz. Packets	1

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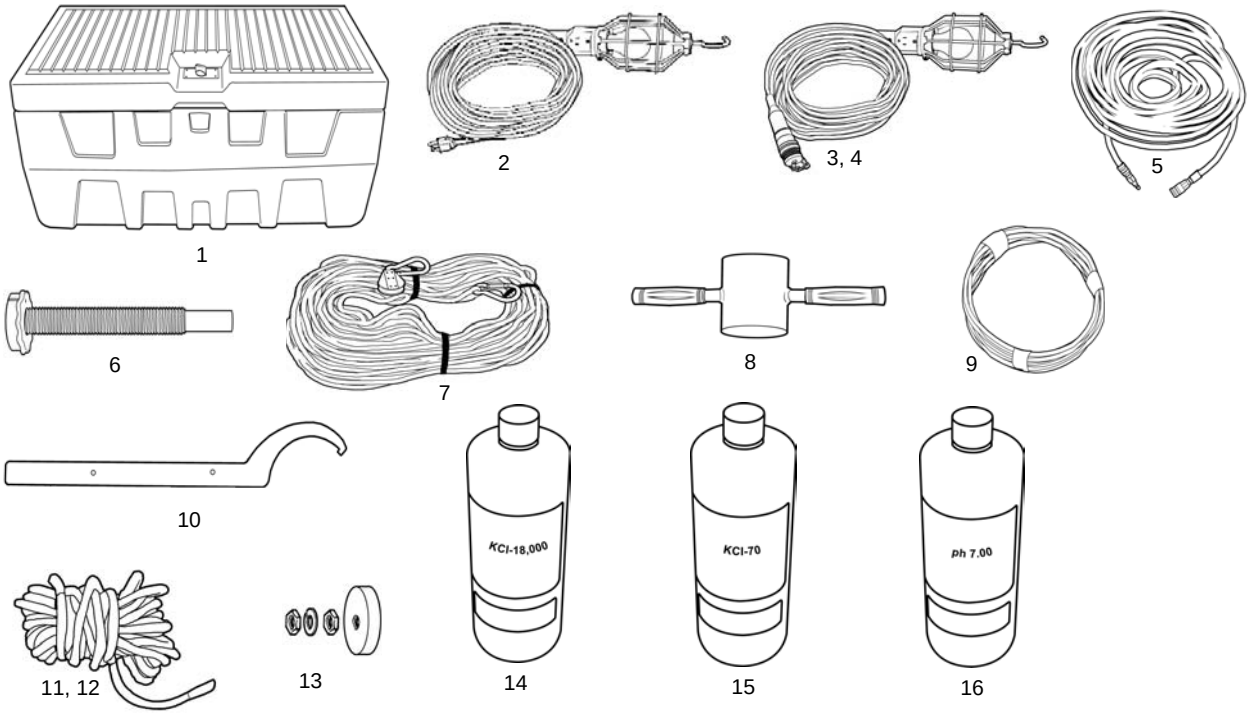
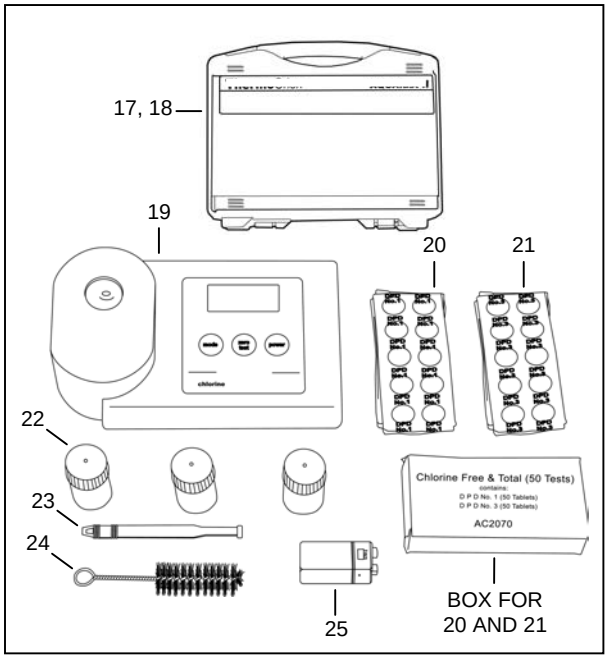
BII Box #8





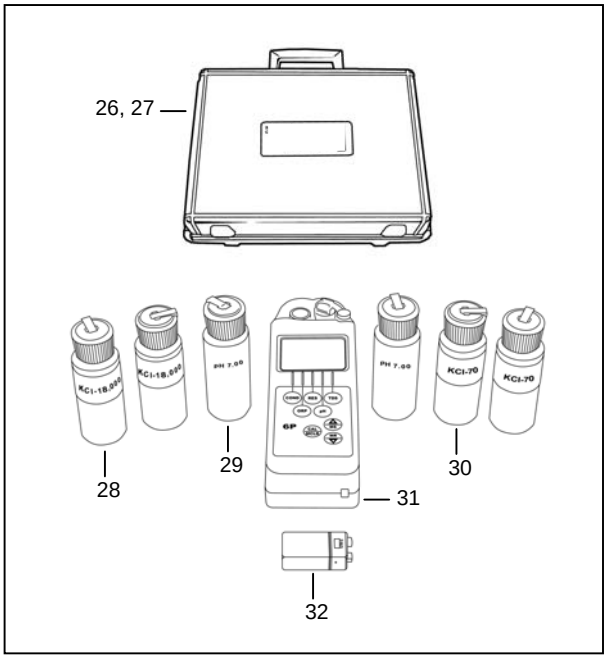


Table 8. BII Box #8.

No.	Item Name	Qty
1	Box	1
2	Light, Trouble	1
3	Light, Work	1
4	Light, Blackout	1
5	Hose, Auxiliary Air	1
6	Spout, Fuel Can	1
7	Rope Assembly, Anchor	1
8	Hammer, Slip, Ground Rod	1
9	Wire, Ground, 25 ft.	1
10	Tool, MF Filter C-Spanner	1
11	Rope, Raw Water Hose Tie-off	1
12	Rope, F-04 Hose	1
13	Hardware, Ground Rod - Hammer	1
14	Calibration Solution – KCI-18000 (32 oz.)	1
15	Calibration Solution – KCI-70 (32 oz.)	1
16	Calibration Solution – pH-7.00 (32 oz.)	1
17	Chlorine Analyzer Kit	1
18	. Case, Chlorine Analyzer Kit	1
19	. Chlorine Analyzer	1
20	. Chlorine Free Test Tablets – DPD-1	50
21	. Total Chlorine Test Tablets – DPD-3	50
22	. Cuvette	3
23	. Mixing Rod	1
24	. Cleaning Brush	1
25	. Battery, 9v-DC	1
26	TDS Meter Kit	1
27	. Case, Carrying, TDS Meter Kit	1
28	. Calibration Solution – KCI-18000	2
29	. Calibration Solution – pH-7.00	2
30	. Calibration Solution – KCI-70	2
31	. Portable TDS Meter	1
32	. Battery, 9v-DC	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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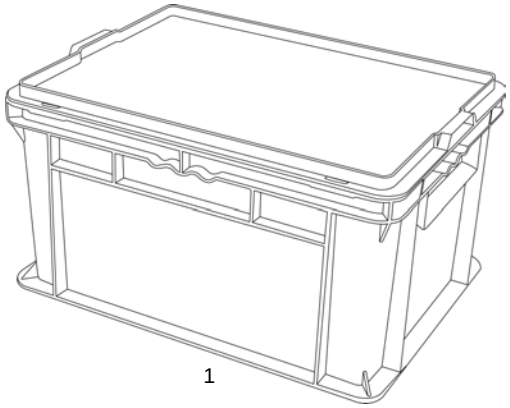
Manuals Storage Box



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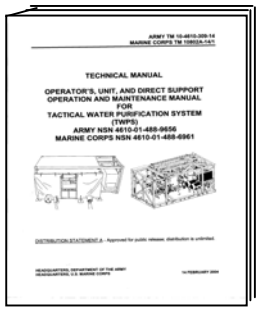

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Table 9. Manuals Storage Box.

No.	Item Name	Qty
1	Box, Storage, Manuals	1
2	TWPS Operation and Maintenance Manual (two volumes)	1
3	TWPS RPSTL	1

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Left End Packout

1. Coil the bisulfite pump discharge, suction, and return tubing together and strap them to the TWPS frame behind the pump using a 12-in. hook and loop strap.
2. Coil the antiscalant and hypochlorite suction and return tubing together and strap them to the TWPS frame behind the pump using a 12-in. hook and loop strap.
3. Pack the ground rod sections and the slide hammer rod in the storage brackets at the left front corner of the skid and secure them with an 18-in. hook and loop strap (see Figure 2).
4. Store the protractor (level) in the protractor (level) storage box (see Figure 2).

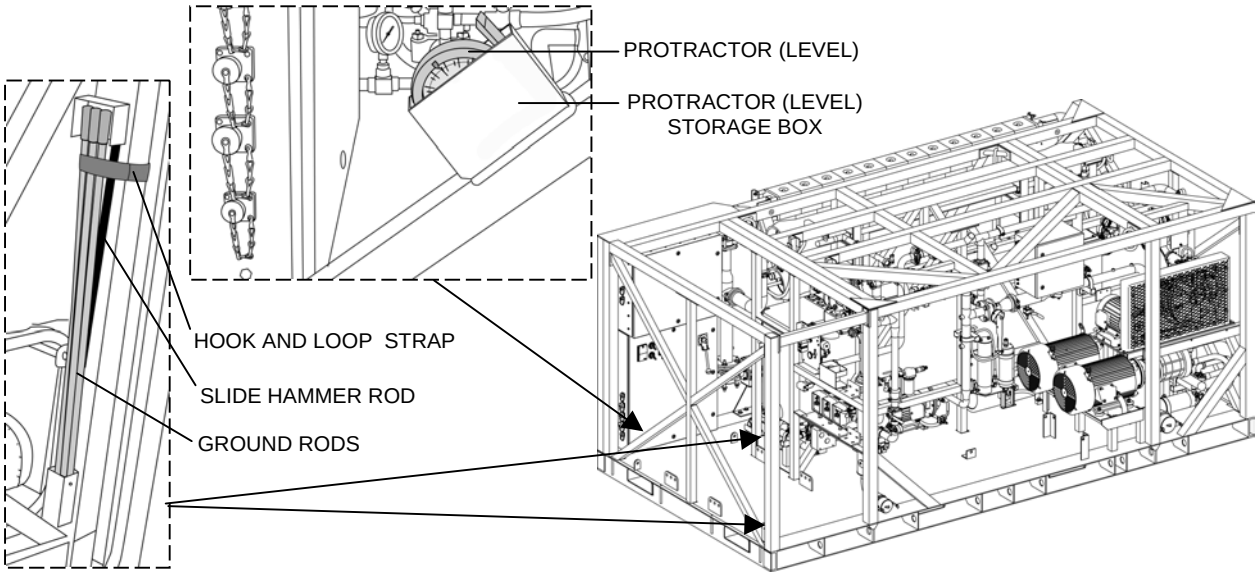

Figure 2. Ground and Slide Hammer Rod Storage.

Raw Water Suction Hose Packout

Pack five 3-in. x 10-ft., green-banded raw water suction hoses lengthwise on top of the RO feed tank. Slide them in, male end first, from the right side of the skid. Be sure the female ends of the hoses don't stick outside the skid frame. Wrap the right ends of the five hoses together and secure them to the TWPS using a 10-ft. ratchet strap.

Pack five additional 3-in. x 10-ft., green-banded raw water suction hoses lengthwise on top of the RO feed tank. Slide them in, male end first, from the right side of the skid. Be sure the female ends of the hoses don't stick outside the skid frame. Wrap the right ends of the five hoses together and secure them to the TWPS using another 10-ft. ratchet strap.

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Operator Station Packout

1. Install the operator station overhead support beam across the front of the operator station using eight bolts and lock washers (see Figure 3).
2. Wrap the support beam pad around the support beam and secure with the hook and loop strip.
3. Lower and secure the operator station roof (see Figure 3).
    a. One person supports the roof while another person removes the roof support retaining pins.
    b. Carefully lower the roof until it rests on the TWPS frame.
    c. Secure the roof in the lowered position with the roof support retaining pins.

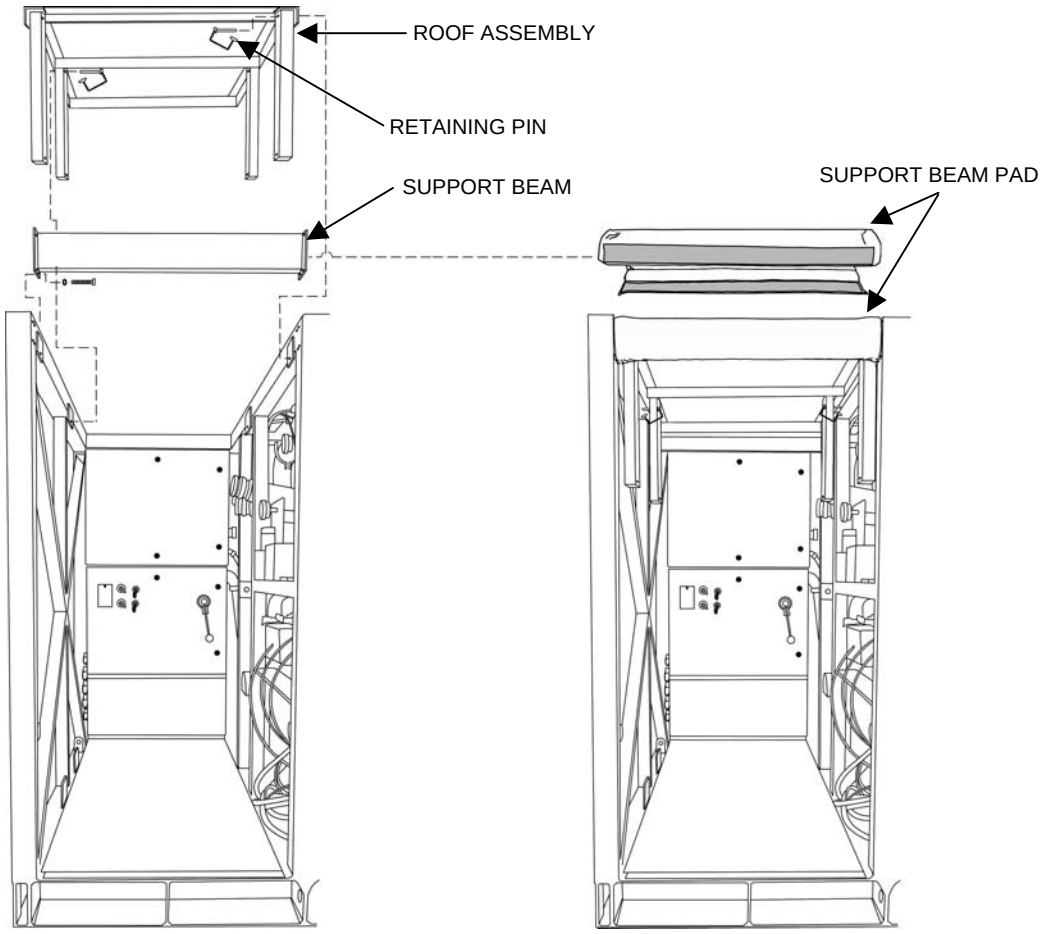

Figure 3. Operator Station Overhead Support Beam and Roof Packout.

4. Coil the ends of the 5 RO element drain hoses and the RO vessel drain hose together at the Operator Station end of the TWPS and secure them to the TWPS using an 18-in. hook and loop strap (see Figure 4).

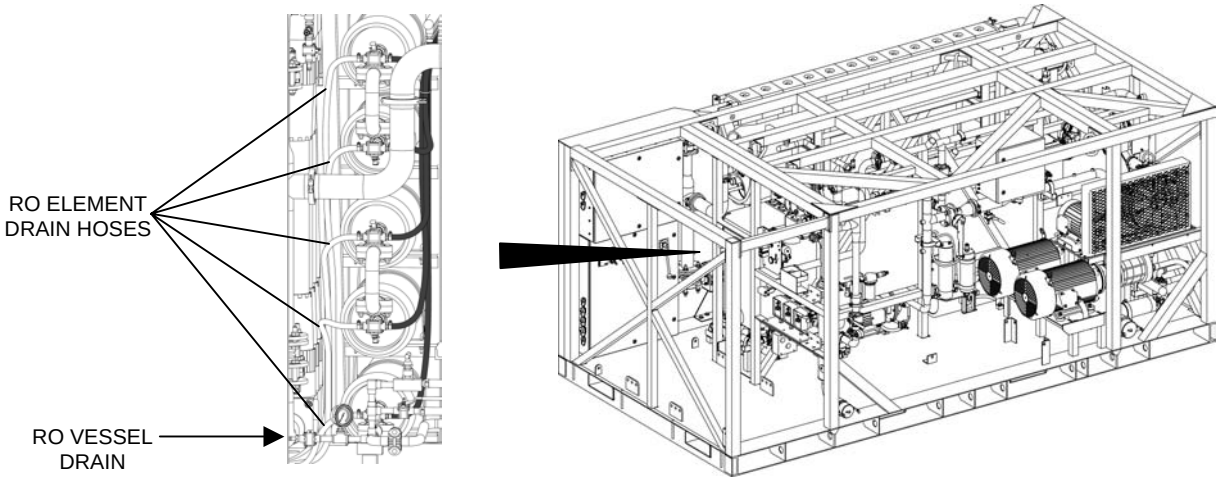

Figure 4. Left End RO Element Drain Hoses and RO Vessel Drain Hose.

5. Place the TWPS Technical Manuals and the Repair Parts and Special Tools List (RPSTL) Manual in the manuals storage box and put the cover on the box.
6. Set the manuals storage box under the chemical injection pumps next to the fire extinguisher (see Figure 5).
7. Place one of the Chemical Injection System buckets inside another one. Place BII bucket #7 (chlorine bucket) inside the two buckets.
8. Place BII bucket #6 (lubricants bucket) inside the third Chemical Injection System bucket.
9. Place the buckets on the floor, to the right side of the Power Distribution Panel, then place BII Box #5 beside them (see Figure 5).
10. Place the three chemical injection bucket colored lids on top of the buckets.

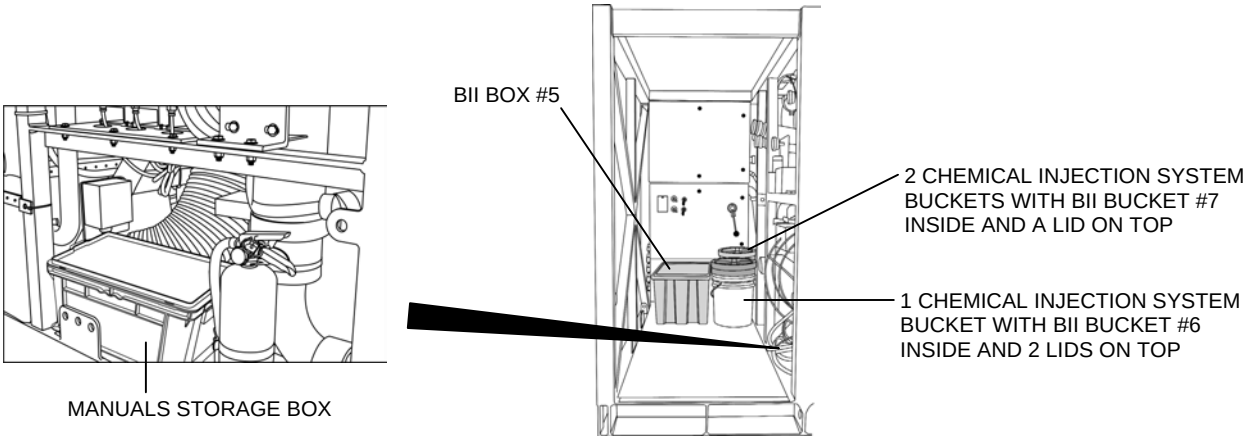

Figure 5. Operator Station Packout 1.

11. With one person inside the operator station area and another outside, feed the power cable through the skid frame and coil it on top of the BII box and buckets (see Figure 6). Be sure the coiled-up cable does not stick outside the skid frame.

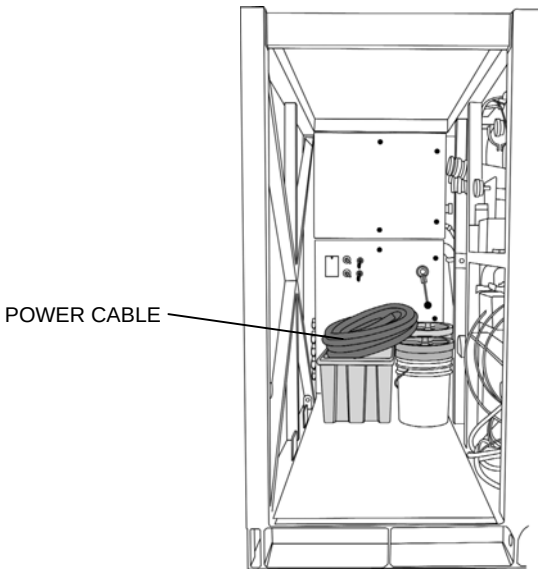

Figure 6. Operator Station Packout 2.

12. Place one of the 3,000-gallon distribution tanks on top of the power cable (see Figure 7):

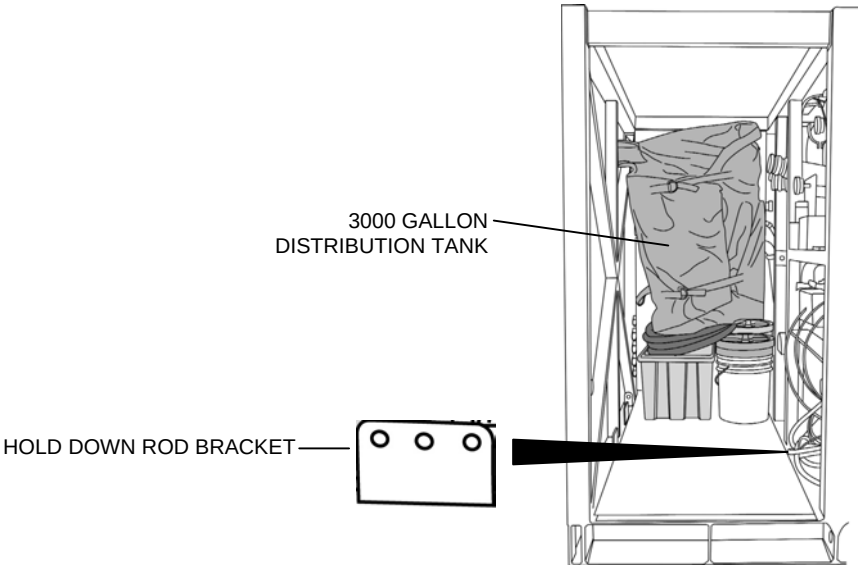

Figure 7. Operator Station Packout 3.

13. Install the fire extinguisher in its bracket next to the S-2 strainer.
14. Attach the long end of a 10-ft. ratchet strap to the center hole of the hold down rod bracket on the floor below the feed flow control panel and temporarily lay the strap out of the way on top of the frame above the feed flow control panel (see Figure 7).

WARNING

Three person lift. Three people are required to safely lift Diesel-Driven Pump Skid. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

Two person lift. Two people are required to safely lift the Motor-Driven Pump Skids. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

15. Place the diesel pump skid sideways on the floor in front of the BII box and buckets, with the pump end facing out (see Figure 8).
16. Secure the skid with a long retaining rod.
17. Place the two distribution nozzles inside the diesel pump skid and secure them with two 18-in. hook and loop straps.

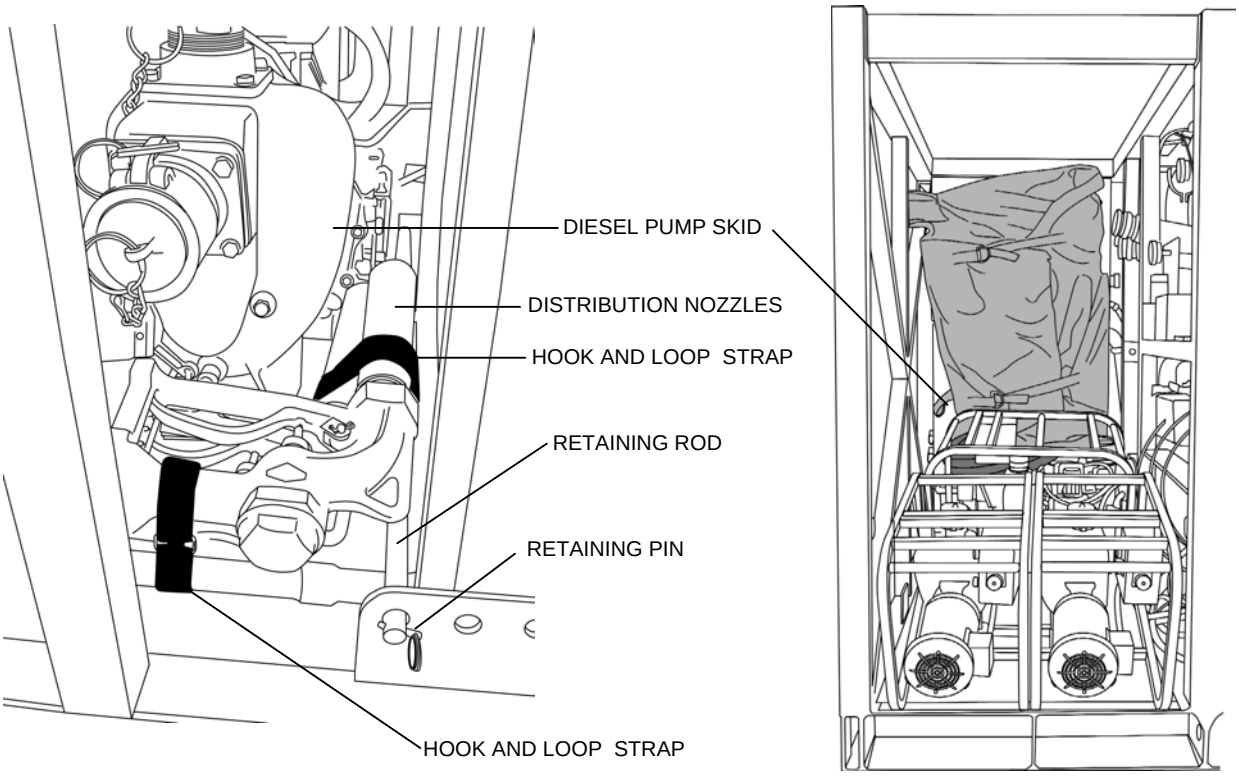

Figure 8. Operator Station Packout 4.

18. Place the two motor-driven pump skids side by side in front of the diesel pump skid, with the motor end of the skids facing out (see Figure 9).
19. Secure the skids with two long retaining rods.

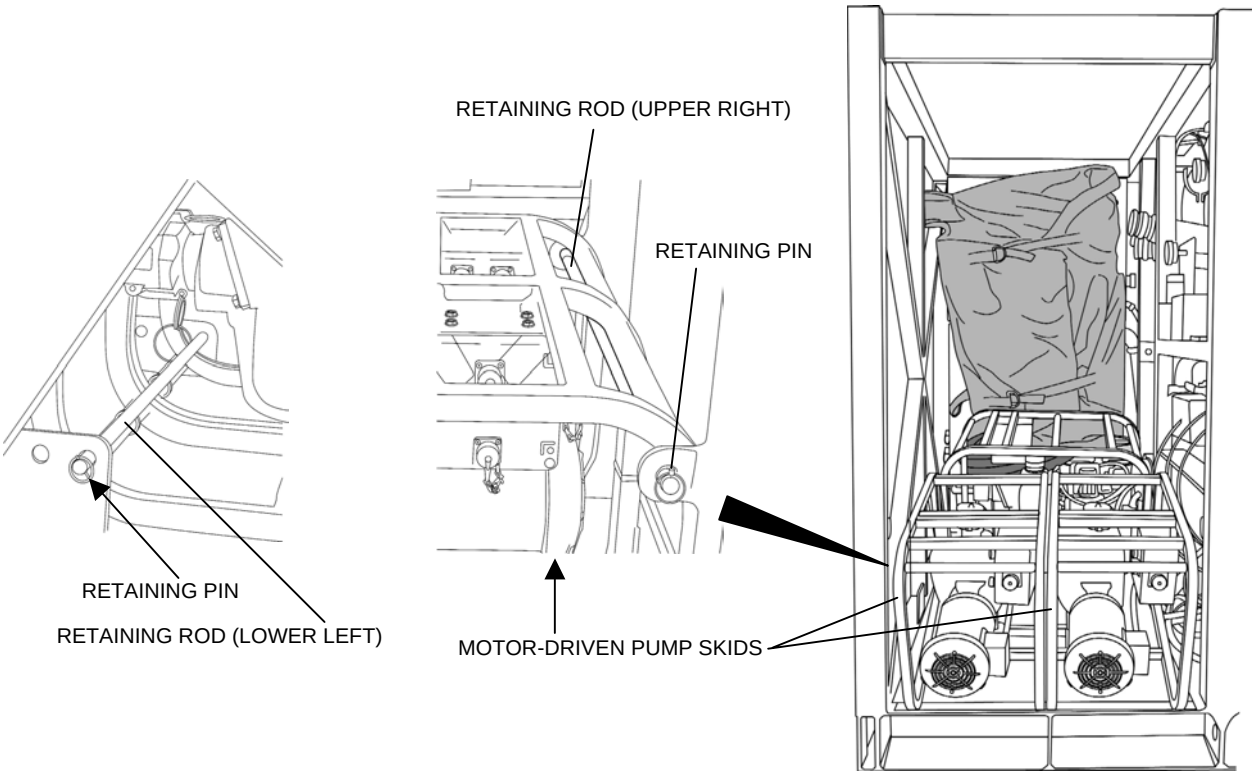

Figure 9. Operator Station Packout 5.

20. Place Adaptor A-09 inside the left motor-driven pump skid. Secure it with a 36-in. hook and loop strap run through the adaptor and around the pump suction (see Figure 10).

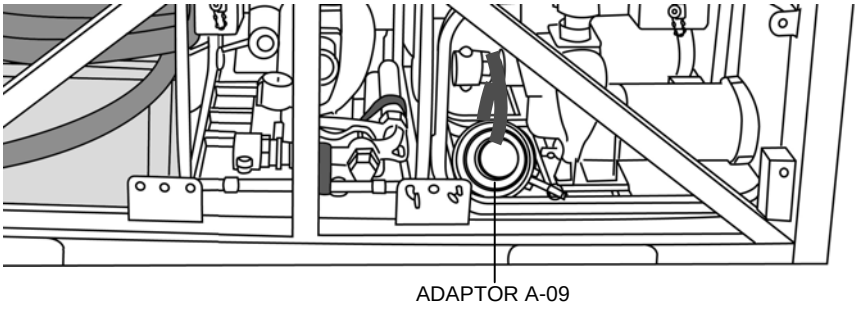

Figure 10. Adaptor A-09 Packout.

21. Get the two 10-ft. ratchet straps with the plastic tubes.
22. Hook the long section of the two 10-ft. ratchet straps to the round center frame member of the diesel pump skid and temporarily lay the straps on the pump power cables (see Figure 11).
23. Place BII Box #4 on top of the diesel pump skid and place the pump power cables on top of the box (see Figure 11).
24. Place the remaining three BII boxes and the diesel pump fuel tank assembly on top of the motor-driven pump skids (see Figure 11).
25. Route one of the 10-ft. ratchet straps (one end attached to the diesel-pump skid earlier) over the boxes and through the fuel tank assembly frame. Attach the free end of the strap to the motor-driven pump skid.

NOTE

The plastic tube that is provided with two of the 10-ft. ratchet straps is needed to prevent the ratchet hardware from rubbing a hole in the General Purpose Cover or Winter Cover that is installed over the MC-TWPS unit.

26. Slide the plastic tube over the ratchet hardware.

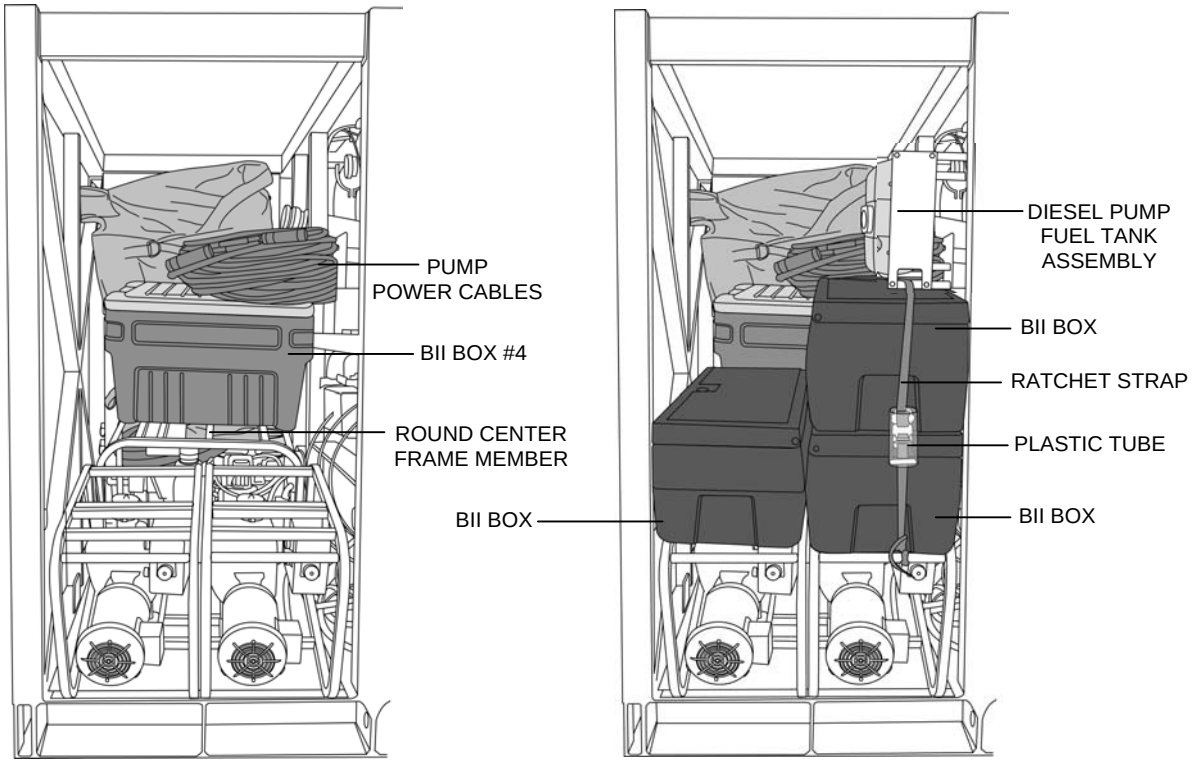

Figure 11. Operator Station Packout 5 and 6.

27. Stack the long, rolled-up discharge hoses (four 2 x 50 raw water hoses and two 2 x 65 product water distribution hoses) on top of and beside the pump power cables (see Figure 12).
28. Place the MF feed tank on top of the BII boxes.
29. Retrieve the 10-ft. ratchet strap from on top of the skid frame above the feed flow control panel, route it over the hoses, and attach it to the diesel pump skid.

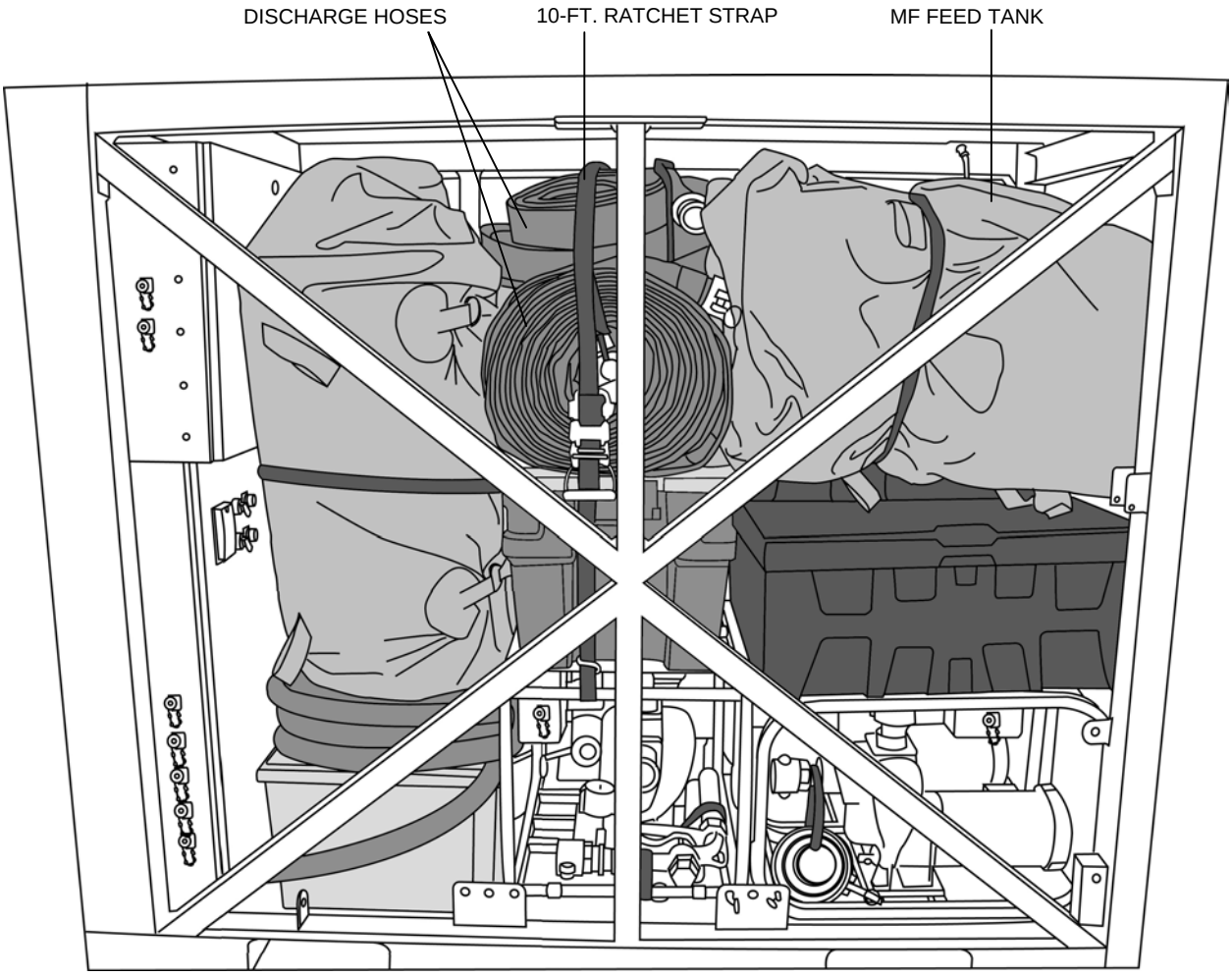

Figure 12. Operator Station Packout 7.

30. Retrieve the remaining ratchet strap from on top of the Operator Control Panel, route it over the MF feed tank, attach it to the motor-driven pump skid, and tighten the strap (see Figure 13).
31. Slide the plastic tube over the ratchet hardware.
32. Place the pump priming pitcher inside the right motor-driven pump skid and secure it with an 18-in. hook and loop strap (see Figure 13).

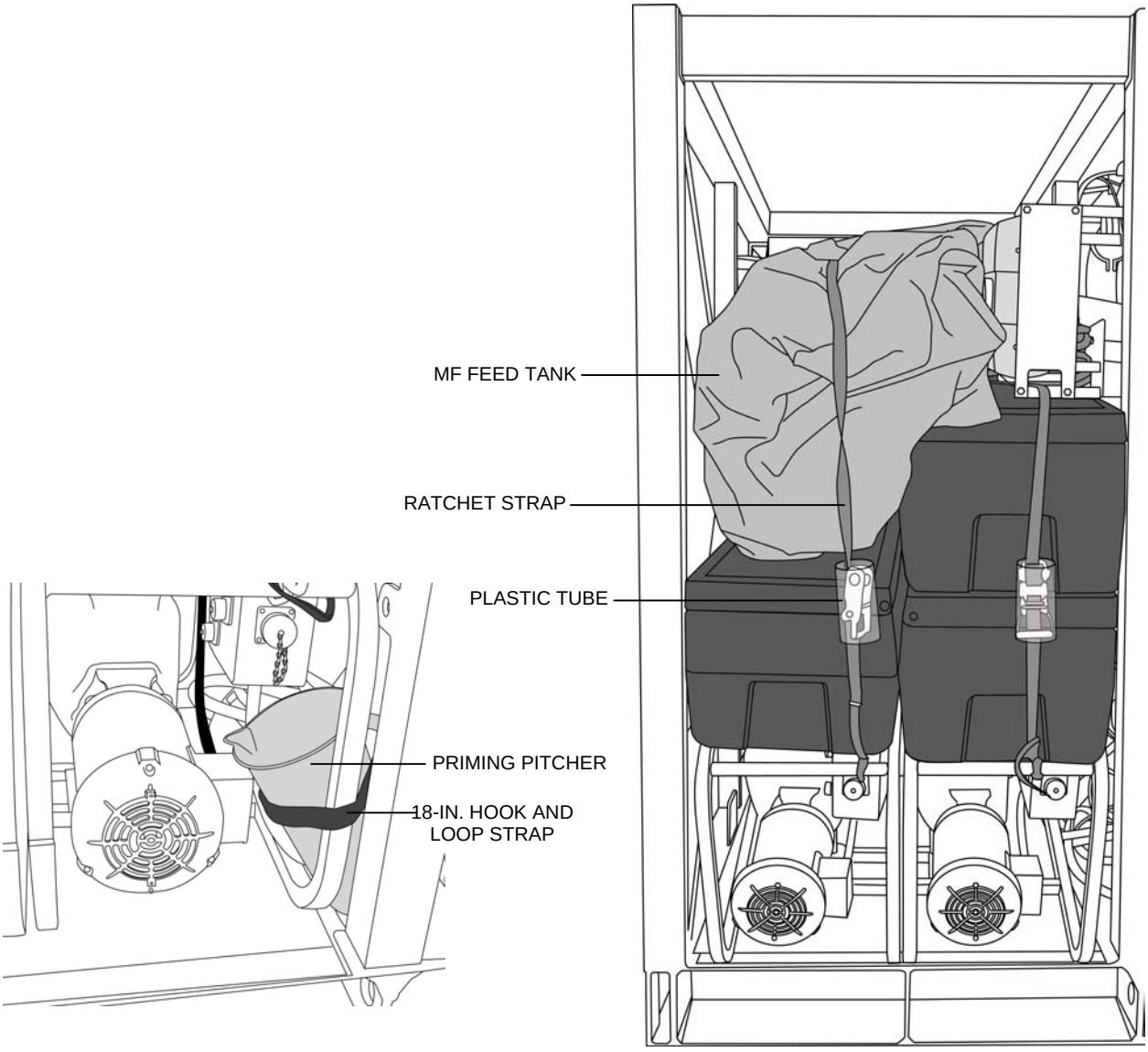

Figure 13. Operator Station Packout 8.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

Equipment Area Packout

1. Make sure the NBC tank is secured to Strainer S-2 with two 10-ft. ratchet straps.
2. Coil the product utility hose and the Strainer S-4 drain hoses together and secure them to the TWPS using an 18-in. hook and loop strap (see Figure 14).
3. Place the anchor flat on the floor behind the NBC tank. Slide it underneath the piping next to the turbocharger (see Figure 14).

WARNING

Two person lift. Two people are required to safely move the cyclone separator assembly. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

4. Place the cyclone separator unit on the floor with the separator facing up (see Figure 14). Slide it back and to the right as far as possible.

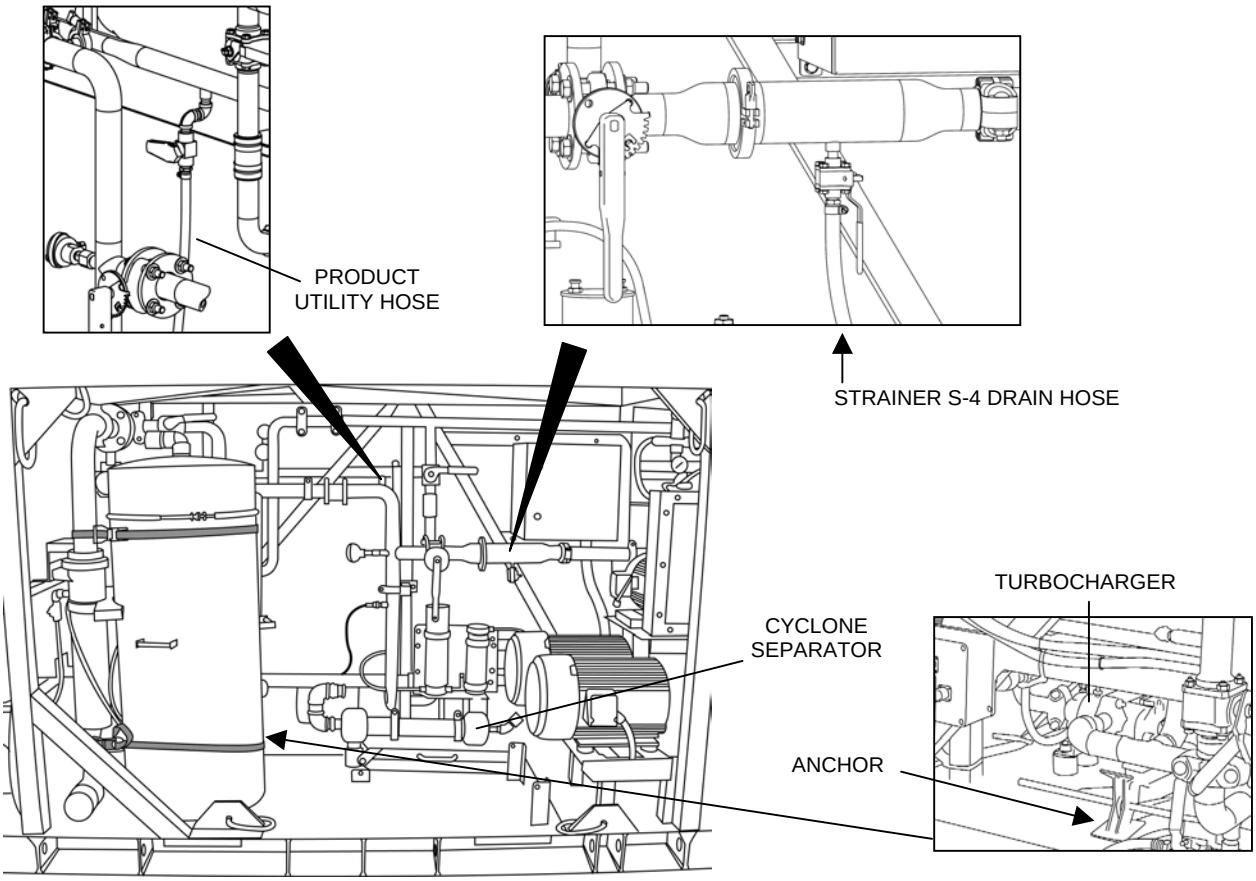

Figure 14. Equipment Area Packout 1.

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CAUTION

When packing the items in the following step, be careful not to damage the tubing, wires, or sensors mounted behind the NBC tank.

5. Curl the eight remaining 10-ft. suction hoses and pack them behind the NBC tank and on top of the cyclone separator (see Figure 15).

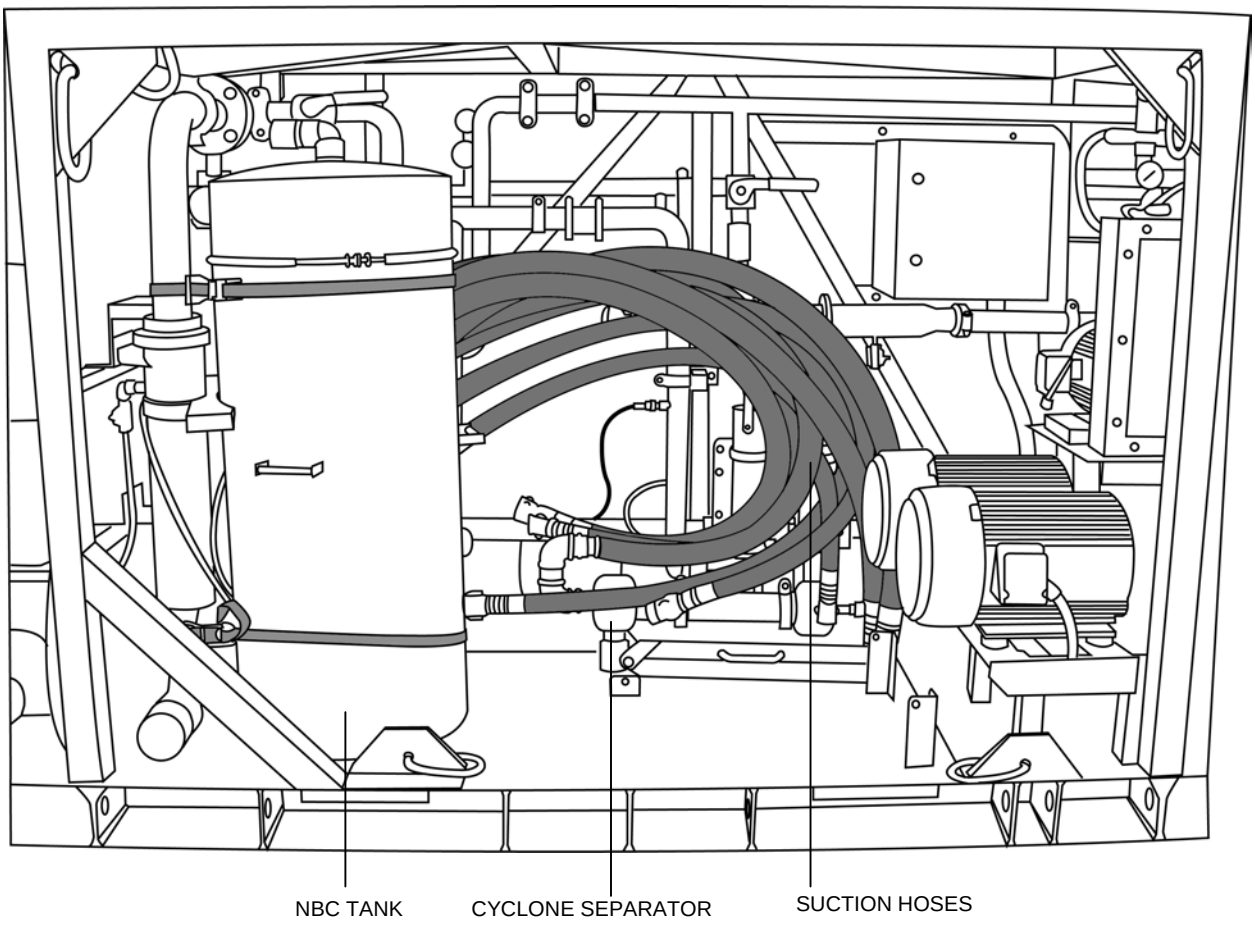

Figure 15. Equipment Area Packout 2.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0029 00**
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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

WARNING

Three person lift. Three people are required to safely move the MF pump skid. Use your legs, not your back. Failure to observe this warning may result in back injury.

6. Move the MF pump skid onto the TWPS skid. Position the pump end inside the mounting brackets and install the retaining rod.
7. Place the three short rolled-up discharge hoses inside the pump skid (see Figure 16).
8. Stack the closed bisulfite and citric acid chemical buckets on top of each other next to the cyclone separator, and place the fuel can in front of them (see Figure 16).
9. Place the operator's tool kit on top of the inside high pressure pump motor (see Figure 16).

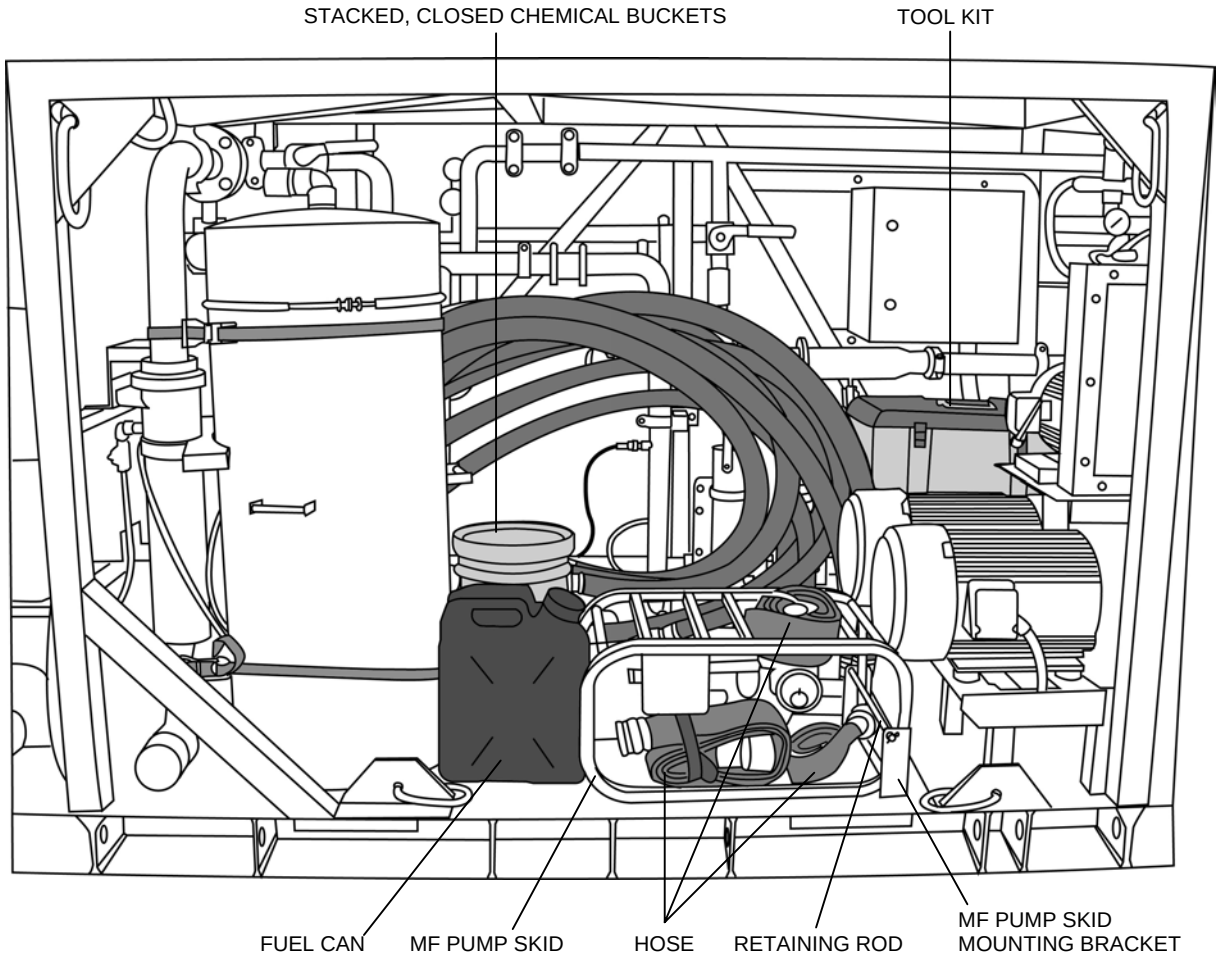

Figure 16. Equipment Area Packout 3.

10. Place the remaining 3000-gallon distribution tank on top of the MF pump skid (see Figure 17).

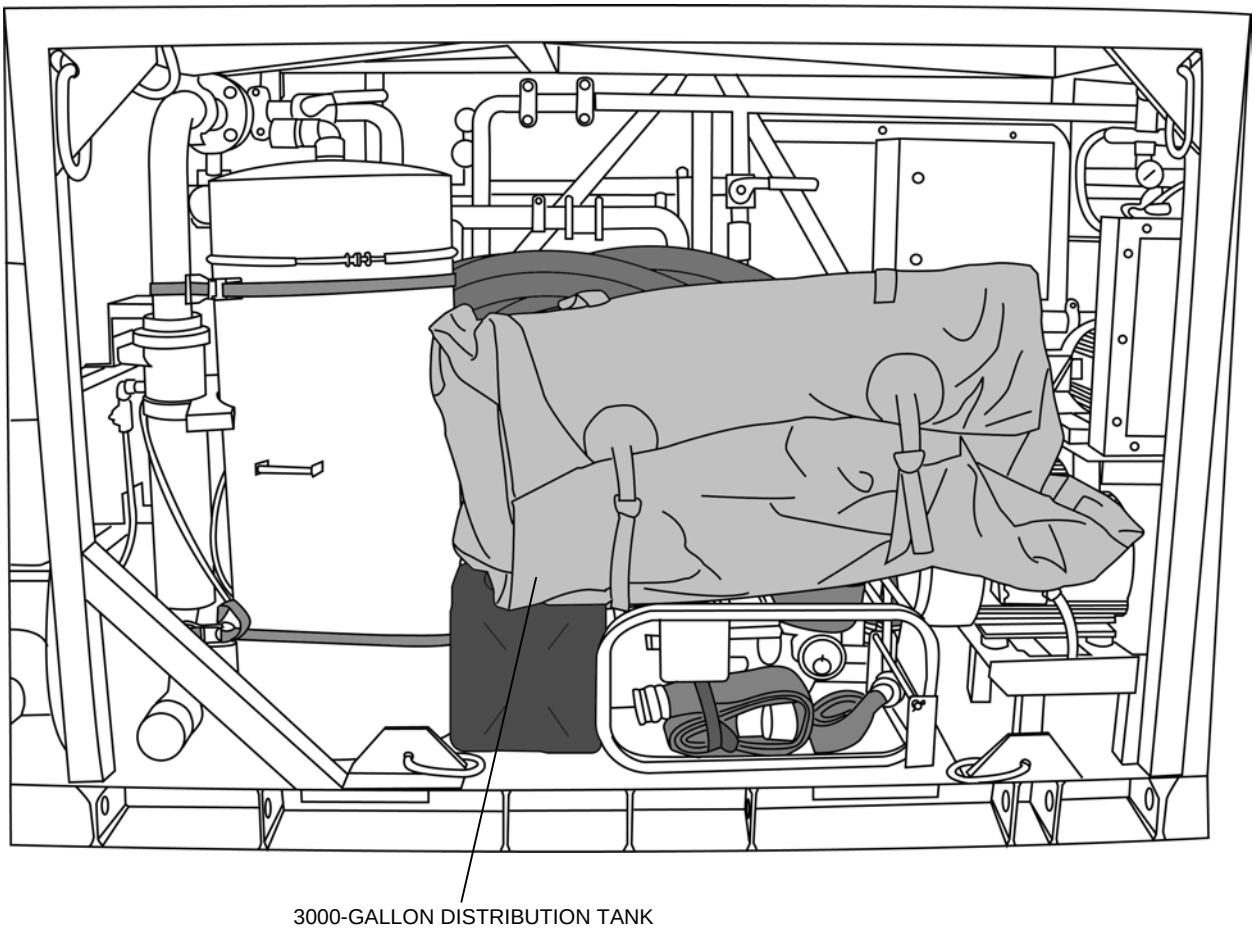

Figure 17. Equipment Area Packout 4.

CAUTION

The ratchet hardware on the ratchet straps that are installed over the distribution tank must not rub against the tank. Wrap the tail end of the straps around the metal ratchets after the strap is installed and tightened. Failure to observe this caution may result in the ratchet rubbing a hole in the tank during movement.

11. Attach a 10-ft. ratchet strap to the MF feed pump skid and route it over the distribution tank (see Figure 18). Secure the other end around the pipe between manual valve V-212 and Strainer S-4.
    a. Tighten the strap so that the tank does not stick out beyond the front of the MF feed pump skid.
    b. Wrap the strap end around the metal ratchet to protect the tank from the ratchet.
12. Pack the following items behind and on top of the distribution tank (see Figure 18):
    - Tripod assembly
    - Two 2 x 5 product water suction hoses (not visible in Figure 18)
    - 3 x 3 MF suction hose (not visible in Figure 18)
    - 5/8-in. x 50-ft. auxiliary hose assembly P06
    - Floating inlet strainer
    - 6 in. x 50 ft., red-banded waste discharge hose
    - 4-in. x 5-ft., red-banded cleaning suction hose
    - Three 3-in. x 10-ft., green-banded raw water suction hoses
13. Attach the long section of two 10-ft. ratchet straps to the skid frame, route them over the packed-out items, and attach the other ends to the MF feed pump frame (see Figure 18).
14. Attach the long section of a 10-ft. ratchet strap to strainer S-2, route it in front of the fuel can and the MF feed pump skid frame, and attach the other end to the pump skid frame (see Figure 18).
15. Wrap the ratchet strap ends around the metal ratchet to protect the tank from the ratchet.

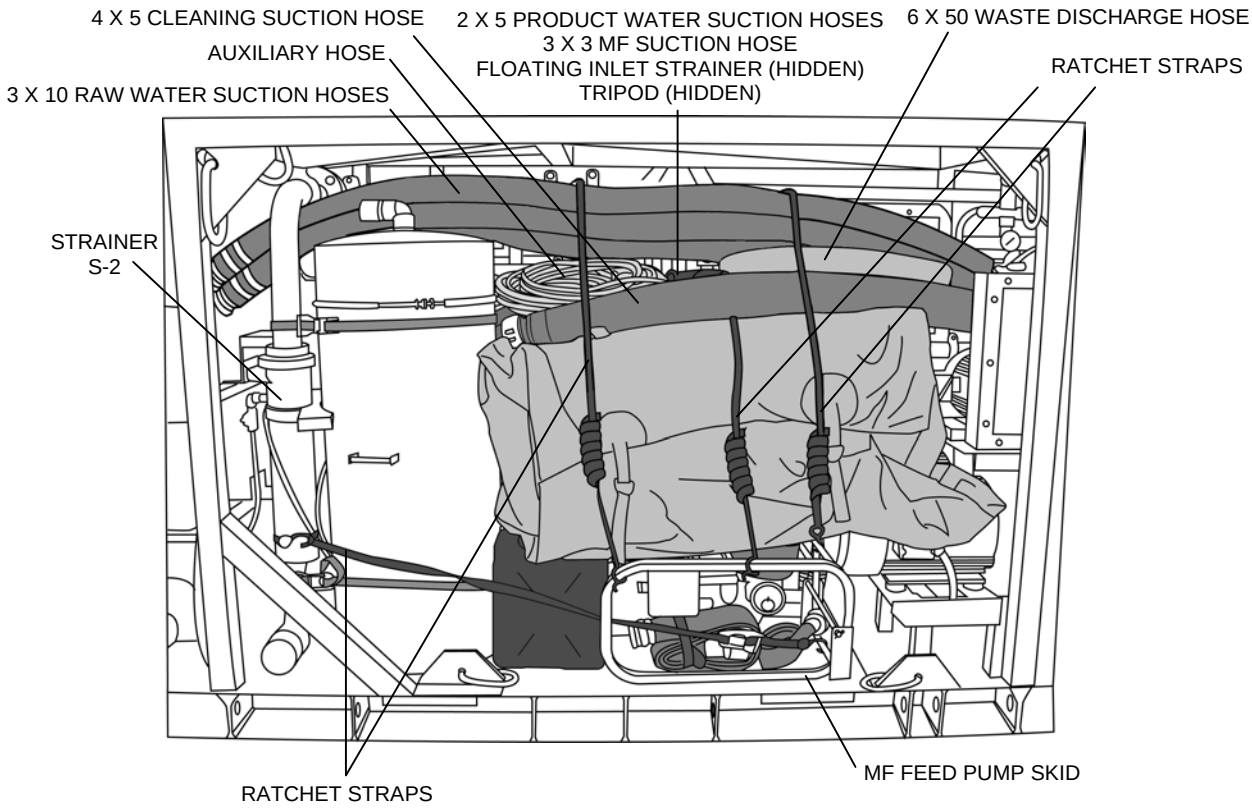

Figure 18. Equipment Area Packout 5.

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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

Right End Packout

1. At the right end of the skid, strap Adaptor A-11 to the vertical pipe next to the air compressor, using an 18-in. hook and loop strap (see Figure 19).

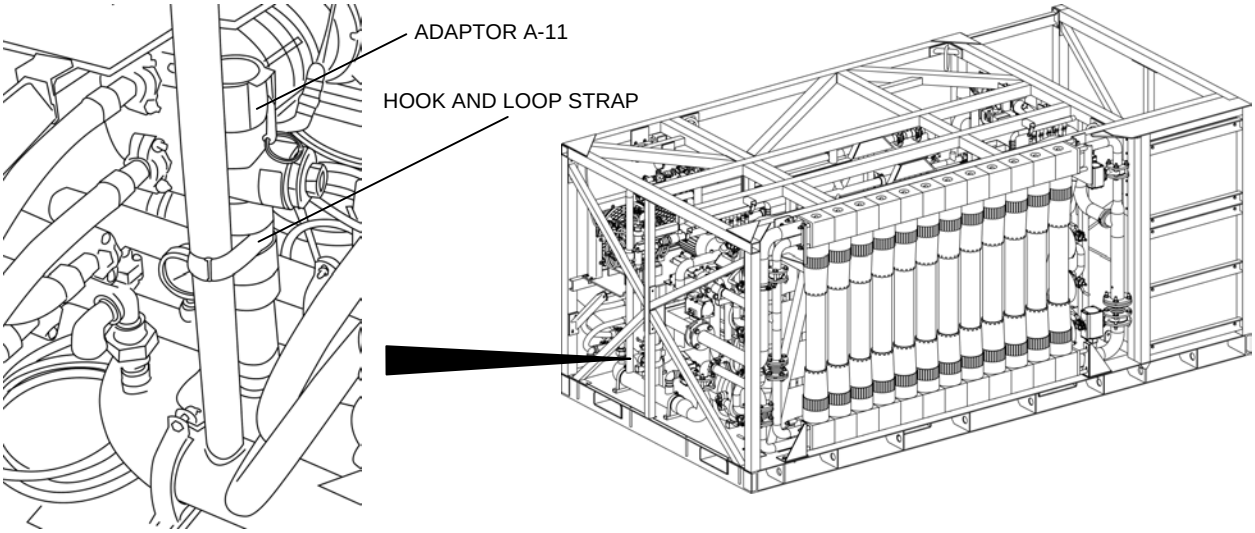

Figure 19. Adaptor A-11 Packout.

2. Gather the ends of the 5 RO element drain hoses and the MF filtrate sample/ drain hose together at the right end of the TWPS and secure them to the TWPS using an 18-in. hook and loop strap (see Figure 20).

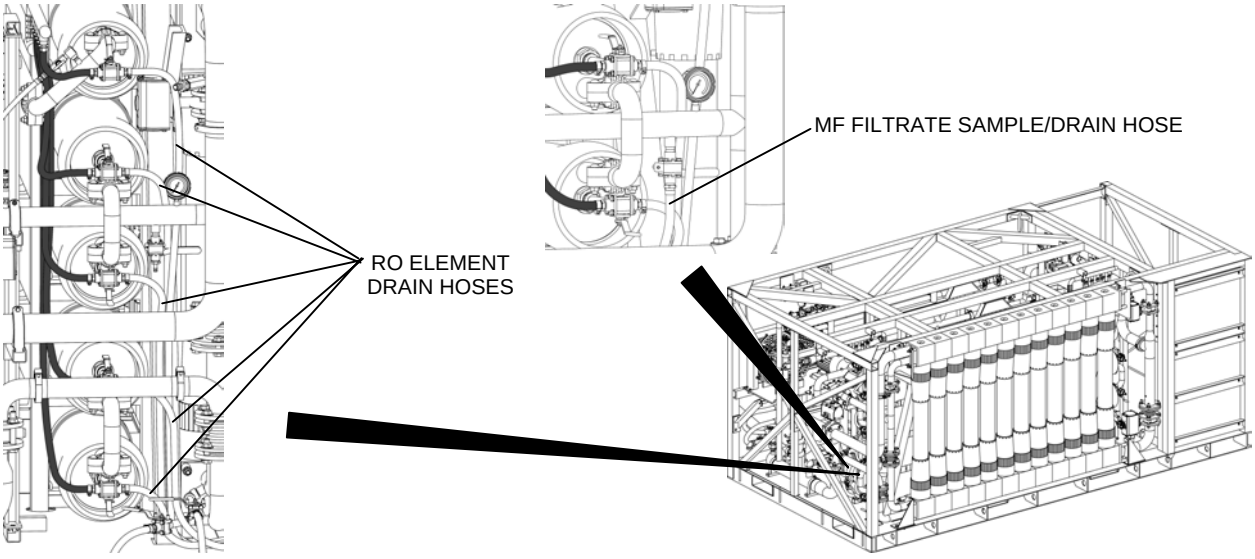

Figure 20. Right End RO Element Drain Hoses and MF Filtrate Sample/Drain Hose.

3. At the right, back corner of the skid, strap the RO element pusher to the vertical pipe at the left of the MF filters, using two 18-in. hook and loop straps (see Figure 21).

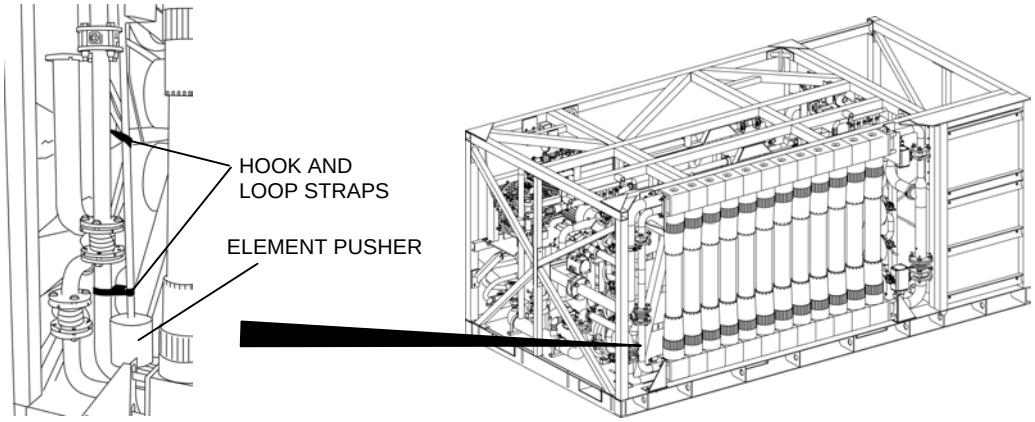

Figure 21. RO Element Pusher Packout.

Transport Reinforcing Chain Installation

Install the two transport reinforcing chain assemblies across the front of the equipment area and tighten the shackles to remove all slack and provide moderate tension (see Figure 22).

NOTE

The two chain assemblies are not the same length. Install the longer assembly between the ring above the NBC tank and the ring below the HP pumps.

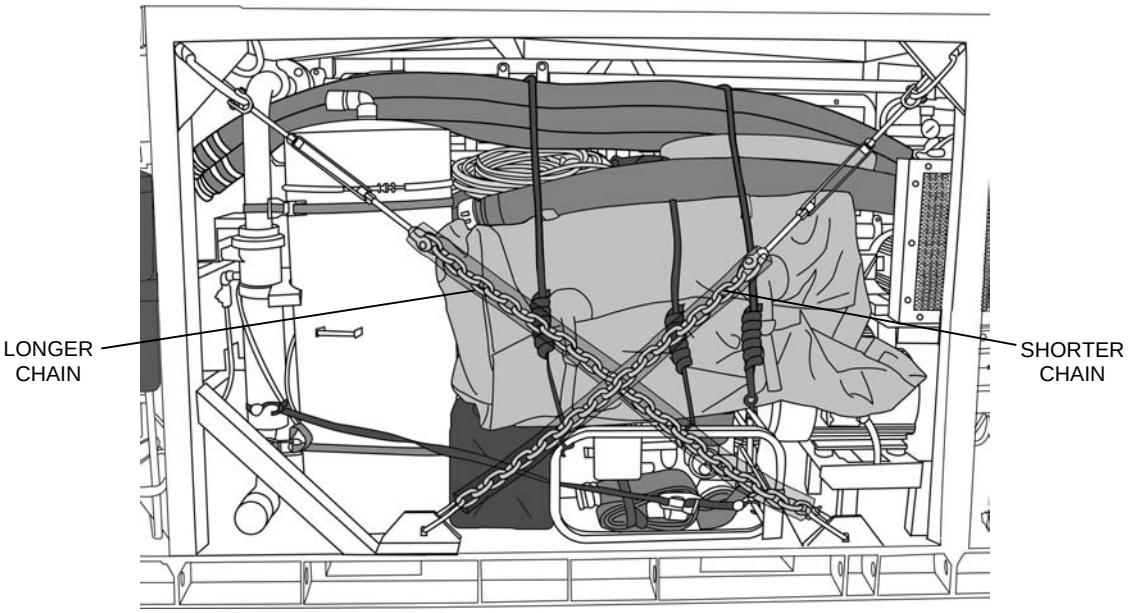

Figure 22. Transport Reinforcing Chain Installation.

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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

General Purpose Cover Installation

If the General Purpose Cover is not installed and if the MC-TWPS is not to be transported by helicopter, install the General Purpose Cover as follows (see Figure 23 and Figure 24):

1. Make sure the roof support sheets are spaced evenly over the top of the TWPS.
2. Unfold the general purpose cover.
3. Loosen the hook and loop strip and unzip the zippers at the four corners of the cover.
4. Orient the cover so that the inlet and discharge flaps are at the front of the TWPS unit.
5. Pull the cover over the top of the TWPS unit.
6. Align the top seams of the cover with the top of the TWPS frame.
7. Secure the inner hook and loop straps (1) at the corners of the cover to the TPWS frame.
8. Zip the zippers at the four corners of the cover, adjusting the position of the cover as necessary for a proper fit at the corners.
9. Secure the hook and loop strip at the four corners of the cover.
10. Loosen the hook and loop strip and unzip the zippers for each panel of the cover, secure the hook and loop straps (1) at each panel to the TWPS frame, then zip the zippers (2) and re-secure the hook and loop strips (3).
11. Secure the outer straps at all four corners of the cover (4).
12. Make sure the straps (5) and snaps (6) at the expandable end of the cover above the operator station roof are secured.
13. Secure the bottom straps at the ends of the cover to the loops on the TWPS I-beam (7).
14. Secure the bottom straps at the front and back of the cover to the TWPS I-beam (8).
15. Check that all zippers, hook and loop strips and flaps, snaps, and straps are secured and tightened all the way around the TWPS.

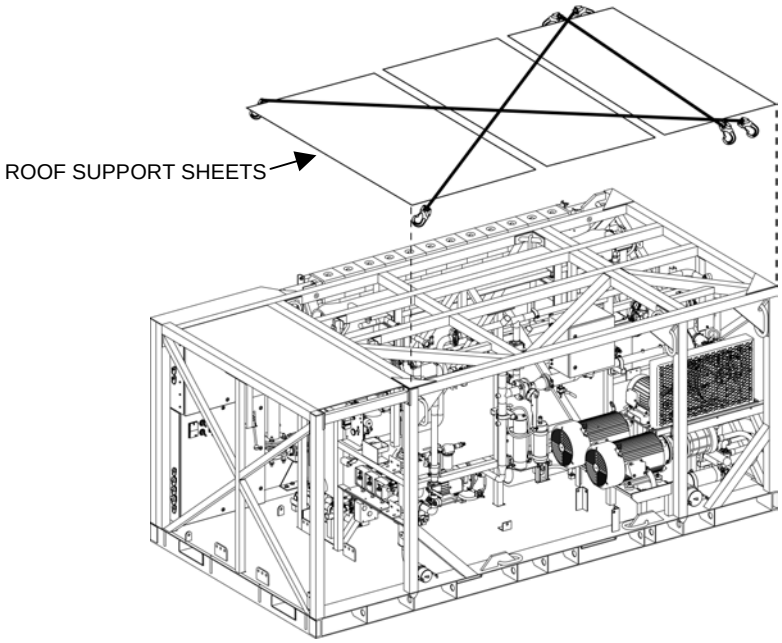

Figure 23. Roof Support Sheet Positioning.

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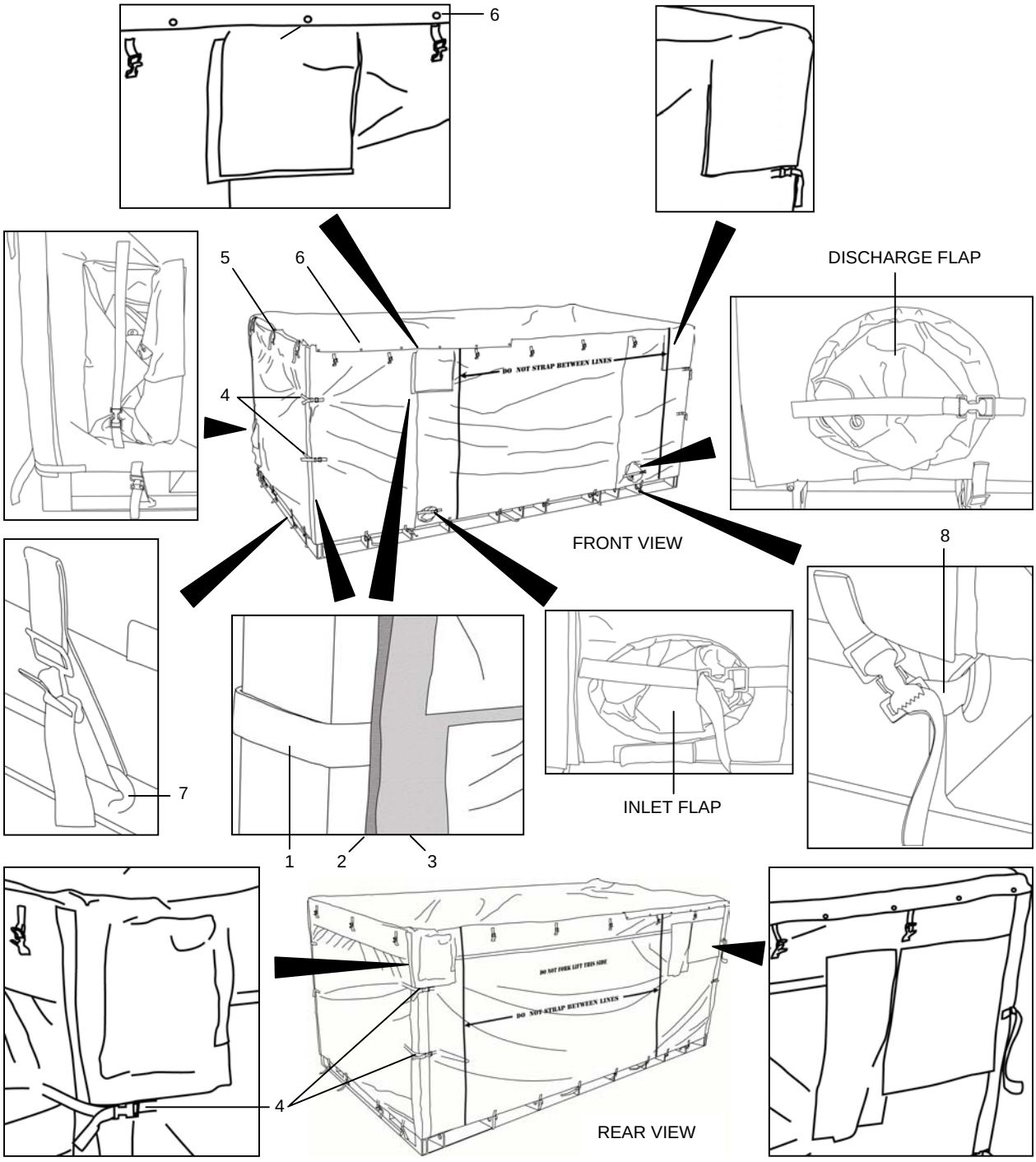

Figure 24. MC-TWPS General Purpose Cover Installation.

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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

Cargo Net Installation

If the TWPS is to be transported by helicopter, the General Purpose Cover is removed from the MC-TWPS and the cargo nets are installed. Install the cargo nets as follows:

1. Packout the General Purpose Cover as follows:
    a. Loosen the hook and loop strips and unzip the zippers at the four corners of the cover.
    b. Remove and fold the cover.
    c. Loosen the straps that secure the distribution tank and hoses in the equipment area.
    d. Remove the roof support sheets straps and the roof support sheets.
    e. Roll the 3 roof support sheets together as tightly as possible without damaging the sheets and secure them in a roll using the roof support sheet straps.
    f. Place the rolled sheets on top of the hoses toward the back of the equipment area.
    g. Fold the General Purpose Cover and place it on top of the tank and hoses in front of the rolled sheets and under the straps. Then tighten the straps (see Figure 25).
2. Remove the two cargo net bags from under the high-pressure pumps (see Figure 25).
    a. Take the two cargo nets out of the bags.
    b. Tie the bag cinch ropes to a strap anywhere in the packed out TWPS and tuck the bags under the strap so they will not blow off during transportation.

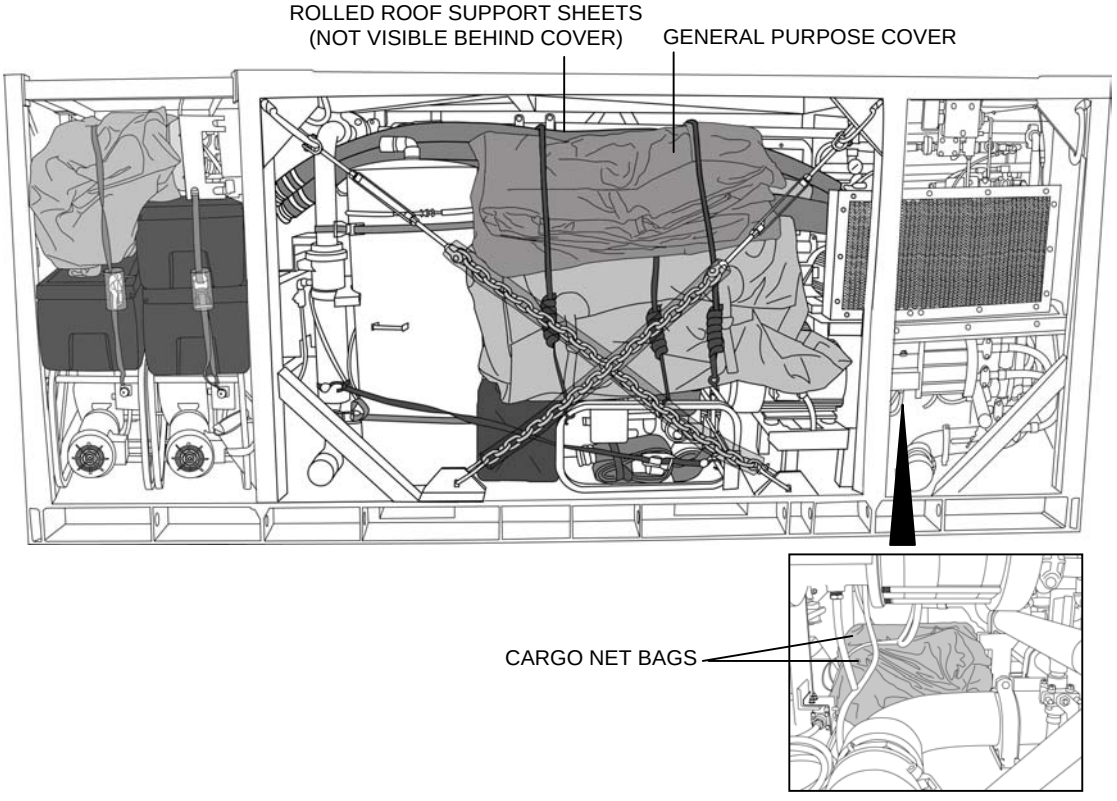

Figure 25. General Purpose Cover Packout and Cargo Net Storage Location.

3. Install the cargo net in front of the equipment area as follows (see Figure 26):
    a. Open the larger of the two cargo nets and secure the buckled straps (1), (2), and (3) to the TWPS frame in order.
    b. Secure the remaining buckled straps (4 through 9) to the TWPS frame in no particular order.
    c. Clip the carabiners (10 through 14) to the TWPS frame.
    d. Tighten the rope lock on the cinch rope and snap the lock handle down to lock it in place.

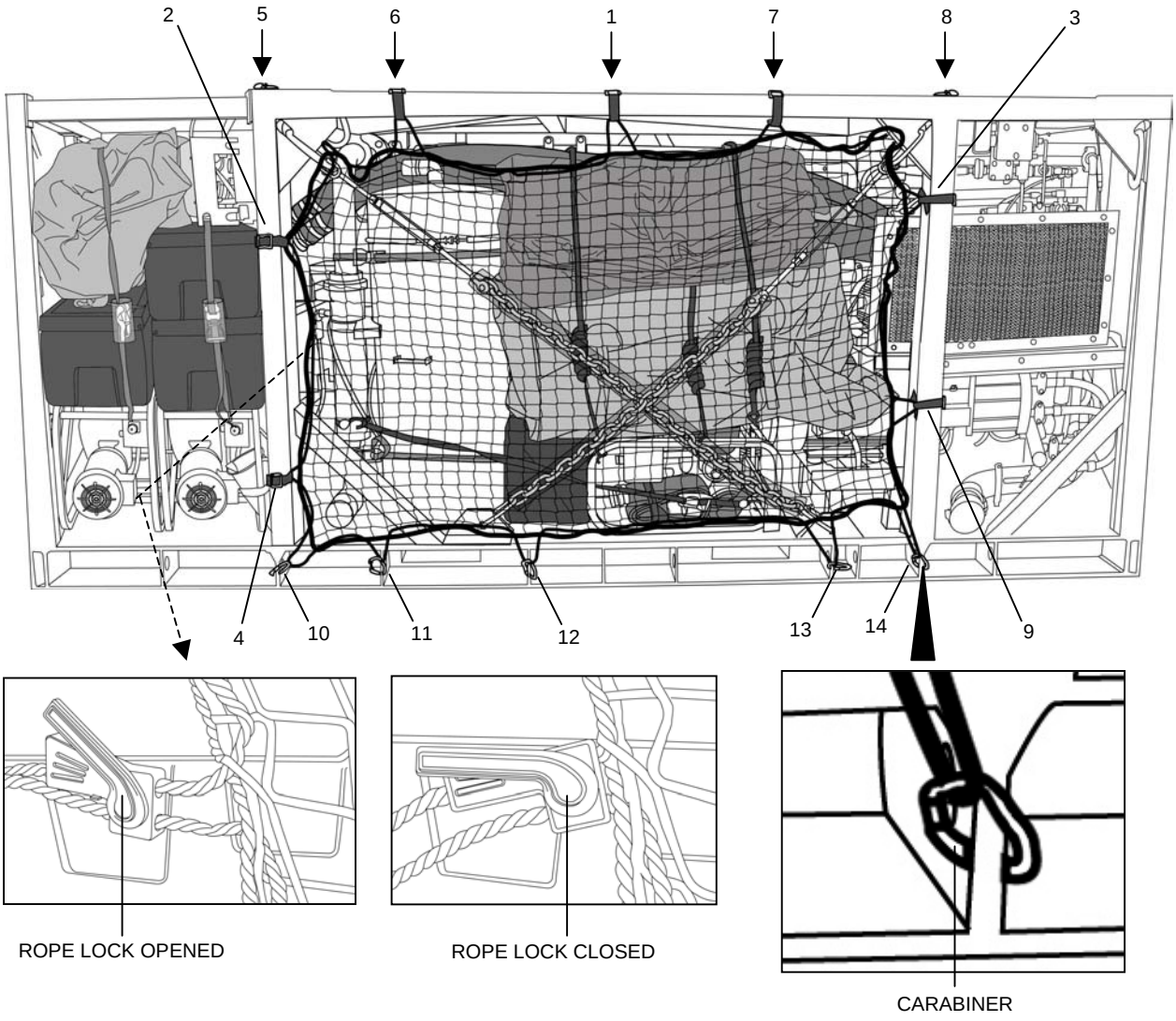

Figure 26. Front Cargo Net Storage Installation.

4. Install the cargo net at the side of the operator station as follows (see Figure 27):
    a. Open the remaining cargo net and secure the buckled straps (1), (2), and (3) to the TWPS frame in order.
    b. Secure the buckled straps (4 through 9) to the TWPS frame in no particular order.
    c. Clip the carabiners (10 through 13) to the loops on the TWPS frame.
    d. Tighten the rope lock on the cinch rope and snap the lock handle down to lock it in place.

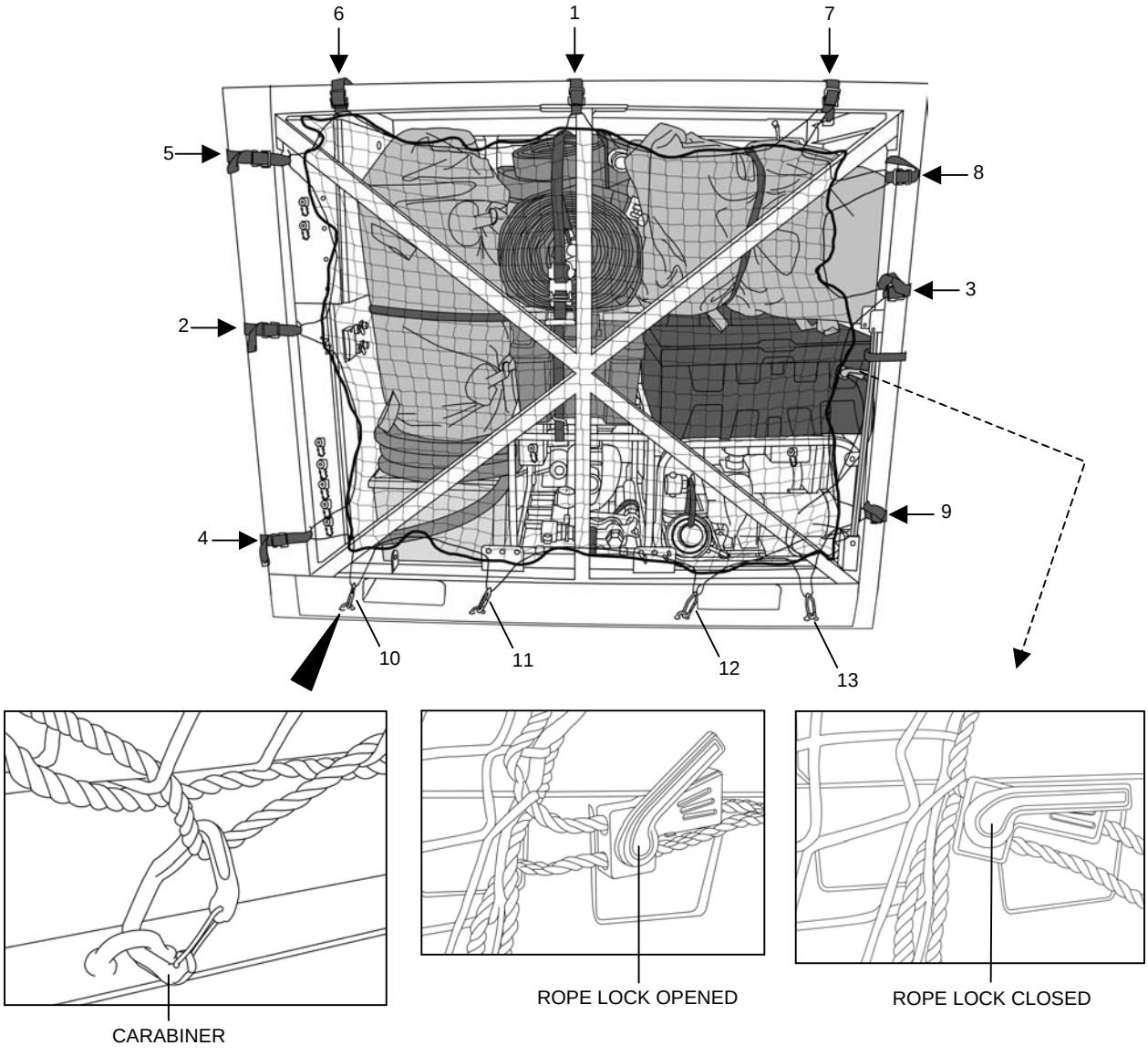

Figure 27. Side Cargo Net Installation.

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PREPARATION FOR MOVEMENT – MARINE CORPS UNIT

Loading and Securing the MC-TWPS to an MTVR

To transport the MC-TWPS on an MK23 or MK25 Medium Tactical Vehicle Replacement (MTVR) truck, the MC-TWPS is loaded onto and secured to the MTVR as follows:

1. Remove the truck side panels and store them under the bed.
2. Place a length of 4x4 lumber against the headboard to space the TWPS from direct contact. This avoids potential damage to the fabric cover.

CAUTION

If the MC-TWPS is set onto the MTVR using a forklift, insert the forks through the forklift pockets from the front of the TWPS. Do not insert the forks through the pockets at the back of the TWPS where the Micro-Filtration (MF) assembly is located. Failure to observe this caution may result in significant damage to the MF assembly.

NOTE

After positioning the TWPS onto the MTVR, check to make sure that the overhang beyond the truck bed does not exceed the authorized limit of 6 inches.

3. Position the TWPS with the operator control station end of the TWPS at the rear or the truck.
4. Push the other end of the TWPS all the way up to against the 4x4 spacer.

NOTE

The MC-TWPS may be secured to the MTVR using standard 5K straps. The straps are looped through the TWPS D-rings and back to the truck bed rings. This doubled strap installation is required to provide proper impact rating.

Alternatively, the MC-TWPS may be secured to the MTVR using 10K straps. The 10K straps are attached directly from ring to ring. They do not need to be looped (doubled).

5. Attach straps from the TWPS tie-down rings to the cargo tie-down rings located along each side of the bed to secure the TWPS to the truck bed and prevent longitudinal movement (see Figure 28).
6. Raise the ISO locks into the locked position to provide additional transverse movement security.

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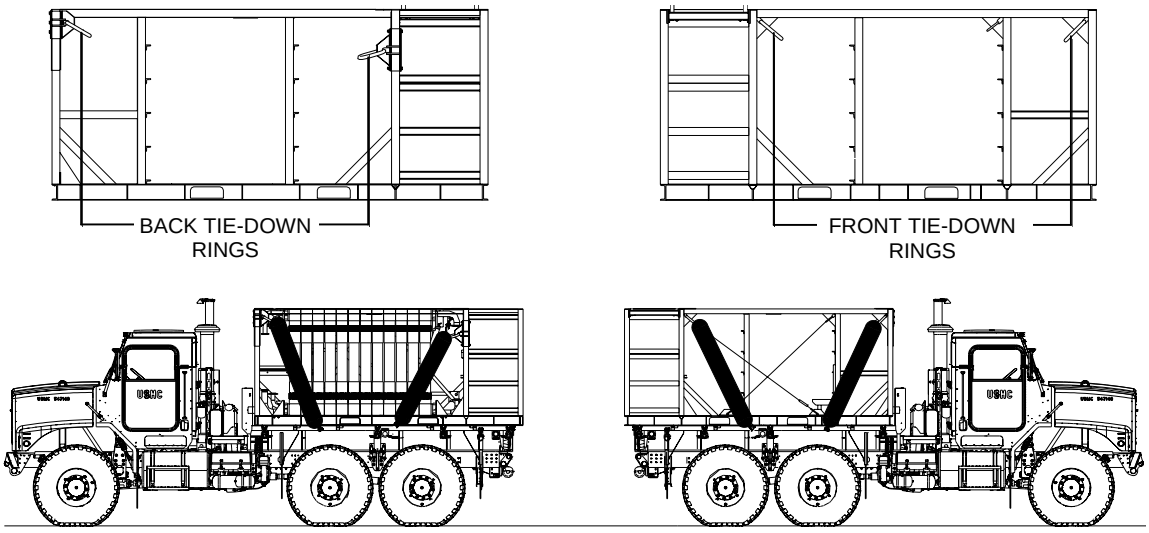

Figure 28. MC-TWPS Strapped to MTVR.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0030 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – MARINE CORPS
EXTENDED CAPABILITY MODULES

INITIAL SETUP:

Reference
TM 10-5430-237-12&P
Personnel Required
Three Operator/Crew
Equipment Condition
TWPS removed from service

GENERAL:

This work package provides instructions for packing out MC-TWPS extended capability module equipment for movement from one deployed location to another, including short storage periods (up to 30 days) between deployments. Packout instructions are provided for the following Marine Corps extended capability modules:

- Cold Weather Module
- Cleaning Waste Storage Module
- NBC Water Treatment System Module
- NBC Survivability Module
- Ocean Intake Structure System (OISS) Module

The extended capability module packout procedures can be performed at the same time that the MC-TWPS unit is packed out in accordance with WP 0029, Preparation for Movement – Marine Corps Unit.

If the TWPS unit will be in storage for more than 30 days, refer to WP 0032, Preparation for Storage – Marine Corps Unit, before performing the packout procedures described in this work package.

UNIT SHUTDOWN AND PRESERVATION

NOTE

These Unit Shutdown and Preservation procedures are also listed in WP 0029, Preparation for Movement – Marine Corps Unit. If you have already performed these shutdown and preservation procedures, proceed to the desired extended capability module packout procedures in this work package.

Before starting equipment/component disassembly and packout, the MC-TWPS must be shut down, flushed and drained, and the power source must be secured and disconnected. Preservation of the Micro-Filtration (MF) and Reverse Osmosis (RO) elements may also be required based on the expected length of the shutdown.

1. Refer to WP 0017 and WP 0018 for shutdown and preservation requirements and procedures.
2. Disconnect the power and ground cables from the Tactical Quiet Generator (TQG) as follows:

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WARNING

High voltage electrical hazard. High voltage is produced when the generator set is in operation. Make sure that the Tactical Quiet Generator has been properly shut down before attempting to disconnect the power or ground cable from the TQG. Failure to observe this warning could result in injury or death from electrical shock.

NOTE
Refer to TM 5-6115-545-12 for generator operation.

a. Disconnect the TWPS power cable leads from the generator lugs labeled L1, L2, and L3.
b. Disconnect the TWPS power cable white lead from the generator Neutral lug and the green lead from the generator Ground lug.
c. Tuck the TWPS power cable end inside the TWPS frame.
d. Disconnect the ground cable from the generator Ground lug.

COLD WEATHER MODULE PACKOUT

Preparation for Cold Weather Module Packout

NOTE
Perform the Preparation for Packout procedures described in WP 0029 for the MC-TWPS unit at the same time you perform these Preparation for Cold Weather Module Packout procedures. This helps to ensure that water is drained from all tanks, pumps, and hoses before the water has a chance to freeze.

Prepare the cold weather module for packout as follows:

1. Sort by length and lay out the following heating blanket hook and loop straps that were stored when the blankets were installed:
   - Two 18-in. hook and loop straps
   - Eight 36-in. hook and loop straps
   - Ten 48-in. hook and loop straps
2. Remove the raw water, MF feed, and product water distribution pump covers.

CAUTION

Connector damage or poor electrical connection. Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before capping a connection. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal. Failure to observe this caution may result in connector damage or a poor electrical connection.

3. Disconnect and cap all hose and adaptor heating blankets and pump heating collar power cables.

4. Remove the hose heating blankets and pump heating collars.
5. Tightly roll up the heating blankets as follows:
    a. Lay out the blanket with the air vents facing up. Open the air vents (see Figure 1).
    b. Starting at the end opposite the power cable, double the blanket over as shown and roll it up as tightly as possible.
    c. At the power cable end, make sure the cable is rolled up inside the blanket.

NOTE

Be sure the blankets are rolled up as tightly as possible so they will all fit in their designated packout locations.

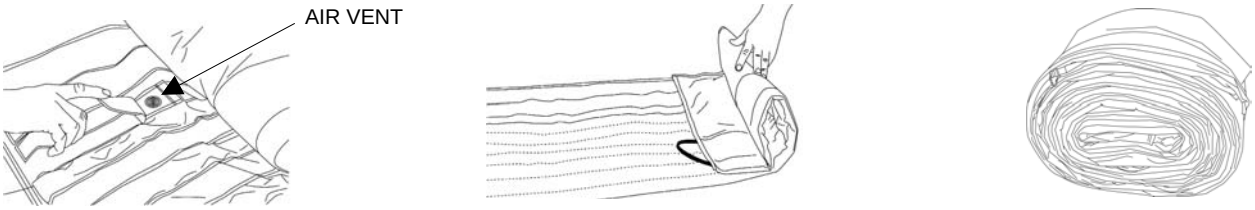

Figure 1. Rolling Up the Hose Heating Blankets.

    d. Secure each rolled-up blanket with a hook and loop strap as indicated in the table below:

Table 1. Straps to Secure Heating Blankets.

Heating Blanket Stencil	Hook and Loop Strap(s) to Use
A02	18-in.
F01-1	48-in.
F01-2	48-in.
F03-1	48-in + 36-in.
F03-2	48-in + 36-in.
F07	48-in + 18-in.

Heating Blanket Stencil	Hook and Loop Strap(s) to Use
F12	48-in.
P02	36-in + 36-in.
P03-1	36-in.
P04	36-in.
P05	48-in.

6. Turn off the diesel-fired heater and allow it to cool.
7. Disassemble the heating ducts, plenums, and registers and set them aside.
8. After the diesel-fired heater has cooled, drain and ventilate the fuel tank as follows (see Figure 2):
    a. Remove the drain plug from the bottom of the fuel tank and drain the fuel into a fuel can.
    b. Remove the fuel cap from the fuel tank.
    c. Connect the quick-disconnect air hose (BII Box #8) to the quick-disconnect fitting in Air System Section 1.
    d. Connect the air blowgun (air nozzle, Operator's Tool Kit) to the other end of the air hose.
    e. Blow air into the diesel-fired heater fuel filler port to ventilate the fuel tank.
    f. Clean the drain plug threads, apply antiseizing tape to the threads and reinstall the drain plug into the bottom of the fuel tank.
    g. Reinstall the fuel cap.

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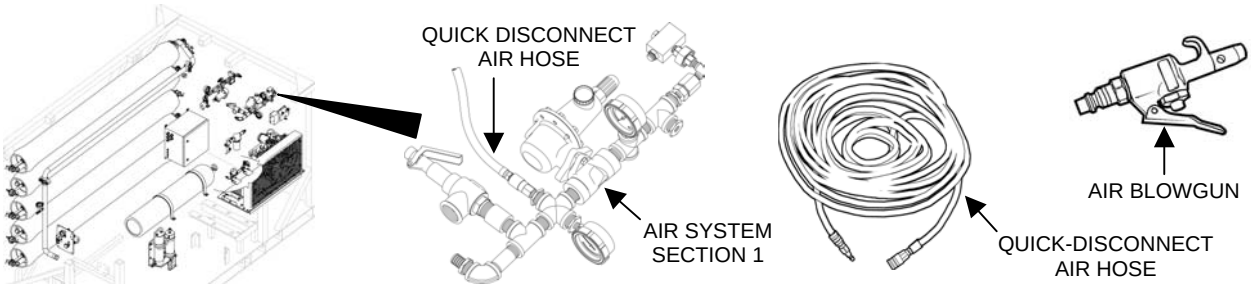

Figure 2. Quick-Disconnect Air Hose Connections.

Cold Weather Module Box Packout

Obtain and packout the following cold weather components in order (see Figure 3):

1. Metal Cold Weather Module Box dimensions 42.5-in. x 58.5-in. x 84.5-in.
2. Pump insulating platform
3. Pump insulating platform
4. Pump insulating platform
5. Pump insulating platform
6. Diesel-fired heater
7. Return air connector
8. F07 hose heating blanket (3-in. x 21-ft.)
9. Ice auger blade
10. Ice auger handle
11. Ice intake strainer
12. Diesel engine exhaust hose
13. P-2 pump insulating cover
14. P-3 pump insulating cover
15. Pump heating collar (pack inside main plenum)
16. Pump heating collar (pack inside main plenum)
17. Pump heating collar (pack inside main plenum)
18. Heat gun (pack inside main plenum)
19. Main plenum
20. P-1 pump power cable
21. A-02 adaptor heating blanket
22. A-02 insulating collar
23. P03-1 hose heating blanket (2-in. x 6-ft.)
24. P04 hose heating blanket (2-in. x 7.1-ft.)
25. Right hot air plenum
26. General purpose transformer (face down in a metal frame)
27. Winter cover main section (fold neatly in thirds and as flat as possible with the front panel on the outside)
28. Winter cover top panel (fold flat as possible)
29. Winter cover back panel (fold flat as possible)
30. P-1 pump insulating cover
31. P-7 pump insulating cover
32. F03-2 hose heating blanket (2-in. x 50.5-ft.)
33. F03-2 hose heating blanket (2-in. x 50.5-ft.)
34. F03-1 hose heating blanket (2-in. x 50.5-ft.)
35. F01-1 hose heating blanket (3-in. x 5-ft.)
36. F01-2 hose heating blanket (3-in. x 11-ft.)
37. F03-2 hose heating blanket (2-in. x 50.5-ft.)
38. P05 hose heating blanket (2-in. x 66.5-ft.)
39. P05 hose heating blanket (2-in. x 66.5-ft.)
40. P02 hose heating blanket (1.5-in. x 41.5-ft.)
41. Diesel heater inlet or outlet duct – compressed (12-in. x 20-ft. expanded)
42. Diesel heater inlet or outlet duct – compressed (12-in. x 20-ft. expanded)
43. 100-ft. extension cord
44. F-12 hose heating blanket (2-in. x 9-ft.)
45. 8-in. x 6-ft. heating duct
46. 4-in. x 5-ft. 8-in. duct (pack inside second 8-in. x 6-ft. heating duct)
47. 8-in. x 6-ft. heating duct
48. Close and latch the front box cover
49. Close and latch the top box cover

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0030 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – MARINE CORPS
EXTENDED CAPABILITY MODULES

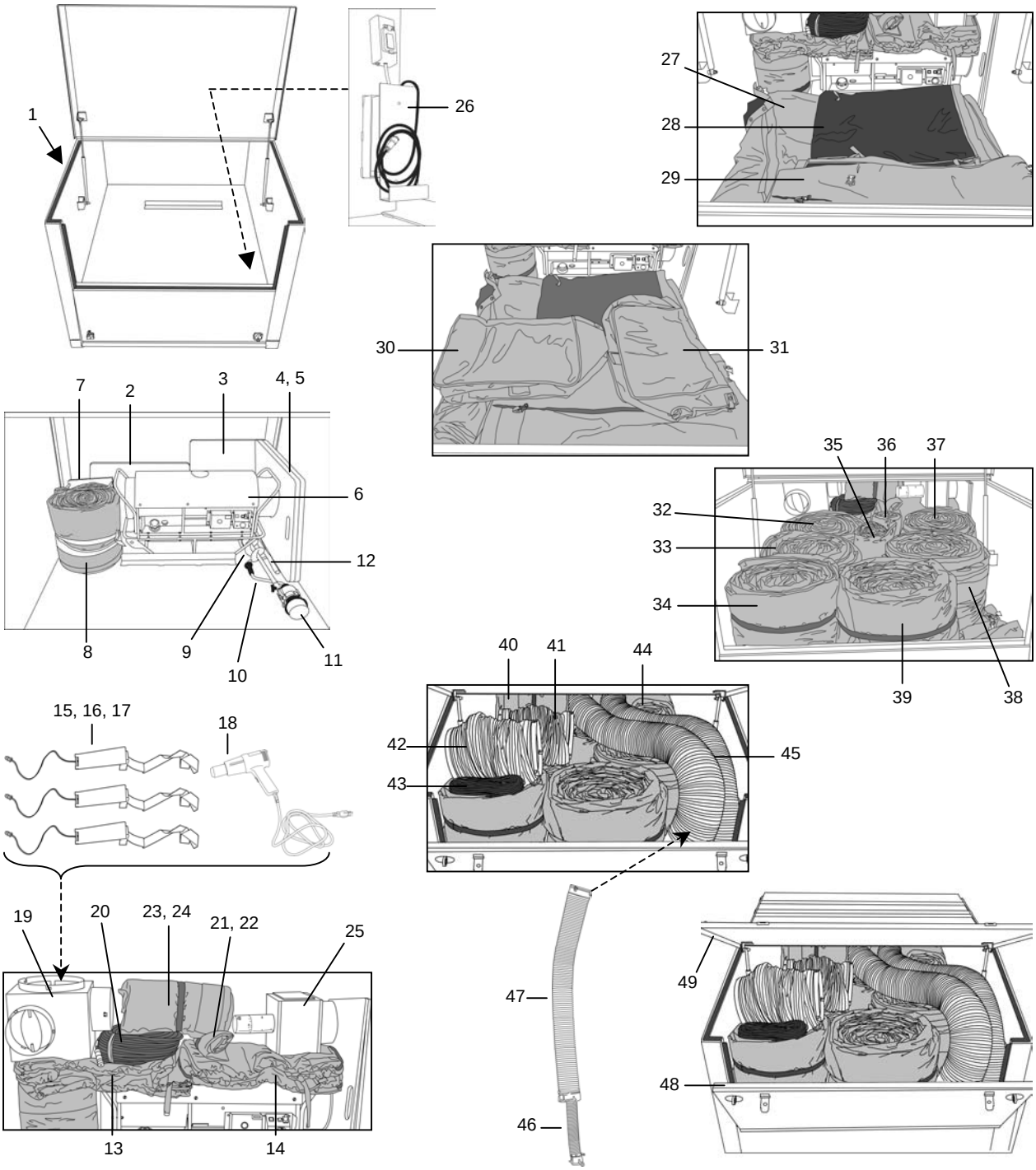

Figure 3. Cold Weather Module Box Packout.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0030 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – MARINE CORPS
EXTENDED CAPABILITY MODULES

CLEANING WASTE STORAGE MODULE PACKOUT

Obtain and open the Cleaning Waste Storage Module Box (1), dimensions 36-in. x 24-in. x 20-in., and packout as follows (see Figure 4):

1. Layout two 36-in. hook and loop straps.
2. Neutralize and dispose of the waste in the cleaning waste storage tank (see WP 0020).
3. Remove the A-16 adaptors from the tank and waste hoses.
4. Pack up the tank using the procedures in TM 1-5430-23-12&P.
5. Wrap two 36-in. hook and loop straps around the tank to help keep the tank rolled up.
6. Pack the 1500-gallon cleaning waste storage tank (2).
7. Pack the three A-16 Adaptors (3).
8. Close and latch the box cover (4).

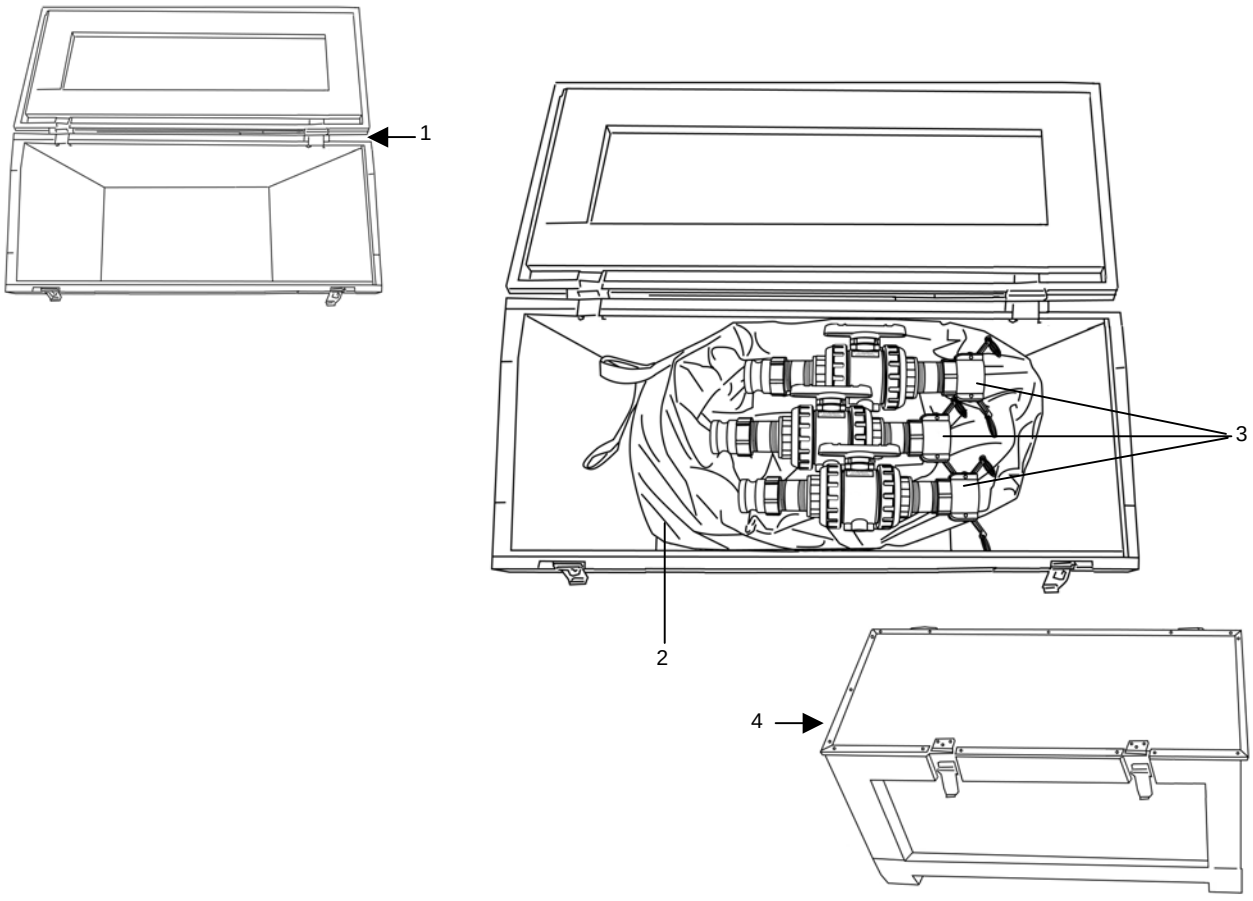

Figure 4. Cleaning Waste Storage Module Box Packout.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0030 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – MARINE CORPS
EXTENDED CAPABILITY MODULES

NBC WATER TREATMENT SYSTEM MODULE PACKOUT

The NBC Water Treatment System Module consists of filter media that is received in one wooden box and that remains stored in the shipping box until it is used. The wooden shipping box contains four bags of activated carbon and six bags of ion exchange resin. Each bag is packed inside a cardboard box (see Figure 5). The filter media boxes are packed in an ISO container with the TWPS unit and the other extended capability module boxes as required for a mission. Refer to WP 0084, Shipping and Storage Instructions.

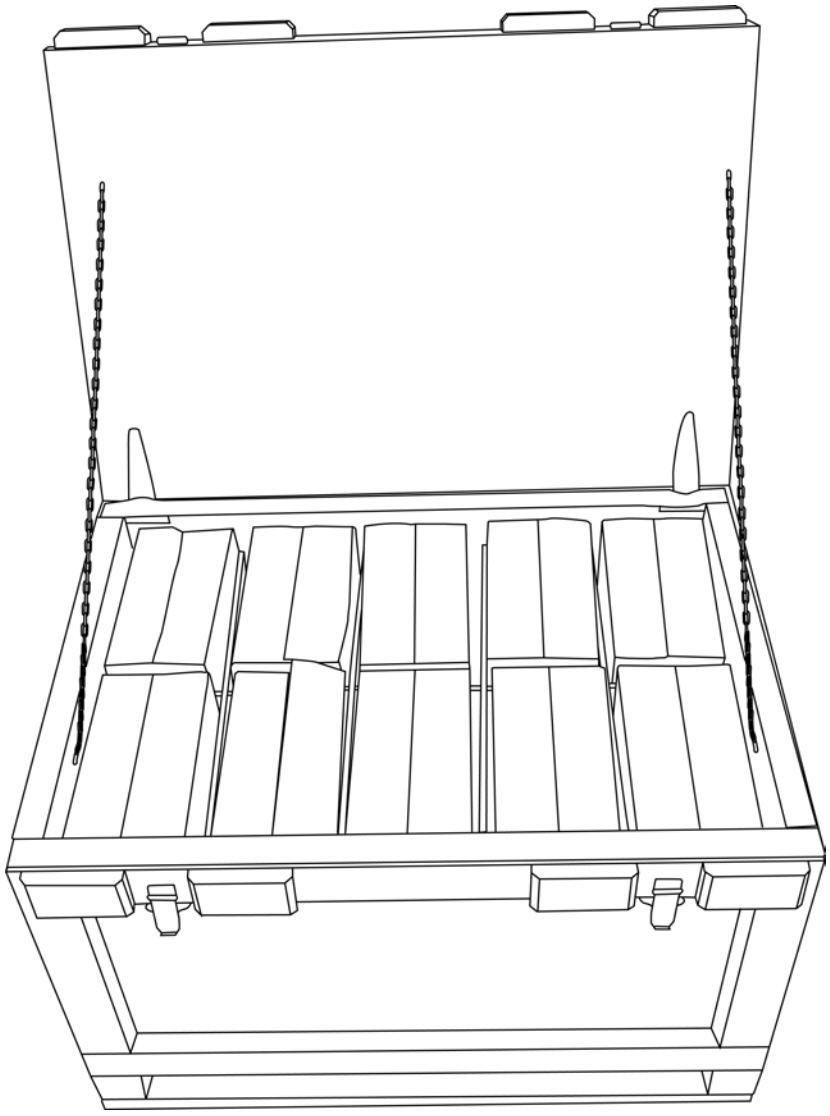

Figure 5. NBC Media and Shipping Box.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0030 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – MARINE CORPS
EXTENDED CAPABILITY MODULES

NBC SURVIVABILITY MODULE PACKOUT

The NBC Survivability Module consists of one CAC cover and 3 CAC cover tie-down ropes. Packout the cover and tie-down ropes as follows (see Figure 6):

1. Lay the CAC out flat, coil the three ropes and place them on top of the CAC (1).
2. From both ends, fold the long sides of the CAC into the middle (2).
3. Fold the long sides into the middle a second time (3).
4. Fold the longs sides on top of each other (4).
5. Roll the CAC up (5) and put it in its storage bag (6).
6. Pack the cover in the bag on the high pressure pumps between the 3000-gallon distribution tank and the air compressor assembly.
7. Connect one end of 10-ft. ratchet strap to a lifting loop on the high pressure pump, bring the strap over the top of the CAC bag, and secure the other end to the skid of the MF feed pump.
8. Tighten the strap.

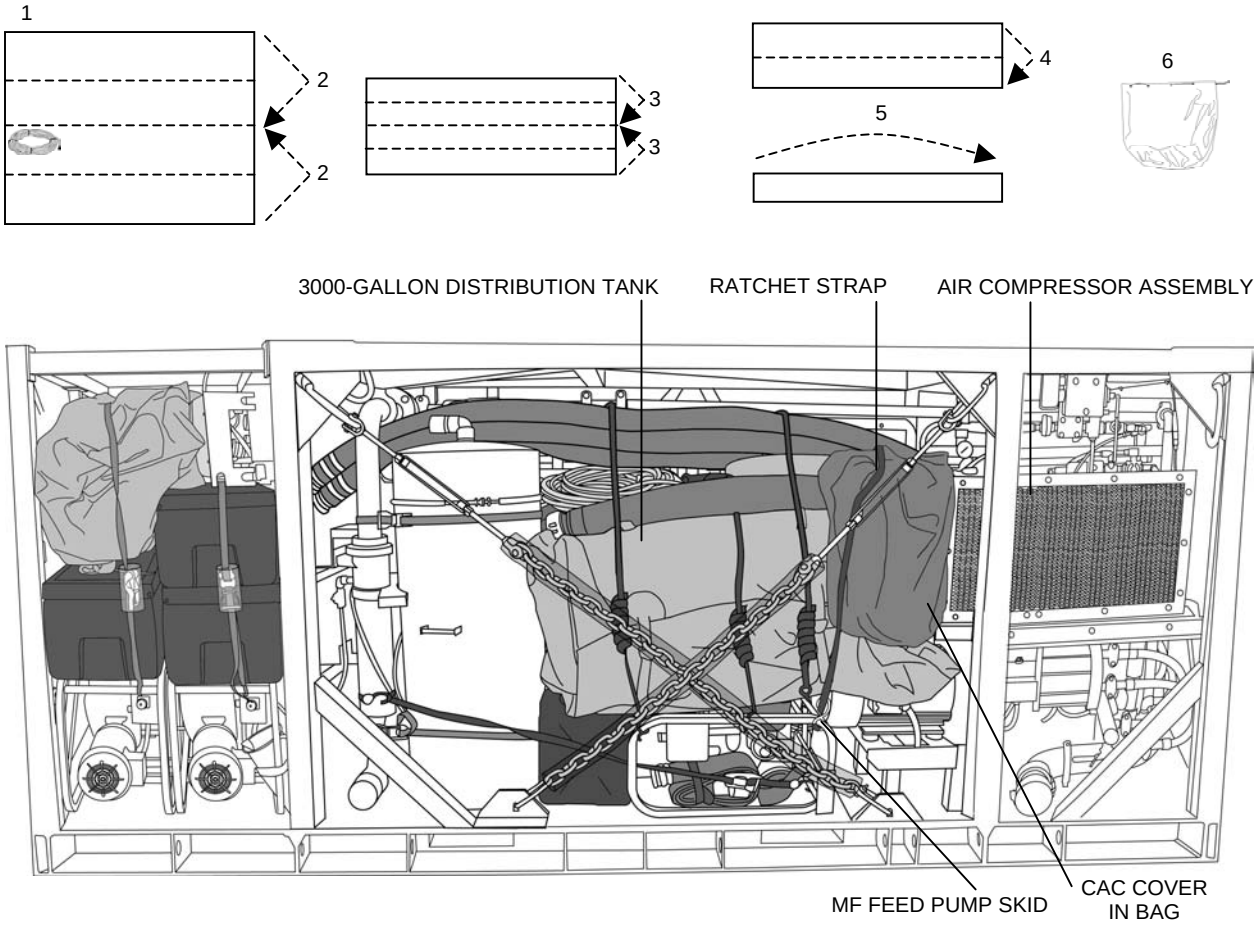

Figure 6. CAC Cover Packout.

**TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS
PREPARATION FOR MOVEMENT – MARINE CORPS EXTENDED CAPABILITY MODULES** **0030 00**

OCEAN INTAKE STRUCTURE SYSTEM (OISS) MODULE PACKOUT

Packout the OISS module as follows:

NOTE

In order to retrieve the OISS, it may be necessary to jet the wellpoints while removing them from the sand. Refer to WP 0008, Ocean Intake Structure System (OISS) Set-Up, for the procedures for jetting the wellpoints. However, instead of jetting the wellpoints into the sand, the wellpoints are pulled out of the sand while jetting water through them.

1. Retrieve the OISS.
2. Disassemble the OISS.
3. Rinse the OISS components with fresh water.
4. Separate all metal pipe sections, but leave the elbows and small tees on the 60-in. riser pipes.
5. Set the OISS components aside to dry. Continue OISS packout when the components are dry.
6. Pack the riser pipes and wellpoints in bags as follows (see Figure 7):
    a. Pack the four 24-in. riser pipes into the small storage bag.
    b. Pack four 60-in. risers with one tee and one elbow into both of two long storage bags that have tie-down loops on one side of the bag.
    c. Pack the four wellpoints in the long storage bag that does not have tie-down loops. Alternate the direction of the wellpoints when packing.

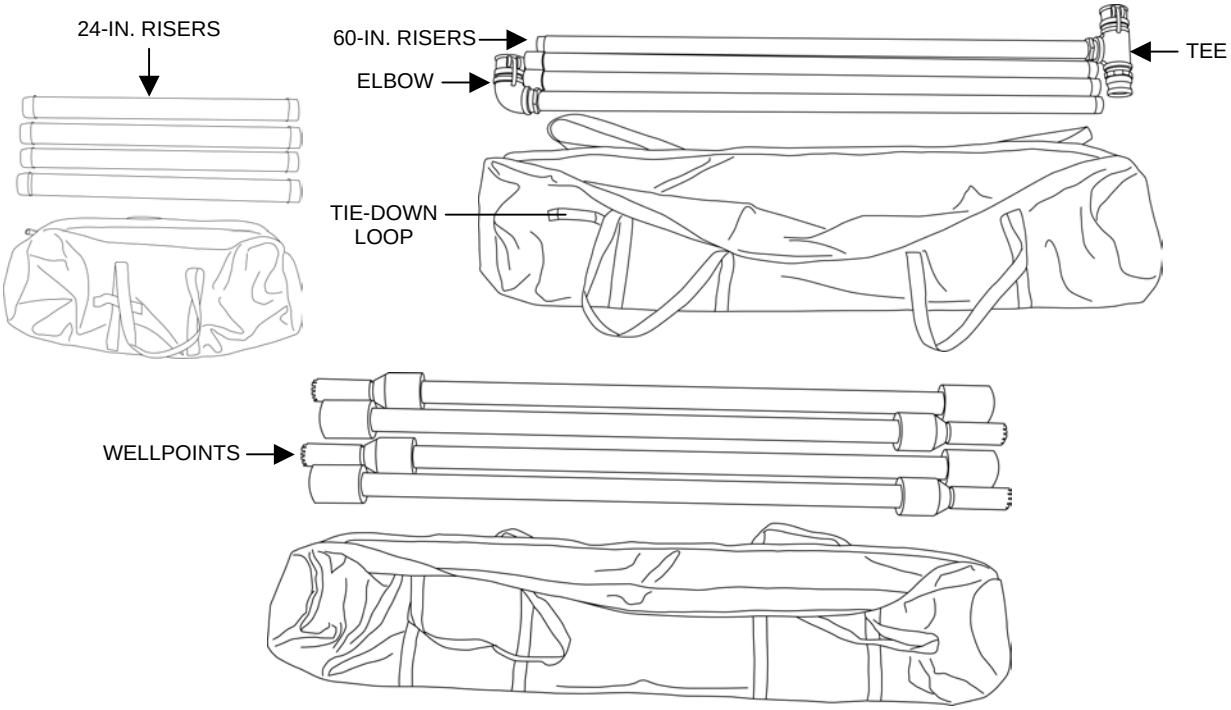

Figure 7. OISS Riser and Wellpoint Packout into Bags.

7. Pack the three bags with the riser pipes onto the MC-TWPS as follows (see Figure 8):
    a. Insert the two long bags with the 60-in riser pipes on top of the tanks and hoses in the Operator Station with the bag tie-down loops facing toward the inside of the TWPS. Move the bags as close to the outer TWPS frame as possible.
    b. Set the short bag with the 24-in. risers on top of the two long bags with the bag tie-down loop facing towards the inside of the TWPS. Move the bag toward the entrance to the Operator Station and as close to the outer TWPS frame as possible.
    c. Feed a 6-ft. ratchet strap through the tie-down loop near the end of the two long bags and through the tie-down loop on the short bag.
    d. Secure the three bags to the diagonal TWPS frame member near the front of the Operator Station (1).
    e. Using a second 6-ft. ratchet strap, secure the three bags together at the other end of the short bag (2).
    f. Using a third 6-ft. ratchet strap, feed the strap through the tie-down loops near the middle of the two long bags and secure the bags to the vertical TWPS frame member near the middle of the Operator Station (3).
    g. Tighten all three ratchet straps.
    h. Attempt to shift the three bags by hand by pushing and jiggling the bags.
    i. Tighten the three ratchet straps again.
    j. Repeat the previous two steps until there is no play in the pipes inside the bags.

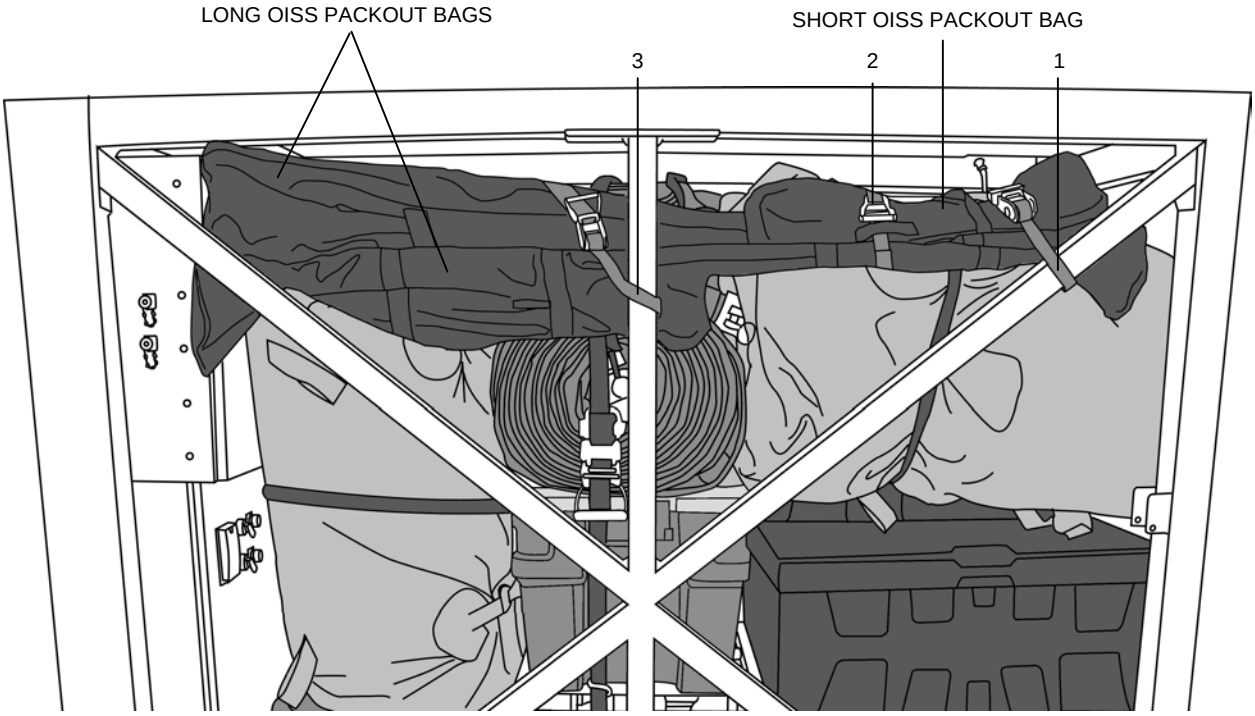

Figure 8. Bags with OISS Risers Packed onto MC-TWPS.

8. Pack the bag with the four wellpoints onto the TWPS as follows (see Figure 9):
   a. Position the bag above the NBC tank near the front of the TWPS.

CAUTION

Do not overtighten the straps when securing the wellpoint storage bag to the TWPS frame. Failure to observe this CAUTION may crack or break the wellpoints.

   b. Using two 6-ft. ratchet straps, secure the bag to the diagonal TWPS frame members at the top of the unit (1). Do NOT overtighten the straps.

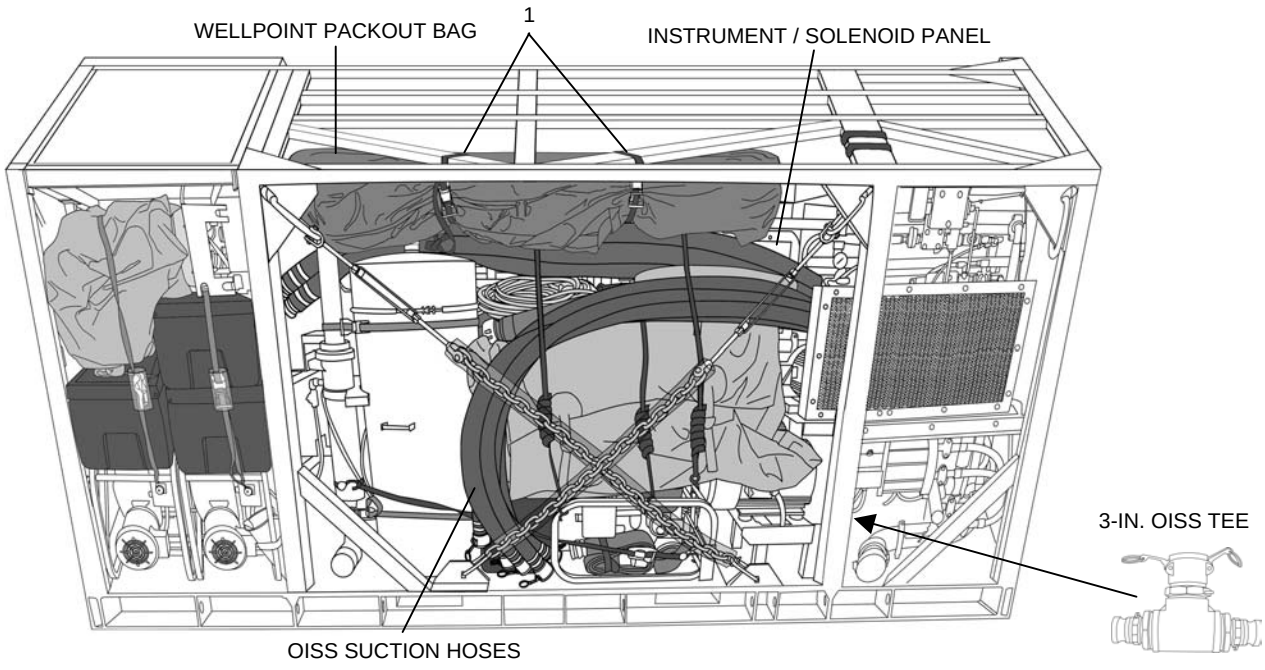

Figure 9. Bag with OISS Wellpoints Packed onto MC-TWPS.

9. Insert the six 2 x 10 yellow-banded OISS suction hoses in the equipment area around the previously packed equipment (see Figure 9). Using a 6-ft. ratchet strap, strap the upper ends of the hoses to the TWPS frame near the instrument / solenoid panel.
10. Strap the 3-in., OISS tee to a High Pressure Pump support frame as follows (see Figure 9):
    a. Feed one 36-in hook and loop strap through the straight part of the tee and secure the strap around the pump support frame.
    b. Wrap a second 36-in. hook and loop strap around the female end of the tee and the pump support frame.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS PREPARATION FOR STORAGE – ARMY UNIT

0031 00

INITIAL SETUP:

Materials:
Marker Tags (WP 0079, Table 1, item 42)
Corrosion Preventive Compound (BII) (WP 0079, Table 1, item 17)
Lubricating Oil, Compressor (WP 0079, Table 1, item 30)
Petroleum Jelly (WP 0079, Table 1, item 32)
Personnel Required
Three Operator/Crew
Equipment Condition
TWPS removed from service
At least 1500 gallons of useable product water must be available in the distribution tanks

GENERAL:

This work package contains the operator procedures required to prepare the TWPS for storage. The procedures covered in this work package include:

- Long term shutdown
- Component cleaning, flushing, and drying
- Diesel engine preservation
- Winter heater preservation
- General clean up and preservation
- Distribution system cleaning, flushing, and drying
- RO and MF Elements
- Air system preservation
- Corrosion prevention
- Shipping and Storage Instructions

LONG TERM SHUTDOWN

A long-term shutdown is performed when shutting down the TWPS in preparation for storage.

Long term shutdown is accomplished by completing the following procedures in the order listed:

- MF Cleaning with RO Acid Cleaning. Refer to WP 0024.
- RO Preservation (preserved with a bisulfite solution). Refer to WP 0025.

COMPONENT CLEANING, FLUSHING, AND DRYING

NOTE

At least 1500 gallons of useable product water must be available in the distribution tanks.

Raw Water System

1. Remove the floating inlet strainer from the raw water hoses.
2. Remove debris from the floating inlet strainer and flush with product water. Set aside to dry.
3. Rinse the anchor rope with product water. Set aside to dry.
4. If used, flush the inside and outside of the OISS risers and intake screens with product water. Flush the inside of the suction hoses and fittings with product water. Set aside to dry.

5. Fill the MF feed tank with product water.
6. Remove the raw water discharge hose from the tripod and the MF feed tank and direct the hose toward the raw water source.
7. Place the open end of the raw water suction source hose into the MF feed tank as far as it will go. Place the middle of the hose on top of the tripod and secure the hose to the tripod with a hook and loop strap (see Figure 1)

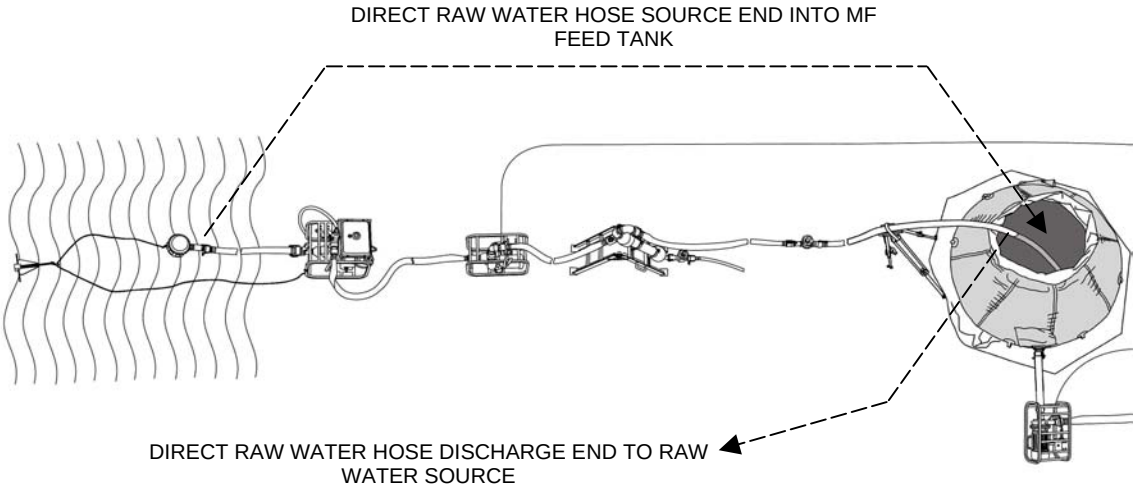

Figure 1. Raw Water System Flush Layout.

NOTE

The suction hose will need to be held up to avoid collapse of the MF feed tank floatation collar as water is pumped out of the MF feed tank through the raw water hoses and out to the raw water source.

8. Start the raw water pump(s) and allow the system to flush for 2 minutes.
9. Shut down the raw water pumps.
10. Remove the raw water suction hoses and set aside to dry.
11. Remove all of the adaptors. Remove loose dirt and set aside to dry, or blow dry using air from the auxiliary air hose.
12. Remove the raw water discharge hoses and place in a clean area. Wipe the hoses clean of loose dirt. Roll up and strap.
13. Remove loose dirt from the cyclone separator. Using the auxiliary air hose, blow air into the inlet connection and then the outlet connection at the top.
14. Open the drain on each of the pumps. Place the pump cap in the inlet connection. Using the auxiliary air hose, blow air into the pump outlet to dry the inside of each pump. Cap the outlet connection.
15. Remove the loose dirt from the outside of the pump assemblies.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0031 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – ARMY UNIT

MF Feed Tank and P-3 Pump

1. Drain the MF feed tank
2. Remove the suction hose and set aside to dry.
3. Pull the tank inside out and allow to dry.
4. Remove the discharge hoses and place in a clean area. Wipe the hoses clean of loose dirt. Roll up and strap.
5. Remove the loose dirt from the outside of the MF Feed Pump assembly.
6. Open the pump drain. Place the plug in the inlet connection.
7. Using the auxiliary air hose, blow air into the pump outlet to dry the inside of the pump. Plug the outlet connection.

MF Feed System

1. Turn the main circuit breaker to the OFF position. Valve V-111 will open to drain any residual MF cleaning solution back into Strainer S-2. After 1 minute, turn the main breaker back to ON to close the valve (see Figure 2).

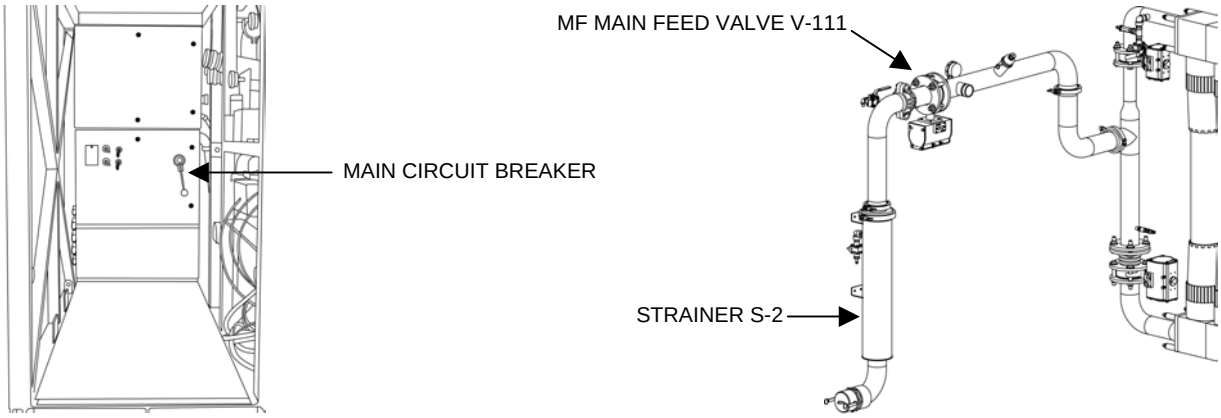

Figure 2. Main Circuit Breaker, Valve V-111, and Strainer S-2.

WARNING

Residual caustic chemical. There may be diluted, residual caustic cleaning solution in Strainer S-2. Wear a protective face shield, chemical gloves, and chemical apron when removing and flushing the strainer. Keep water ready when handling. Avoid inhaling chemical fumes. Failure to observe this warning may result in irritation of the nose, throat and eyes. Skin contact with diluted caustic may result in chemical burns if not rinsed immediately.

2. Put on the protective face shield, chemical gloves, and chemical apron.
3. Remove and clean the S-2 strainer (refer to WP 0040).
4. Remove the MF inlet connection cap so that rinse water drains.
5. Flush the S-2 strainer housing with product water.
6. Using the auxiliary air hose, blow the strainer and the strainer housing dry.
7. Install the strainer.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0031 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – ARMY UNIT

RO System

1. Remove strainer S-4 and clean (refer to WP 0041).
2. Install after cleaning.
3. Make sure the following RO system drain valves are open (see Figure 3 for valve location).
    a. RO Vessel Drain Valve V-408
    b. RO Feed Tank Auxiliary Drain Valve V-210
    c. Turbocharger Reject Side Drain Valve V-410
    d. Turbocharger Feed Side Drain Valve V-303
    e. Feed Piping Drain Valve V-304
    f. HP Pump Outlet Drain Valves V-301 and V-302
    g. RO Feed Pump Drain Valve V-211

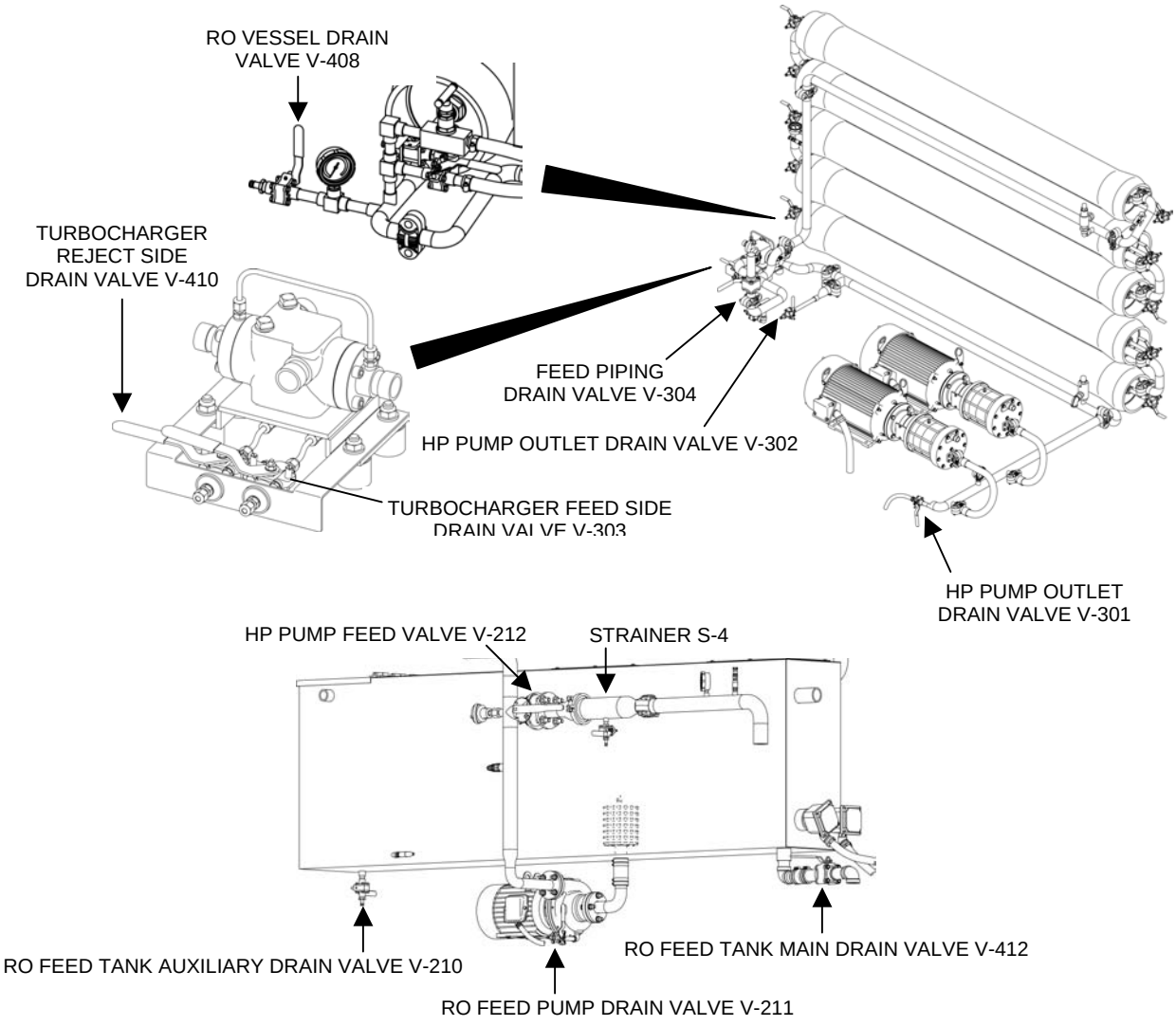

Figure 3. RO System Drain Valves.

4. Set the RO product 3-way valves V-501 through V-510 to the drain position (see Figure 4).

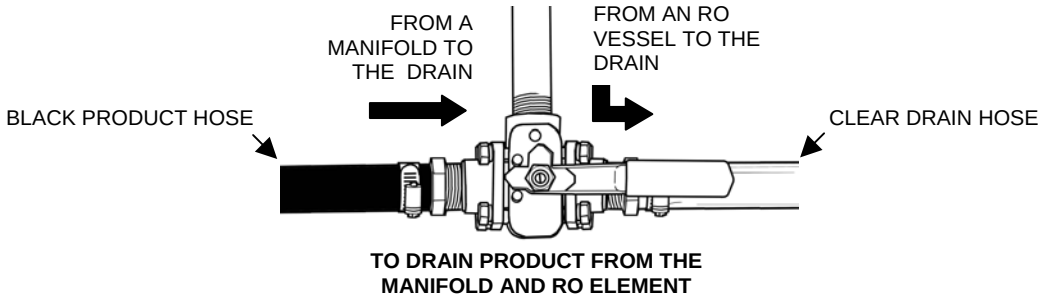

Figure 4. RO Product 3-Way Valve in the Drain Position.

5. Wait until all drainage stops. Then close all the drain valves that were opened in the previous two steps.
6. When water stops draining from the drain tubes, disconnect each tube from its valve and hold the end up to drain the residual water from the tube. Then reconnect the tube to its valve. (It is not necessary to perform this step for a drain tube that is secured to its valve with a hose clamp.)

Chemical System

1. If the Bisulfite pump CP-1 has not been used, these procedures apply only to the antiscalant and hypochlorite pumps.
2. Rinse the chemical buckets with product water. Partially fill one bucket and set back in place in the operator's station.
3. Place the chemical pump suction tubes into the bucket. Be sure the suction tube inlets rest near the bottom of the bucket.
4. Direct the return tube so that it drains to the ground. Do not place it in the pitcher.
5. Make sure that the speed control dial is set to OFF on each pump (turned fully counterclockwise).
6. If used, set the Bisulfite Pump switch on the OCP to ON. Set the Antiscalant/Hypochlorite Pump switch on the OCP to ON.
7. Prime each pump as follows:
    a. Turn the speed dial to 80.
    b. After the pump has started, turn the stroke dial to 80.
    c. Rotate the black knob on the priming valve one-half turn. Note that the water is drawing up the suction tube, entering the pump housing and flowing out the return tube.
    d. When primed, turn the black priming knob to its original position.
8. Operate each pump for 10 minutes to flush the pumps and the chemical tubing with product water.
9. After 10 minutes, turn the speed dial on each pump to the OFF position (turned fully counterclockwise).
10. Drain each system as follows (see Figure 5):

a. Disconnect the suction tube from suction valve housing at the bottom of the pump.
b. Disconnect the other end of the suction tube from the foot valve housing.
c. Drain the suction tube into the bucket.
d. Disconnect the discharge tube from the top of the four-function valve and direct the tube to drain into the bucket.
e. Disconnect the other end of the discharge tube from the injection valve housing.
f. Use the auxiliary air hose to purge the water from the discharge tube and into the bucket.
g. Reconnect the discharge tube to the injection valve housing.
h. Unscrew the suction valve housing from the bottom of the pump and set aside. Be careful to keep the suction cartridge valve in the proper position.
i. Disconnect the priming/return tube from the side of the four-function valve.
j. Unscrew the four-function valve from the top of the pump.
k. Lift the discharge cartridge valve out of the pump case and set aside with the upside facing up.
l. Use the auxiliary air hose to blow into the top (discharge) opening of the pump to purge any remaining water from the pump.
m. Reinstall the discharge cartridge valve and the four-function valve. Make sure the cartridge valve is properly oriented.
n. Reinstall the priming/return tube and the discharge tube to the four-function valve.
o. Reinstall the suction cartridge valve and suction valve housing to the bottom of the pump. Make sure the cartridge valve is properly oriented.
p. Reinstall the suction tube to the suction valve housing.
q. Reinstall the suction tube to the foot valve housing.

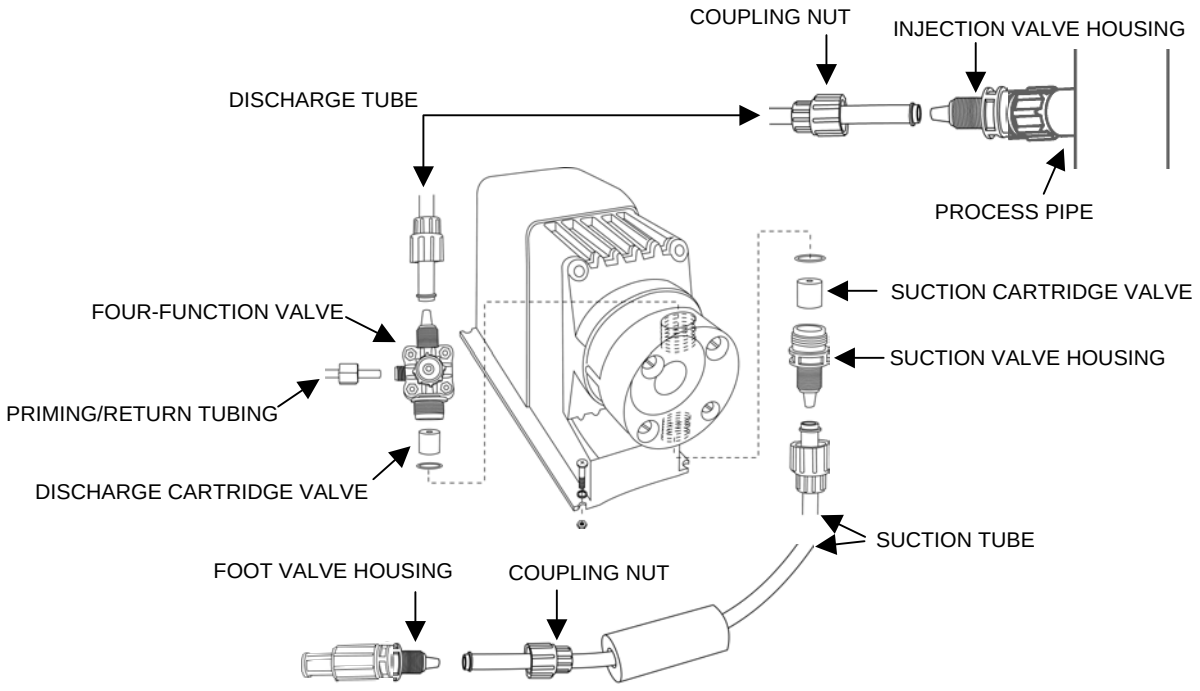

Figure 5. Chemical System Component Removal for Draining the System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0031 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – ARMY UNIT

DIESEL ENGINE PRESERVATION

1. Remove the fuel tank.
2. Remove the screen filter from the fuel filler port and fully drain the fuel tank.
3. Ventilate the fuel tank as follows (see Figure 6):
    a. Connect the quick-disconnect air hose (BII Box #8) to the quick-disconnect fitting in Air System Section 1.
    b. Connect the air blowgun (air nozzle, Operator's Tool Kit) to the other end of the air hose.
    c. Blow air into the fuel filler port to ventilate the fuel tank.

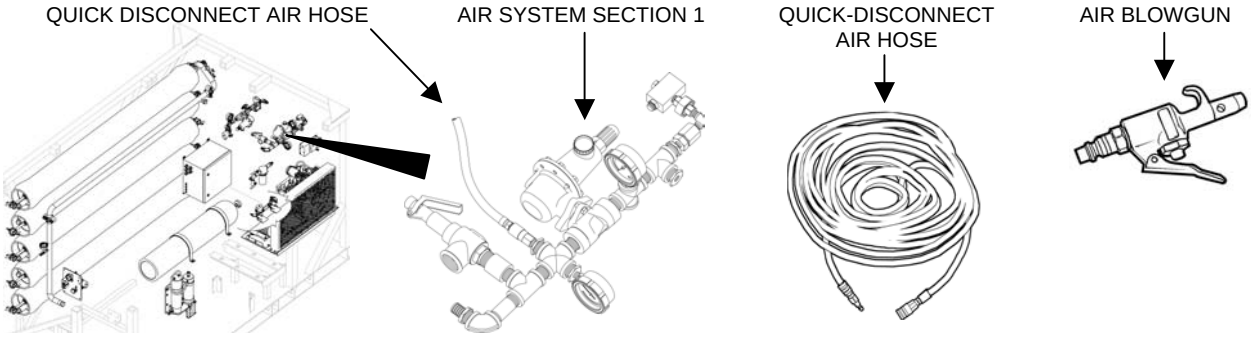

Figure 6. Quick-Disconnect Air Hose Connections.

4. Reinstall the screen filter.
5. Make sure the decompression lever is up (see Figure 7). Pull the recoil starter slowly until it feels tight.
6. Couple the two tank fuel lines together and the two diesel engine fuel lines together.

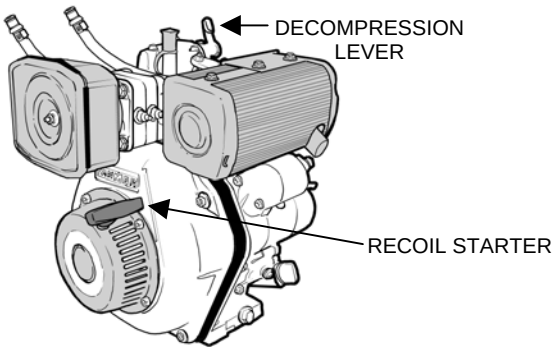

Figure 7. Diesel Engine Decompression Lever and Recoil Starter.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0031 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – ARMY UNIT

WINTER HEATER PRESERVATION

If the winter heater has been used, drain the fuel. Use the auxiliary air hose to blow remaining fuel from the tank.

GENERAL CLEAN UP AND PRESERVATION

1. Wash down the skid floor and generator area deck with potable water. Wash any area with salt accumulations. Blow all wet surfaces dry with air from the auxiliary air hose.
2. Contact Unit Maintenance to prepare the TQG for long term storage.
3. Hose heating blankets.
    a. Remove loose dirt.
    b. Layout to dry if wet.
    c. Place in clean area and roll up tightly. Bind with the appropriate strap (WP 0028).
4. Wash down the fabric wall and allow to dry.
5. Packout boxes
    a. Clean up and dry the inside of the packout boxes.
    b. Inventory the contents of each box against the contents list attached to the box cover and as listed in WP 0028.
    c. Replace missing or damaged parts
    d. Be sure all parts are dry. Pack out all boxes except Boxes 5 and 7.
    e. After the cleaning procedures, Box 5 will be empty. Leave this box empty. Do not place the AC-350 sodium hydroxide (caustic) back into the box.
    f. Remove the calcium hypochlorite container from Box 7. Leave this box empty.
    g. Store unused chemical in accordance with Unit standard operating procedures

DISTRIBUTION SYSTEM CLEANING, FLUSHING, AND DRYING

Complete this procedure after product water is no longer needed for cleaning and flushing.

1. Remove the loose dirt from the outside of the pump assemblies
2. Start the pumps and run until all of the water has been removed from the distribution tanks.
3. Remove the suction hoses and set aside to dry. Install caps and plugs when dry.
4. Remove all of the adaptors. Remove loose dirt and set aside to dry, or blow dry using air from the auxiliary air hose. Install caps and plugs when dry.
5. Remove the discharge hoses and place in a clean area. Wipe the hoses clean of loose dirt. Install caps and plugs. Roll up the hoses and secure with straps.
6. Open the drain on each of the pumps. Place the cap in the inlet connection. Using the auxiliary air hose, blow air into the pump outlet to dry the inside of each pump. Cap the outlet connection.
7. Open the zippers on the distribution tanks and pull inside out to dry. If possible, the tanks should be hung up from the tank bottom handle.

RO AND MF ELEMENTS

Unless otherwise directed, the RO and MF elements remain in place for long-term storage after a deployment. If the RO elements are removed, the vessels may remain empty, or the RO simulators may be installed (WP 0036 or WP 0041). Write one of the following two messages on a marker tag and tie the tag to valve V-502 at the operator control station end of the RO vessels to indicate the condition of the vessels as appropriate.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0031 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – ARMY UNIT

"Warning. RO simulators are installed.
Remove and install RO elements to produce potable water."
or
"Caution. RO vessels are empty. Install RO elements before operation."

WARNING

Residual caustic chemical. There may be diluted, residual caustic cleaning solution in the MF elements. Wear a protective face shield, chemical gloves, and chemical apron if removing the elements. Keep water ready when handling. Avoid inhaling chemical fumes. Failure to observe this warning may result in irritation of the nose, throat and eyes. Skin contact with diluted caustic may result in chemical burns if not rinsed immediately.

If the MF elements are removed (WP 0040), wear the protective face shield, chemical gloves, and chemical apron when handling the elements to provide protection from residual caustic cleaning solution. Write the following note on a marker tag and attach the tag to the main circuit breaker handle:

"Caution. MF elements are not installed. Install before operating this equipment."

AIR SYSTEM PRESERVATION

Complete these procedures when air is no longer needed for drying.

1. Run the compressor until hot. Stop the compressor.
2. Replace the AF-2 Purifier Filter Cartridge (WP 0042).
3. Loosen the screw and clamp and remove the intake filter AF-1 assembly from the compressor first stage valve head (see Figure 8) (WP 0042).
4. Turn on the compressor. Slowly spray 10cc (about one ounce) of compressor oil into the open intake in the valve head.
5. Run the compressor for 5 minutes. Turn the compressor switch to OFF.
6. Tape the air inlet port of the valve head closed.
7. Tie the intake filter assembly with the filter to the air compressor.

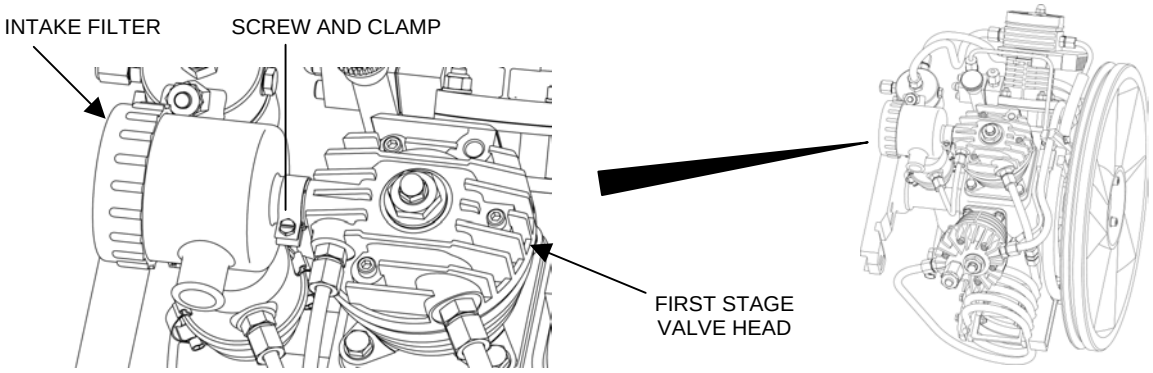

Figure 8. Air Compressor Intake Filter.

8. Open High Pressure Vent Valve V-904. Close when vented (see Figure 9).
9. Open Low Pressure Vent Valve V-910. Close when vented (see Figure 9).
10. Close Low Pressure Air Shutoff Valve V-909 (see Figure 9).

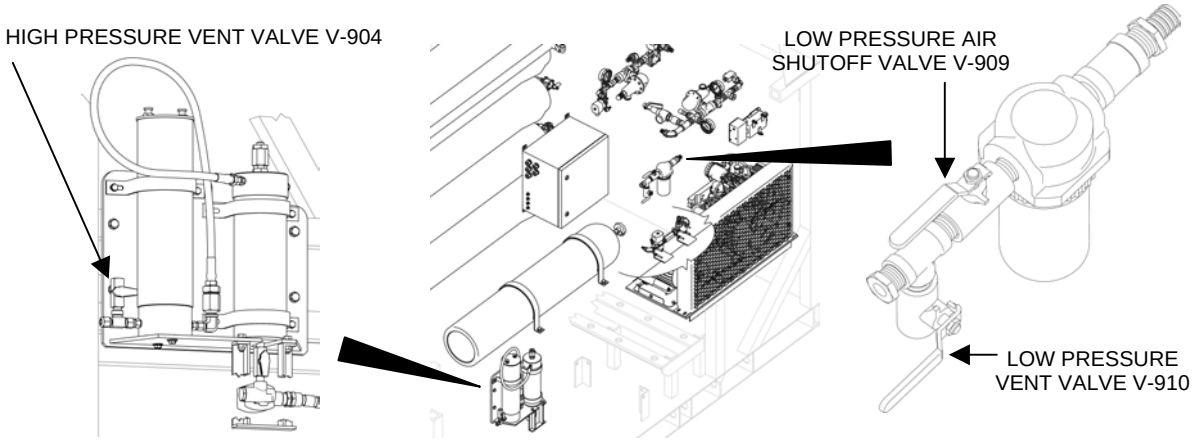

Figure 9. Vent Valves V-904 and V-910 and Shut-Off Valve V-909.

11. Remove the AF-2 Purifier Filter Cartridge (WP 0042). Lubricate the filter chamber head threads with petroleum jelly. Reinstall the head. Write the following note on a marker tag and attach the tag to the filter head:

**"Caution: Air purification cartridge is not installed.
Install before operating this equipment."**

12. Loosen the compressor belt tension (see Figure 10):
    a. Loosen the drive motor mounting nuts.
    b. Turn the belt adjustment bolt counter clockwise.

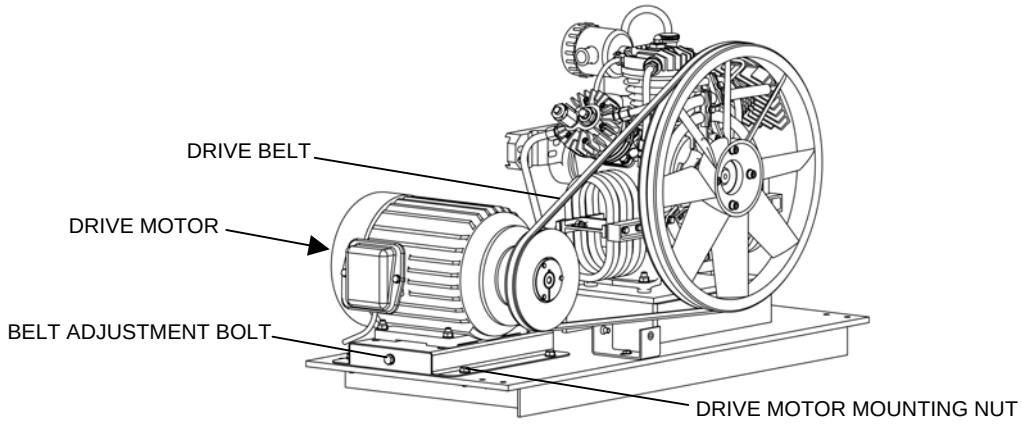

Figure 10. Compressor Belt Tension Adjustment.

13. Write the following note on a marker tag and attach the tag to the belt guard:

**"Caution: Tighten belt before operation.
Install air inlet filter housing and filter (AF-1) before operating."**

CORROSION PREVENTION

Spray the components listed in Table 1 with the corrosion preventive compound (BII bucket 6).

Table 1. Components to Spray with Corrosion Preventive Compound.

ITEM	COMPONENT TO SPRAY
P-1 and P-8 diesel engine-driven pump	Throttle linkage area (see Figure 11). Electric starter mounting hardware.
P-2 and P-7 electric motor-driven pumps	Exposed motor shaft and shaft sleeve clamp.
Turbocharger	Exposed threads of turbocharger assembly mounting studs.
RO Feed Pump	Exposed threads of RO feed pump assembly mounting studs.
High Pressure Pumps	Exposed threads of HP pump mounting bolts.
Compressor	Exposed motor and compressor shafts. Motor mounting hardware.
Pipe Couplings	Coupling clamps, bolts, nuts and gasket retainer. (See Figure 12 below for examples).
Expansion Joints	Retainer wire ball slots (one at MF inlet and two at MF outlet)
Pressure Transmitters PT-101, PT-102, PT-201, and PT-302	Electrical connectors
Ratchet Straps	Ratchet strap hardware
A-TWPS flat rack	(A-TWPS only) Hardware that secures the A-TWPS skid to the flat rack.

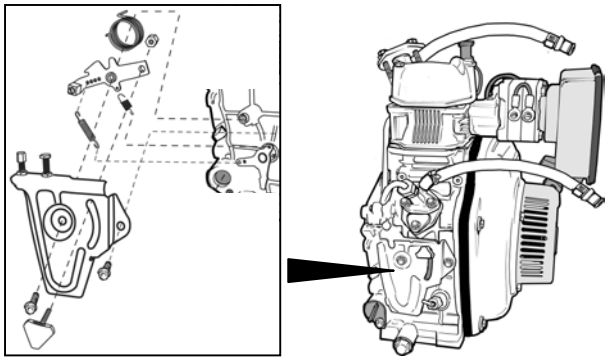

Figure 11. P-1 / P-8 Throttle Linkage Area.

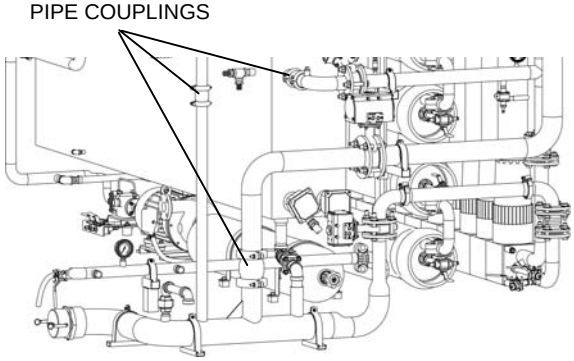

Figure 12. Examples of Pipe Couplings.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0031 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – ARMY UNIT

SHIPPING AND STORAGE INSTRUCTIONS

Complete the instructions for shipping and storage in accordance with the Shipping and Storage Instructions (S&SI).

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS PREPARATION FOR STORAGE – MARINE CORPS UNIT

0032 00

INITIAL SETUP:

Materials:
Marker Tags (WP 0079, Table 1, item 42)
Corrosion Preventive Compound (BII) (WP 0079, Table 1, item 17)
Lubricating Oil, Compressor (WP 0079, Table 1, item 30)
Petroleum Jelly (WP 0079, Table 1, item 32)
Personnel Required
Three Operator/Crew
Equipment Condition
TWPS removed from service
At least 1500 gallons of useable product water must be available in the distribution tanks

GENERAL:

This work package contains the operator procedures required to prepare the TWPS for storage. The procedures covered in this work package include:

- Long term shutdown
- Component cleaning, flushing, and drying
- Diesel engine preservation
- Winter heater preservation
- General clean up and preservation
- Distribution system cleaning, flushing, and drying
- RO and MF Elements
- Air system preservation
- Corrosion prevention
- Shipping and Storage Instructions

LONG TERM SHUTDOWN

A long-term shutdown is performed when shutting down the TWPS in preparation for storage.

Long term shutdown is accomplished by completing the following procedures in the order listed:

- MF Cleaning with RO Acid Cleaning. Refer to WP 0024.
- RO Preservation (preserved with a bisulfite solution). Refer to WP 0025.

COMPONENT CLEANING, FLUSHING, AND DRYING

NOTE

At least 1500 gallons of useable product water must be available in the distribution tanks.

Raw Water System

1. Remove the floating inlet strainer from the raw water hoses.
2. Remove debris from the floating inlet strainer and flush with product water. Set aside to dry.
3. Rinse the anchor rope with product water. Set aside to dry.
4. Fill the MF feed tank with product water.

5. Remove the raw water discharge hose from the tripod and the MF feed tank and direct the hose toward the raw water source.
6. Place the open end of the raw water suction source hose into the MF feed tank as far as it will go. Place the middle of the hose on top of the tripod and secure the hose to the tripod with a hook and loop strap (see Figure 1)

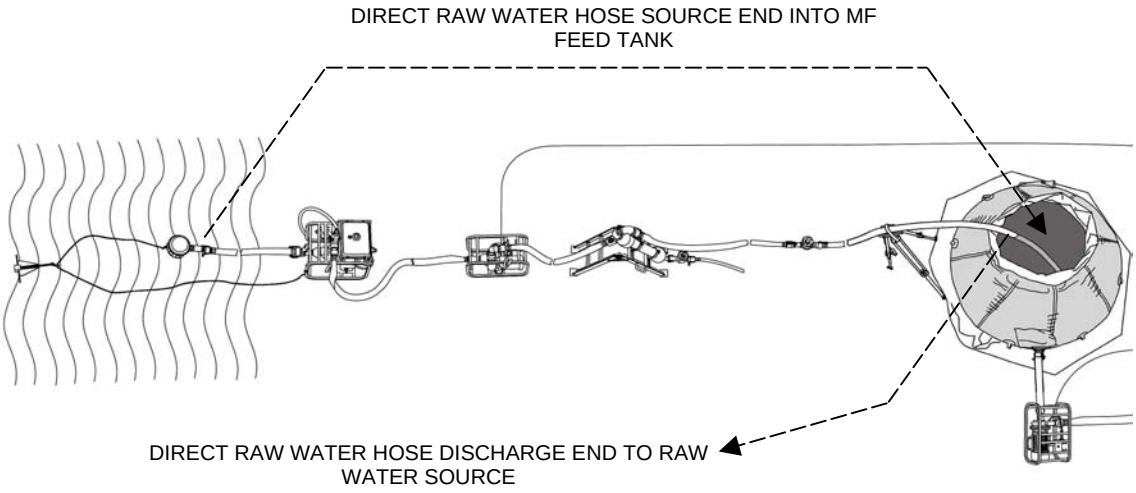

Figure 1. Raw Water System Flush Layout.

NOTE

The suction hose will need to be held up to avoid collapse of the MF feed tank floatation collar as water is pumped out of the MF feed tank through the raw water hoses and out to the raw water source.

7. Start the raw water pump(s) and allow the system to flush for 2 minutes.
8. Shut down the raw water pumps.
9. Remove the raw water suction hoses and set aside to dry.
10. Remove all of the adaptors. Remove loose dirt and set aside to dry, or blow dry using air from the auxiliary air hose.
11. Remove the raw water discharge hoses and place in a clean area. Wipe the hoses clean of loose dirt. Roll up and strap.
12. Remove loose dirt from the cyclone separator. Using the auxiliary air hose, blow air into the inlet connection and then the outlet connection at the top.
13. Open the drain on each of the pumps. Place the pump cap in the inlet connection. Using the auxiliary air hose, blow air into the pump outlet to dry the inside of each pump. Cap the outlet connection.
14. Remove the loose dirt from the outside of the pump assemblies.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0032 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – MARINE CORPS UNIT

MF Feed Tank and P-3 Pump

1. Drain the MF feed tank
2. Remove the suction hose and set aside to dry.
3. Pull the tank inside out and allow to dry.
4. Remove the discharge hoses and place in a clean area. Wipe the hoses clean of loose dirt. Roll up and strap.
5. Remove the loose dirt from the outside of the MF Feed Pump assembly.
6. Open the pump drain. Place the plug in the inlet connection.
7. Using the auxiliary air hose, blow air into the pump outlet to dry the inside of the pump. Plug the outlet connection.

MF Feed System

1. Turn the main circuit breaker to the OFF position. Valve V-111 will open to drain any residual MF cleaning solution back into Strainer S-2. After 1 minute, turn the main breaker back to ON to close the valve (see Figure 2).

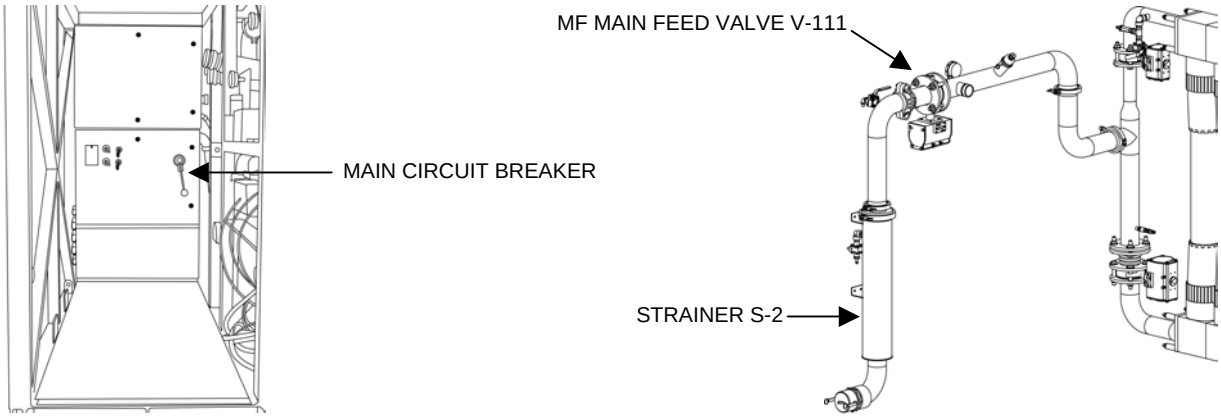

Figure 2. Main Circuit Breaker, Valve V-111, and Strainer S-2.

WARNING

Residual caustic chemical. There may be diluted, residual caustic cleaning solution in Strainer S-2. Wear a protective face shield, chemical gloves, and chemical apron when removing and flushing the strainer. Keep water ready when handling. Avoid inhaling chemical fumes. Failure to observe this warning may result in irritation of the nose, throat and eyes. Skin contact with diluted caustic may result in chemical burns if not rinsed immediately.

2. Put on the protective face shield, chemical gloves, and chemical apron.
3. Remove and clean the S-2 strainer (refer to WP 0040).
4. Remove the MF inlet connection cap so that rinse water drains.
5. Flush the S-2 strainer housing with product water.
6. Using the auxiliary air hose, blow the strainer and the strainer housing dry.
7. Install the strainer.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0032 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – MARINE CORPS UNIT

RO System

1. Remove strainer S-4 and clean (refer to WP 0041).
2. Install after cleaning.
3. Make sure the following RO system drain valves are open (see Figure 3 for valve location).
    a. RO Vessel Drain Valve V-408
    b. RO Feed Tank Auxiliary Drain Valve V-210
    c. Turbocharger Reject Side Drain Valve V-410
    d. Turbocharger Feed Side Drain Valve V-303
    e. Feed Piping Drain Valve V-304
    f. HP Pump Outlet Drain Valves V-301 and V-302
    g. RO Feed Pump Drain Valve V-211

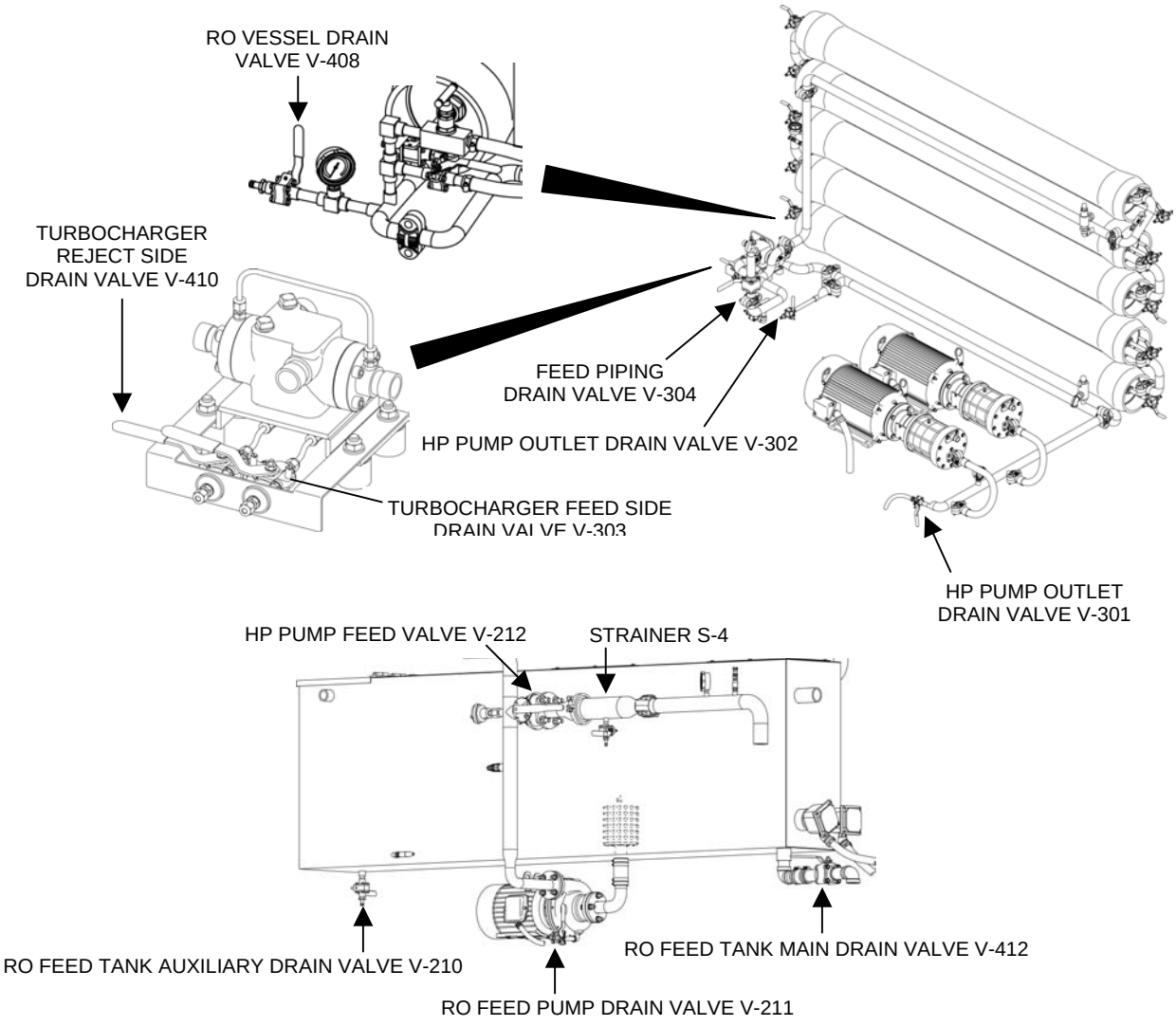

Figure 3. RO System Drain Valves.

4. Set the RO product 3-way valves V-501 through V-510 to the drain position (see Figure 4).

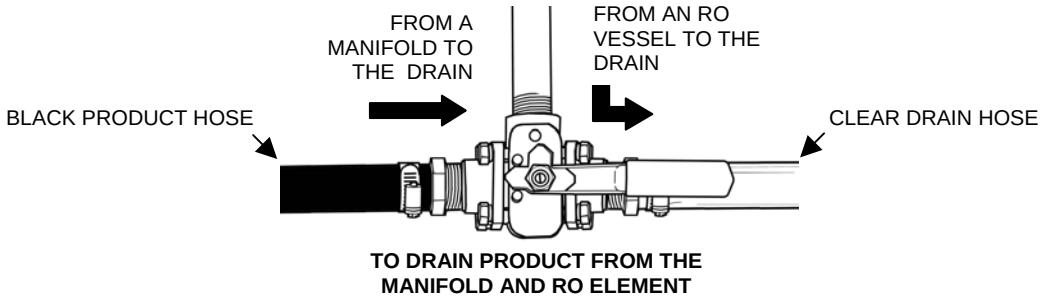

Figure 4. RO Product 3-Way Valve in the Drain Position.

5. Wait until all drainage stops. Then close all the drain valves that were opened in the previous two steps.
6. When water stops draining from the drain tubes, disconnect each tube from its valve and hold the end up to drain the residual water from the tube. Then reconnect the tube to its valve. (It is not necessary to perform this step for a drain tube that is secured to its valve with a hose clamp.)

Chemical System

1. If the Bisulfite pump CP-1 has not been used, these procedures apply only to the antiscalant and hypochlorite pumps.
2. Rinse the chemical buckets with product water. Partially fill one bucket and set back in place in the operator's station.
3. Place the chemical pump suction tubes into the bucket. Be sure the suction tube inlets rest near the bottom of the bucket.
4. Direct the return tube so that it drains to the ground. Do not place it in the pitcher.
5. Make sure that the speed control dial is set to OFF on each pump (turned fully counterclockwise).
6. If used, set the Bisulfite Pump switch on the OCP to ON. Set the Antiscalant/Hypochlorite Pump switch on the OCP to ON.
7. Prime each pump as follows:
    a. Turn the speed dial to 80.
    b. After the pump has started, turn the stroke dial to 80.
    c. Rotate the black knob on the priming valve one-half turn. Note that the water is drawing up the suction tube, entering the pump housing and flowing out the return tube.
    d. When primed, turn the black priming knob to its original position.
8. Operate each pump for 10 minutes to flush the pumps and the chemical tubing with product water.
9. After 10 minutes, turn the speed dial on each pump to the OFF position (turned fully counterclockwise).
10. Drain each system as follows (see Figure 5):

a. Disconnect the suction tube from suction valve housing at the bottom of the pump.
b. Disconnect the other end of the suction tube from the foot valve housing.
c. Drain the suction tube into the bucket.
d. Disconnect the discharge tube from the top of the four-function valve and direct the tube to drain into the bucket.
e. Disconnect the other end of the discharge tube from the injection valve housing.
f. Use the auxiliary air hose to purge the water from the discharge tube and out into the bucket.
g. Reconnect the discharge tube to the injection valve housing.
h. Unscrew the suction valve housing from the bottom of the pump and set aside. Be careful to keep the suction cartridge valve in the proper position.
i. Disconnect the priming/return tube from the side of the four-function valve.
j. Unscrew the four-function valve from the top of the pump.
k. Lift the discharge cartridge valve out of the pump case and set aside with the upside facing up.
l. Use the auxiliary air hose to blow into the top (discharge) opening of the pump to purge any remaining water from the pump.
m. Reinstall the discharge cartridge valve and the four-function valve. Make sure the cartridge valve is properly oriented.
n. Reinstall the priming/return tube and the discharge tube to the four-function valve.
o. Reinstall the suction cartridge valve and suction valve housing to the bottom of the pump. Make sure the cartridge valve is properly oriented.
p. Reinstall the suction tube to the suction valve housing.
q. Reinstall the suction tube to the foot valve housing.

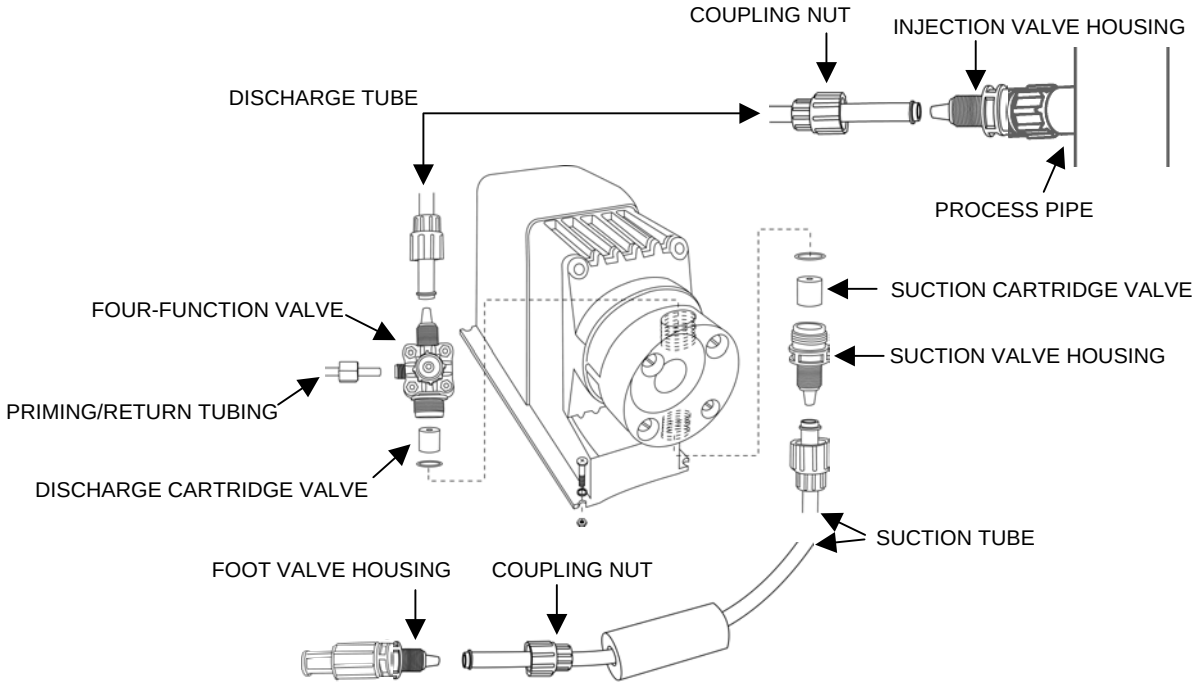

Figure 5. Chemical System Component Removal for Draining the System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0032 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – MARINE CORPS UNIT

DIESEL ENGINE PRESERVATION

1. Remove the fuel tank.
2. Remove the screen filter from the fuel filler port and fully drain the fuel tank.
3. Ventilate the fuel tank as follows (see Figure 6):
    a. Connect the quick-disconnect air hose (BII Box #8) to the quick-disconnect fitting in Air System Section 1.
    b. Connect the air blowgun (air nozzle, Operator's Tool Kit) to the other end of the air hose.
    c. Blow air into the fuel filler port to ventilate the fuel tank.

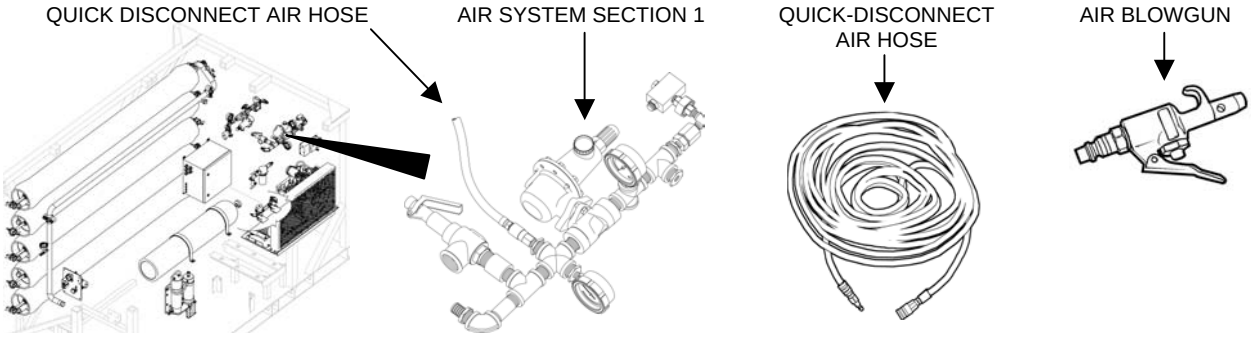

Figure 6. Quick-Disconnect Air Hose Connections.

4. Reinstall the screen filter.
5. Make sure the decompression lever is up (see Figure 7). Pull the recoil starter slowly until it feels tight.
6. Couple the two tank fuel lines together and the two diesel engine fuel lines together.

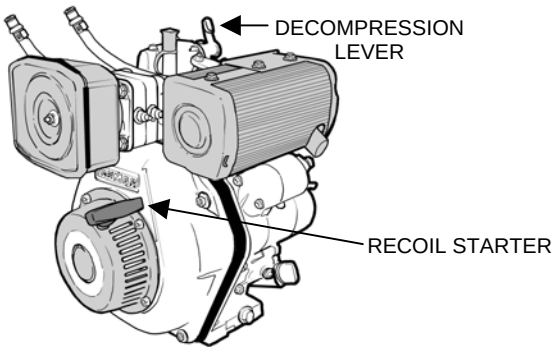

Figure 7. Diesel Engine Decompression Lever and Recoil Starter.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR INSTRUCTIONS PREPARATION FOR STORAGE – MARINE CORPS UNIT

0032 00

WINTER HEATER PRESERVATION

If the winter heater has been used, drain the fuel. Use the auxiliary air hose to blow remaining fuel from the tank.

GENERAL CLEAN UP AND PRESERVATION

1. Wash down the skid floor with potable water. Wash any area with salt accumulations. Blow all wet surfaces dry with air from the auxiliary air hose.
2. Hose heating blankets.
    a. Remove loose dirt.
    b. Layout to dry if wet.
    c. Place in clean area and roll up tightly. Bind with the appropriate strap (WP 0028).
3. Wash down the General Purpose Cover and allow to dry.
4. Packout boxes
    a. Clean up and dry the inside of the packout boxes.
    b. Inventory the contents of each box against the contents list attached to the box cover and as listed in WP 0029.
    c. Replace missing or damaged parts
    d. Be sure all parts are dry. Pack out all boxes except Boxes 5 and 7.
    e. After the cleaning procedures, Box 5 will be empty. Leave this box empty. Do not place the AC-350 sodium hydroxide (caustic) back into the box.
    f. Remove the calcium hypochlorite container from Box 7. Leave this box empty.
    g. Store unused chemical in accordance with Unit standard operating procedures

DISTRIBUTION SYSTEM CLEANING, FLUSHING, AND DRYING

Complete this procedure after product water is no longer needed for cleaning and flushing.

1. Remove the loose dirt from the outside of the pump assemblies
2. Start the pumps and run until all of the water has been removed from the distribution tanks.
3. Remove the suction hoses and set aside to dry. Install caps and plugs when dry.
4. Remove all of the adaptors. Remove loose dirt and set aside to dry, or blow dry using air from the auxiliary air hose. Install caps and plugs when dry.
5. Remove the discharge hoses and place in a clean area. Wipe the hoses clean of loose dirt. Roll up, install caps and plugs and strap.
6. Open the drain on each of the pumps. Place the cap in the inlet connection. Using the auxiliary air hose, blow air into the pump outlet to dry the inside of each pump. Cap the outlet connection.
7. Open the zippers on the distribution tanks and pull inside out to dry. If possible, the tanks should be hung up from the tank bottom handle.

RO AND MF ELEMENTS

Unless otherwise directed, the RO and MF elements remain in place for long-term storage after a deployment. If the RO elements are removed, the vessels may remain empty, or the RO simulators may be installed (WP 0036 or WP 0041). Write one of the two messages below on a marker tag and tie the tag to valve V-502 at the operator control station end of the RO vessels to indicate the condition of the vessels as appropriate.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0032 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – MARINE CORPS UNIT

"Warning. RO simulators are installed.
Remove and install RO elements to produce potable water."
or
"Caution. RO vessels are empty. Install RO elements before operation."

WARNING

Residual caustic chemical. There may be diluted, residual caustic cleaning solution in the MF elements. Wear a protective face shield, chemical gloves, and chemical apron if removing the elements. Keep water ready when handling. Avoid inhaling chemical fumes. Failure to observe this warning may result in irritation of the nose, throat and eyes. Skin contact with diluted caustic may result in chemical burns if not rinsed immediately.

If the MF elements are removed (WP 0040), wear the protective face shield, chemical gloves, and chemical apron when handling the elements to provide protection from residual caustic cleaning solution. Write the following note on a marker tag and attach the tag to the main circuit breaker handle:

"Caution. MF elements are not installed. Install before operating this equipment."

AIR SYSTEM PRESERVATION

Complete these procedures when air is no longer needed for drying.

1. Run the compressor until hot. Stop the compressor.
2. Replace the AF-2 Purifier Filter Cartridge (WP 0042).
3. Loosen the screw and clamp and remove the intake filter AF-1 assembly from the compressor first stage valve head (see Figure 8) (WP 0042).
4. Turn on the compressor. Slowly spray 10cc (about one ounce) of compressor oil into the open intake in the valve head.
5. Run the compressor for 5 minutes. Turn the compressor switch to OFF.
6. Tape the air inlet port of the valve head closed.
7. Tie the intake filter assembly with the filter to the air compressor.

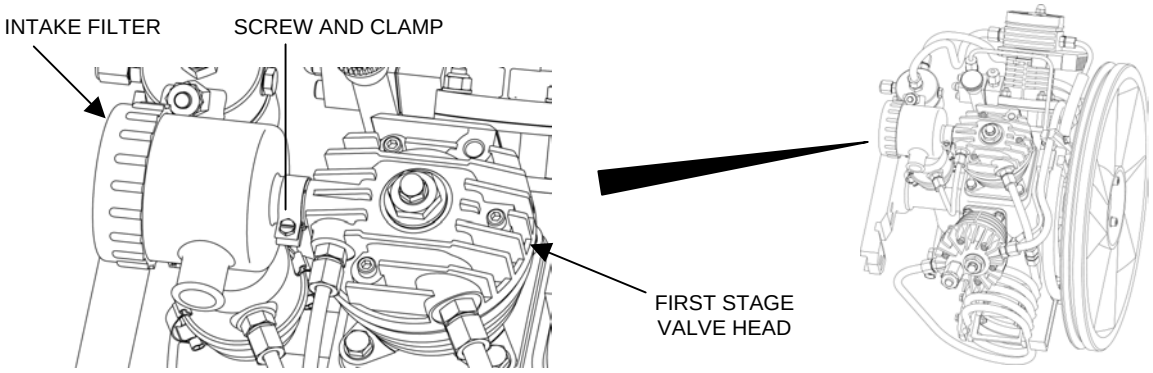

Figure 8. Air Compressor Intake Filter.

8. Open High Pressure Vent Valve V-904. Close when vented (see Figure 9).
9. Open Low Pressure Vent Valve V-910. Close when vented (see Figure 9).
10. Close Low Pressure Air Shutoff Valve V-909 (see Figure 9).

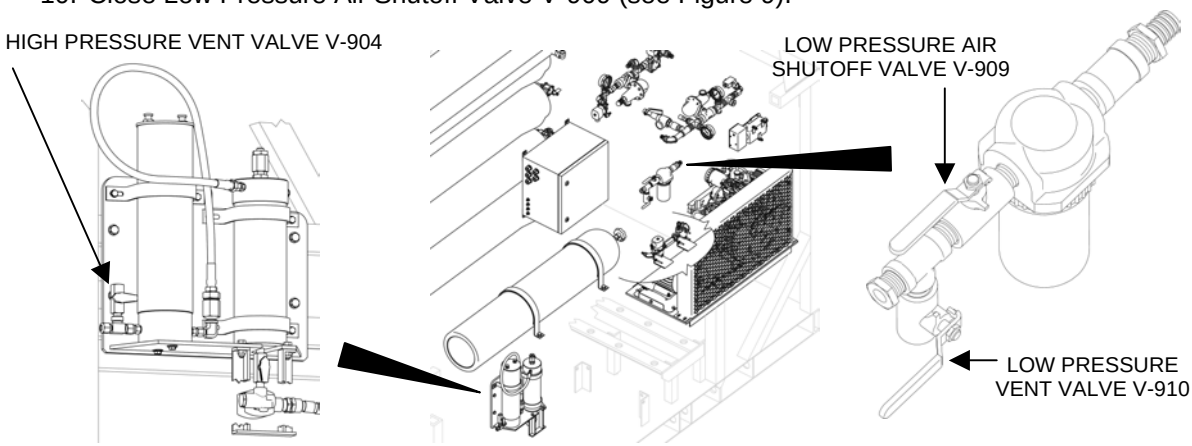

Figure 9. Vent Valves V-904 and V-910 and Shut-Off Valve V-909.

11. Remove the AF-2 Purifier Filter Cartridge (WP 0042). Lubricate the filter chamber head threads with petroleum jelly. Reinstall the head. Write the following note on a marker tag and attach the tag to the filter head:

**"Caution: Air purification cartridge is not installed.
Install before operating this equipment."**

12. Loosen the compressor belt tension (see Figure 10):
    a. Loosen the drive motor mounting nuts.
    b. Turn the belt adjustment bolt counter clockwise.

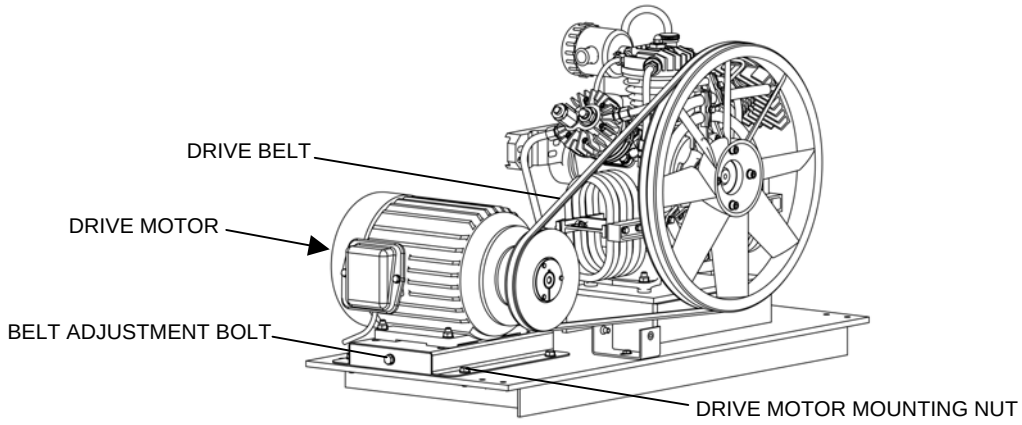

Figure 10. Compressor Belt Tension Adjustment.

13. Write the following note on a marker tag and attach the tag to the belt guard:

**"Caution: Tighten belt before operation.
Install air inlet filter housing and filter (AF-1) before operating."**

CORROSION PREVENTION

Spray the components listed in Table 1 with the corrosion preventive compound (BII bucket 6).

Table 1. Components to Spray with Corrosion Preventive Compound.

ITEM	COMPONENT TO SPRAY
P-1 diesel engine-driven pump	Throttle linkage area (see Figure 11). Electric starter mounting hardware.
P-2 and P-7 electric motor-driven pumps	Exposed motor shaft and shaft sleeve clamp.
Turbocharger	Exposed threads of turbocharger assembly mounting studs.
RO Feed Pump	Exposed threads of RO feed pump assembly mounting studs.
High Pressure Pumps	Exposed threads of HP pump mounting bolts.
Compressor	Exposed motor and compressor shafts. Motor mounting hardware.
Pipe Couplings	Coupling clamps, bolts, nuts and gasket retainer. (See Figure 12 below for examples).
Expansion Joints	Retainer wire ball slots (one at MF inlet and two at MF outlet)
Pressure Transmitters PT-101, PT-102, PT-201, and PT-302	Electrical connectors
Ratchet Straps	Ratchet strap hardware

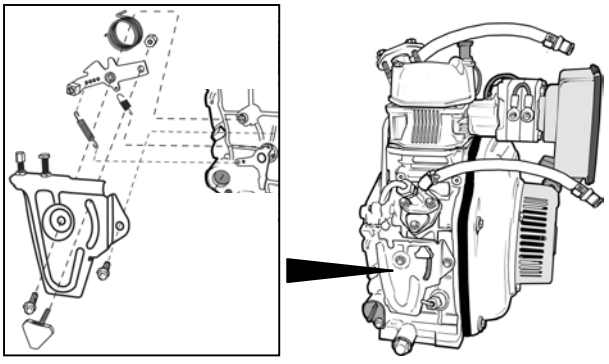

Figure 11. P-1 P-8 Throttle Linkage Area.

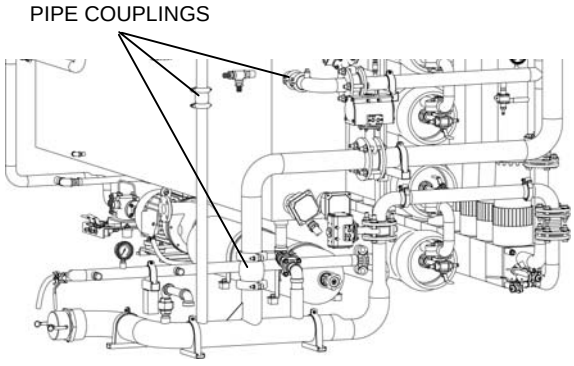

Figure 12. Examples of Pipe Couplings.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0032 00**
OPERATOR INSTRUCTIONS
PREPARATION FOR STORAGE – MARINE CORPS UNIT

SHIPPING AND STORAGE INSTRUCTIONS

Complete the instructions for shipping and storage in accordance with the Shipping and Storage Instructions.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0033 00
TROUBLESHOOTING PROCEDURES
OPERATOR/CREW TROUBLESHOOTING PROCEDURES

This work package covers malfunctions of the various TWPS systems including the related electrical control provided by the OCP and the power provided by the PDP. The malfunctions and troubleshooting procedures are presented in tables as listed.

RAW WATER SYSTEM MALFUNCTIONS

TABLE 1: RAW WATER SYSTEM TROUBLESHOOTING

TABLE 2: DIESEL ENGINE TROUBLESHOOTING

MF SYSTEM MALFUNCTIONS

TABLE 3: MF FEED PUMP P-3 TROUBLESHOOTING

TABLE 4: AUTOMATIC VALVES, AIR SOLENOID VALVES TROUBLESHOOTING

TABLE 5: GENERAL MF SYSTEM TROUBLESHOOTING

TABLE 6: FEED FLOW CONTROL PANEL TROUBLESHOOTING

RO SYSTEM MALFUNCTIONS

TABLE 7: GENERAL RO SYSTEM TROUBLESHOOTING

TABLE 8: HIGH PRESSURE PUMP, TURBOCHARGER TROUBLESHOOTING

AIR SYSTEM MALFUNCTIONS

TABLE 9: GENERAL AIR SYSTEM TROUBLESHOOTING

TABLE 10: AIR COMPRESSOR TROUBLESHOOTING

CHEMICAL SYSTEM MALFUNCTIONS

TABLE 11: CHEMICAL SYSTEM TROUBLESHOOTING

PRODUCT WATER SYSTEM MALFUNCTIONS

TABLE 12: PRODUCT WATER SYSTEM TROUBLESHOOTING

COLD WEATHER SYSTEM MALFUNCTIONS

TABLE 13: COLD WEATHER SYSTEM TROUBLESHOOTING

For all electrical and control malfunctions, except as specifically addressed in the work package, notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

THIS SECTION COVERS:
Raw Water System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Operator

RAW WATER SYSTEM MALFUNCTIONS

Table 1. Raw Water System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Raw Water Pump P1 or P2 (if deployed as the only raw water pump) is rotating but is not pumping water.	Startup:	
		Missing suction hose coupling gasket.	Check all couplings that are out of water for coupling gasket. Install gasket in any couplings that are missing a gasket.
		Loss of prime.	Open vent valve until primed again. Add water if needed.
		During operation:	
		Water intake out of water and sucking air.	Reset intake under water.
		Clogged floating inlet strainer.	Pull in, clean, redeploy.
		Pump (suction lift) is more than 23 feet above the raw water.	Reconfigure pump closer to water source.
		Check valve not closing tightly.	Stop engine. Remove suction hose and Adaptor A-01 from pump. Inspect check valve V-101 valve seat. Remove any material preventing tight closure.
		Leaking shaft seal assembly.	With pump stopped and primed, look for leakage at the back of the pump. Notify Unit Maintenance to replace pump seal assembly if leak found.
		Worn pump impeller or wear plate.	If only one pump is in use, substitute the other pump. If both pumps are in use, interchange P-7 for P-2 (WP 0016) or P-8 for P-1 (A-TWPS only) to allow continued operation. Notify Unit Maintenance to adjust clearance between the impeller and the wear plate or replace if worn.
2	Raw Water Pump P1 or P2 runs noisy or rough.	Noise is at the pump: shaft clamp is loose, impeller is rubbing on wear plate.	Notify Unit Maintenance to check clearance between impeller and wear plate and adjust as needed.
		P-2 only: Noise is at the motor: worn bearings.	Notify Unit Maintenance to replace the motor.

Table 1. Raw Water System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3	Raw Water Pump P2 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB106 manually set to OFF position (black handle down).	Set CB to On position (black handle up) (WP 0011).
		CB106 ground fault breaker has tripped. **WARNING** Electrical Safety. The TWPS unit must be shut down and the Main Circuit Breaker set to OFF prior to disconnecting the power cable. Failure to observe this warning may result in serious injury or death.	Open the PDP. Locate the raw water pump P-2 CB106 ground fault breaker (WP 0011). If the blue lever is down, push it up to reset. If the breaker trips again, isolate the fault as follows: 1) Set the Main Circuit Breaker to OFF. Remove the power cable at the PDP. Check and clean the PDP connector pins. Install the connector cap. Set the Main Circuit Breaker to ON. Push the Start button. If the breaker trips, notify Unit Maintenance to replace the circuit breaker. 2) Set the Main Circuit Breaker to OFF. Disconnect the power cable at the pump. Reconnect the cable at the PDP. Cap the cable connector and lay the cable end over the pump frame. Set the Main Circuit Breaker to ON. Push the start button. If the breaker trips, , the power cable or one of the connectors is damaged. Notify unit maintenance. Operation may be continued using another power cable if available. 3) Notify unit maintenance for further troubleshooting if the fault is not found.
		Damaged or corroded power cable connections.	Notify Unit Maintenance.
		Damaged pump power cable.	Notify Unit Maintenance.
		Corroded pump skid junction box connectors, loose wire inside junction box.	Notify Unit Maintenance.
		Failure of M501 motor contactor – main contacts corroded.	Notify Unit Maintenance.
		Motor windings have failed.	Notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0033 00**
TROUBLESHOOTING PROCEDURES
OPERATOR/CREW TROUBLESHOOTING PROCEDURES

Table 1. Raw Water System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4	Raw Water Pump P2 will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on.	Failure of Raw Water Pump #2 Start button or PLC Slot #1 Input card. Failure of PLC Slot #4 Output card or failure of the motor contactor – actuating coil failure. Failure of PLC Slot #2 Input card or M501 motor contactor auxiliary relay.	Notify Unit Maintenance. Notify Unit Maintenance. Notify Unit Maintenance.
5	Raw Water Pump P-2 was running, but stops and the RED stop button light is ON.	CB106 motor circuit breaker is tripped. Contactor M501 Thermal Overload has tripped.	Open PDP and check CB106 circuit breaker (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to troubleshoot for short circuits. Shut down to standby. Open the PDP and locate contactor M501 (WP 011). Push in the Blue overload reset button. Close the PDP and start the pump. If noise is heard, refer to #2 above. If the failure repeats, check for binding of the motor or pump. If shaft cannot be turned freely by hand remove the hoses and adaptors. Check for and remove any debis in the pump. If debris is not found, notify Unit Maintenance.
6	Raw Water Pump P1 or P2 leaks water along the shaft.	Worn shaft seal assembly.	Notify Unit Maintenance to replace pump seal assembly.
7	Raw Water Pump P1 or P2 leaks water at the inlet or outlet flange.	Deteriorated inlet flapper assembly or outlet flange gasket.	Notify Unit Maintenance to replace inlet flapper assembly or outlet flange gasket .
8	Cyclone separator has no flow through the drain or raw water flow through the cyclone is restricted.	Cyclone is overloaded with too much sand. Cyclone is plugged with sand. Cyclone has an internal failure.	Operate cyclone with valve V-104 fully open. Close Raw Water Flow Valve V-107 and fully open the Cyclone Blowdown Flow Valve V-104 to blow sand out of the cyclone. If this fails to clear the cylcone, remove cyclone drain adaptor A-03. If this doesn't work, poke into the cyclone drain using a piece of wire to clear sand out of the cyclone. If the cyclone is still plugged, pump clean water, such as product water from the distribution tanks, into the cyclone discharge and out the cyclone inlet to the ground. Remove the cyclone from service. Continue operation. Replace the cyclone.
9	Insufficient raw water flow to maintain MF feed tank level even with flow control valve fully open.	Partially clogged floating inlet strainer. P1/P2 pump is not running.	Clean the floating inlet strainer. See corrective action for P1/P2 pump malfunction .

Table 1. Raw Water System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
9 cont	Insufficient raw water flow to maintain MF feed tank level even with flow control valve fully open (continued).	Clogged cyclone separator.	See corrective action for cyclone separator malfunction.
		Air leakage at Adaptor A01	Check gaskets and replace as needed. Be sure the support strap takes the hose weight and keeps the adaptor horizontal.
		Suction lift is too high.	Reconfigure pump closer to water.
		Elevation from pumps is greater than allowed.	Establish new site in accordance with WP 0004.
		Debris caught in pump suction, pump impeller, or Adaptor A-05 check valve V-107.	Remove hoses and adpators. Check for debris. Remove as needed.
		Worn pump impeller or wear plate.	Notify Unit Maintenance to adjust clearance between the impeller and the wear plate or replace as required.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

THIS SECTION COVERS:
Diesel Engine

INITIAL SETUP:
TWPS Operating
Maintenance Level
Operator

DIESEL ENGINE MALFUNCTIONS

Table 2. Diesel Engine Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Diesel engine will not turn over using recoil starter.	Recoil starter broken.	Continue operation using the electric starter. Notify Unit Maintenance to replace recoil starter.
		Engine has seized.	Notify Unit Maintenance to replace the diesel engine.
2	Diesel engine will not turn over using electric starter.	Power cable not connected at the diesel engine or at the power source.	Check that the power cable is firmly connected at the diesel engine and at the power source.
		Power source not energized.	Check that power source is energized.
		Loose electrical connections to the starter magnetic switch.	Tighten electrical connections.
		Corroded electrical connections to the starter magnetic switch.	Clean electrical connections.
		Malfunction of starter switch.	Notify Unit Maintenance to replace electric starter assembly.
		Engine has seized.	Notify Unit Maintenance to replace diesel engine.
3	Diesel engine is hard to turn over using recoil starter.	Decompression lever not pushed down.	Push the decompression lever down.
		Lubricating oil has deteriorated.	Notify Unit Maintenance to change the oil.
		Engine beginning to seize.	Notify Unit Maintenance to replace the diesel engine.
4	Diesel engine turns over but will not start.	New engine or first start after storage.	May take up to 15 pulls to vent fuel lines. Notify Unit Maintenance to bleed fuel system if required.
		Fuel cock is closed.	Open fuel cock.
		Fuel tank empty.	Add fuel and re-start.
		Throttle was not set to START.	Move the throttle to the START position.

Table 2. Diesel Engine Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4 cont	Diesel engine turns over but will not start (continued).	Fuel lines incorrectly connected.	Check for proper connection (WP 0007).
		Air cleaner filter element is dirty.	Check/replace air cleaner filter element (WP 0039).
		Fuel filter is clogged.	Notify Unit Maintenance to clean or replace fuel filter.
		Fuel injection valve is clogged.	Notify Unit Maintenance to clean or replace the fuel injection valve.
		Fuel injection pump has failed.	Notify Unit Maintenance to replace fuel injection pump.
5	Diesel engine turns over easily, but does not start or starts with difficulty.	Fuel injection valve loose.	Tighten nuts to the fuel injection valve retaining plate.
		Incorrect valve head clearance.	Notify Unit Maintenance to check/adjust intake/exhaust valve clearance.
6	Diesel engine stops during operation.		**WARNING** **Never add fuel when the engine is running. Failure to observe this warning may result in fuel igniting causing severe burns.**
		Fuel tank empty.	Add fuel and bleed air from the fuel injection pump.
		Water in fuel.	Drain fuel tank. Refill with new fuel.
		Lube oil level low and engine seized.	Allow engine to cool. Add lube oil, then try to start the engine. If the engine remains seized, notify Unit Maintenance to replace the engine.
		Air cleaner filter element is dirty.	Clean or replace the air cleaner filter element (WP 0039).
		Fuel filter is clogged.	Notify Unit Maintenance to clean or replace the fuel filter.
		Fuel injection valve is clogged.	Notify Unit Maintenance to clean or replace the fuel injection valve.
		Fuel injection pump has failed.	Notify Unit Maintenance to replace fuel injection pump.

Table 2. Diesel Engine Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
7	Diesel engine exhaust continuously emits black smoke after warming up or engine output drops.	Poor fuel quality.	Drain fuel tank. Refill with new fuel.
		Clogged air cleaner filter element.	Clean or replace air cleaner filter element (WP 0039).
		Clogged fuel injection valve.	Notify Unit Maintenance to clean or replace the fuel injection valve.
8	Diesel engine exhaust continuously emits bluish white smoke after warming up or engine output drops.	Poor fuel quality.	Drain fuel tank. Refill with new fuel.
		Too much lube oil.	Notify Unit Maintenance to drain oil to proper level.
		Oil viscosity is too low (oil is too thin).	Notify Unit Maintenance to change the lubricating oil.
		Carbon deposits on intake/exhaust valves.	Notify Unit Maintenance.
		Defective valve stem seal.	Notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

THIS SECTION COVERS:
MF System

INITIAL SETUP:
TWPS Operating
Maintenance Level
Operator

MF SYSTEM MALFUNCTIONS

Table 3. MF Feed Pump P-3 Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	MF Feed Pump P-3 does not come on for Fill/Hold, but valve V-111 cycles OPEN and green Run light comes on. Red stop light is NOT on.	At first start up, circuit breaker CB111 manually set to OFF position (black handle down).	Set CB to On position (black handle up) (WP 0011).
		CB111 ground fault breaker has tripped. **WARNING** **Electrical Safety. The TWPS unit must be shut down and the Main Circuit Breaker set to OFF prior to disconnecting the power cable. Failure to observe this warning may result in serious injury or death.**	Open the PDP. Locate the MF Feed pump P-3 CB111 ground fault breaker (WP 0011). If the blue lever is down, push it up to reset. If the breaker trips again, isolate the fault as follows: 1) Set the Main Circuit Breaker to OFF. Remove the power cable at the PDP. Check and clean the PDP connector pins. Install the connector cap. Set the Main Circuit Breaker to ON. Push the Start button. If the breaker trips, notify Unit Maintenance to replace the circuit breaker. 2) Set the Main Circuit Breaker to OFF. Disconnect the power cable at the pump. Reconnect the cable at the PDP. Cap the cable connector and lay the cable end over the pump frame. Set the Main Circuit Breaker to ON. Push the start button. If the breaker trips, the power cable or one of the connectors is damaged. Notify unit maintenance. Operation may be continued using another power cable if available. 3) Notify unit maintenance for further troubleshooting if the fault is not found.
		Damaged or corroded power cable connections.	Notify Unit Maintenance.

Table 3. MF Feed Pump P-3 Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1 Cont	MF Feed Pump P-3 does not come on for Fill/Hold, but valve V111 cycles OPEN and green Run light comes on. Red stop light is NOT on (continued).	Damaged pump power cable.	Notify Unit Maintenance.
		Corroded junction box connectors, loose wire inside junction box.	Notify Unit Maintenance.
		Failure of M502 motor contactor – main contacts corroded.	Notify Unit Maintenance.
		Motor windings have failed.	Notify Unit Maintenance.
2	MF Feed Pump P-3 does not come on for Fill/Hold, valve V111 cycles OPEN, but green MF Feed Pump Run light does not come on.	Failure of PLC #4 Slot Output card or failure of the motor contactor – actuating coil failure.	Notify Unit Maintenance.
		Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	Notify Unit Maintenance.
3	MF Feed Pump P-3 does not come on for Fill/Hold, valve V-111 remains CLOSED, and green Run light does not come on.	Failure of System Mode Switch or PLC Slot #3 Input card.	Notify Unit Maintenance.
4	MF Feed Pump P-3 will not start in RUN. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on.	Failure of MF Feed Pump Start button or PLC Slot #1 Input card.	Notify Unit Maintenance.
		Failure of PLC Slot #4 Output card or failure of the motor contactor – actuating coil failure.	Notify Unit Maintenance.
		Failure of PLC Slot #2 Input card or M502 motor contactor auxiliary relay.	Notify Unit Maintenance.
5	MF Feed Pump P-3 comes on for Fill/Hold but there is no MF Feed Flow reading on the OCP Feed Flow indicator and flow is not observed flowing from the waste hose.	Automatic valves have not cycled properly.	Complete the BIT self test (WP 0013) to identify which valve is not functioning properly. Notify Unit Maintenance.
		If pump was drained, the pump may be air bound.	With the MF Feed Tank at least 50% full, loosen the MF Feed Discharge Hose (F07) coupling at the TWPS inlet connection until water flows freely. Reconnect and repeat the start up procedures.
6	MF Feed Pump P-3 was running, but stops and the RED stop button light is ON.	CB111 motor circuit breaker is tripped.	Open PDP and check CB111 circuit breaker (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to troubleshoot for short circuits.
		Contactor M502 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactor M01 (WP 0011). Push in the Blue overload reset button. Close the PDP and start the pump. If noise is heard, refer to #2 above.

Table 3. MF Feed Pump P-3 Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6 cont.	MF Feed Pump P-3 was running, but stops and the RED stop button light is ON (continued).	Contactor M502 Thermal Overload has tripped (continued).	If the failure repeats, check for binding of the motor or pump. If shaft cannot be turned freely by hand remove the hoses and adaptors. Check for and remove any debis in the pump. If debris is not found, notify Unit Maintenance.
7	MF Feed Pump P-3 leaks water along the shaft.	Worn or damaged shaft seal.	Notify Unit Maintenance to replace shaft seal.
8	MF Feed Pump P-3 runs noisy or rough.	Missing or damaged gasket on MF pump suction. Strainer S-1 sucked into MF feed pump suction hose when tank level dropped too low. Worn motor bearings.	Replace gasket with one from BII (Table 2, item 53, WP 0076 or Table 2, item 49, WP 0077) Reorient the S-1 strainer and the raw water supply hose so that the strainer is not pushed towards the tank outlet during operation. Notify Unit Maintenance to replace motor.
9	MF Fill and Hold Flow is less than 210 gpm at first startup after fully draining.	MF Feed Pump is air locked	With the MF Feed Tank partially full, remove the pump discharge hose and allow the water to flow for a short time.

Table 4. Automatic Valves, Air Solenoid Valves Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Backwash Fail Alarm comes on during backwash.	Automatic valve failed to operate.	Shut down to standby. Conduct BIT self test procedure (WP 0013). Notify Unit Maintenance to troubleshoot any valve which fails to cycle.
		Backwash air supply solenoid valve XV-901 solenoid coil failure.	Continue with BIT and verify operation of solenoid valve XV-901. If it does not operate, remove the spare coil from the BII and replace (WP 0045). If this does not correct the failure, notify Unit Maintenance.
		Backwash or drain air supply solenoid valve failure.	Notify Unit Maintenance.
		Pressure transmitter PT-102 failure.	Notify Unit Maintenance.
		PLC output card #5 relay failure.	Notify Unit Maintenance.
		If Feed Flow Control is set to Manual, XV-912 failure.	Notify Unit Maintenance. Continue operation in Automatic.
2	Automatic valve (except V-202) fails to cycle when tested during BIT self test.	Valve actuator.	Notify Unit Maintenance.
		PLC output card #5 relay failure.	Notify Unit Maintenance.
		Solenoid coil or solenoid valve failure.	Notify Unit Maintenance.
3	Automatic valve does not cycle fully to the de-energized or BIT energized position.	Damaged valve liner or failed shaft bearing.	Notify Unit Maintenance.
4	Filtrate Flow Control valve V202 fails to operate during BIT test. Or	Control loop failure.	Set the flow control to Manual. Startup. If the flow can be controlled manually, continue operation using the manual flow control. Notify Unit Maintenance.
	RO Feed Tank fills rapidly and overflows. The RO Feed Tank % Level indicator properly reads the increasing level and shows a level of approximately 110% at overflow.	Valve actuator or positioner failure.	If the manual flow control does not work, shutdown and Notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

Table 5. General MF System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Backwash does not initiate.	Failure to push Backwash Start during startup procedures.	Follow procedures (WP 0014).
		Failure of MF Backwash Start button or PLC Slot #2 Input card.	Notify Unit Maintenance.
2	RO Feed Tank % Level reads 0 with level in the tank, reads a level other than actual by observation, or the reading changes up and down rapidly.	Level measurement loop failure.	Continue operation with manual flow control. Notify Unit Maintenance.
3	MF Backwash Flow Low alarm comes on during backwash (less than 190 gpm). Clean Strainer alarm comes on during backwash (less than 210 gpm, but more than 190 gpm)	Dirty MF Feed Strainer S-2.	Check and clean the strainer (WP 0040).
		MF Main Feed Valve V-111, Shell Lower Feed Valve V-113 or Shell Backwash Upper Outlet Valve V-401 fails to fully open.	Conduct BIT (WP 0013). Be sure that these valves cycle fully open. If not, notify Unit maintenance.
		Debris in the MF feed pump.	Remove the pump from the system and check for debris clogging the inlet or stuck in the impeller.
		Flow measurement loop failure.	Resume operation. Note the backwash flow. If it is less than 175 gpm, the flow measurement loop may have failed. Continue operation. Notify Unit Maintenance.
		Worn MF feed pump impeller or wear ring.	If the backwash flow is less than 210 gpm, but not less than 190 gpm, the MF feed pump may be worn. Continue operation. Notify Unit Maintenance.
4	MF TMP High Alarm.	Pressure Transmitter PT-102 failure.	Compare TMP with Operating Data Log entries. If it is much higher than previous entries, PT-101 or 102 may have failed. Compare the difference between pressure gauges PI-101 and PI-102 with the TMP display. If the pressure gauges show a lower TMP, this also confirms PT-101 or 102 failure. Continue operation. Notify Unit Maintenance.
		MF TMP Zero out of adjustment.	Check TMP for zero at next PMCS shutdown.
		MF fouled and ready for routine cleaning.	Schedule routine cleaning within 40 hours.

Table 5. General MF System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5	MF Feed Flow display shows zeros when MF feed pump is on and observed to be pumping.	MF Feed Flow Measurement loop failure.	Open the Instrument/Solenoid Panel door and check Flow Transmitter FT-101 (WP 0043). 1) If the display is blank, shutdown, set the Main breaker to OFF and then back to ON. If this does not correct the problem, re-program the transmitter (WP 0043). If this still does not correct the problem, notify Unit Maintenance. 2) If the error message “E-PROM FAILURE (LOAD DEFAULTS?)” is displayed, re-program the transmitter (WP 0043). 3) Continue operation. Notify Unit Maintenance.

Table 6. Feed Flow Control Panel Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	V-202 does not respond in manual mode, but functions properly in automatic mode.	Pressure regulating valve PRV-903 defective.	Notify Unit Maintenance.
2	Pressure gauge PI-904 reading does not increase or decrease as PRV-904 is adjusted, but V-202 moves as expected.	Feed flow control panel gauge PI-904 defective.	Notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

THIS SECTION COVERS:
RO System

INITIAL SETUP:
TWPS Operating
Maintenance Level
Operator

RO SYSTEM MALFUNCTIONS

Table 7. General RO System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	RO Feed Pump P-4 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB116 manually set to OFF position (black handle down).	Set CB to On position (black handle up) (WP 0011).
		Failure of the motor contactor – main contacts corroded.	Notify Unit Maintenance.
		Electrical wiring or motor failure.	Notify Unit Maintenance.
2	RO Feed Pump P-4 will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on.	Failure of RO Feed Pump Start button or PLC Slot #1 Input card.	Notify Unit Maintenance.
		Failure of PLC Slot #4 Output card or failure of the M503 motor contactor – actuating coil failure.	Notify Unit Maintenance.
		Failure of PLC Slot #2 Input card or M503 motor contactor auxiliary relay.	Notify Unit Maintenance.
3	RO Feed Pump P-4 was running, but stops and the RED stop button light is ON.	CB116 circuit breaker has tripped.	Open PDP and check CB116 circuit breaker (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to check for shorts.
		Contactor M503 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactor M503. Push in the Blue overload reset button (WP 0011). Close the PDP and start the pump. If the failure repeats, notify Unit Maintenance.
4	RO Feed Pump P-4 leaks between pump and motor.	Worn or damaged shaft seal.	Notify Unit Maintenance to replace the seal.

Table 7. General RO System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5	RO Feed Tank Low Level Alarm and HP pump stops.		Reset the PLC as follows: - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON)
		1) MF Feed Tank almost empty.	(1) Check level in MF Feed Tank. It should never be less than one-third full. If it is, troubleshoot raw water system as described in Table 1.
		2) Level measurement loop failure	(2) Open the RO Feed Tank cover. If the actual level is not almost empty, the level measure loop has failed. Notify Unit Maintenance.
		3) MF Filtrate Flow control failure.	(3) Restart. After the first backwash, the level should be back between 95% and 105% when the next backwash begins. If the level is not reached and the alarm repeats, switch to manual flow control and continue operation. Notify Unit Maintenance. If the flow cannot be controlled in manual, shutdown until the problem is corrected.
6	RO Feed Pressure Low alarm (during normal operation) and HP Pumps stop automatically (or will not start). RO Feed Pump remains on.		Reset the PLC as follows: - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Follow normal startup procedures. - Watch HP Pump Feed Pressure gage PI-202. If the system was in backwash and the RO tank level is low, see response for RO feed tank low level alarm, item 5.
		Pressure gage PI-202 does not drop below 35 psig and alarm repeats.	
		1) Pressure transmitter PT-201 failure	1) Replace PT-201 with the spare located in the BII (WP 0041). Continue operation.
		2) After replacing PT-201 continue operation. If the alarm repeats, the failure is in the measurement loop electrical system.	(2) Notify Unit Maintenance.

Table 7. General RO System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6 cont.	RO Feed Pressure Low alarm (during normal operation) and HP Pumps stop automatically (or will not start). RO Feed Pump remains on (continued).	**Pressure gage PI-202 drops below 35 psig.**	
		1) In-line Strainer S-4 plugged.	1) Remove and inspect In-line strainer S-4. Clean if dirty
		2) RO Feed Tank Strainer S-3 plugged.	2) Remove / inspect RO Feed Tank Strainer S-3. Clean if dirty (WP 0041)
		3) RO feed pump impeller and/or wear ring are worn or corroded.	3) Notify Unit Maintenance.
7	Cleaning solution does not heat up with heater switch set to AUTO 2. Or	CB201 or CB204 Circuit Breaker Tripped.	Open PDP and check circuit breakers CB201 and CB204 (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to check for shorts.
	The solution does not heat up at least 30 degrees in 30 minutes with the heater switch in AUTO 2.	Tank Heater Switch or PLC slot 1 Input card failure.	Notify Unit Maintenance.
		Failure of PLC Slot #4 Output card or failure of the heater contactor – actuating coil failure.	Notify Unit Maintenance.
		Broken heating element(s).	Notify Unit Maintenance.
8	Heaters do not turn off when RO feed tank temperature rises above 110 degrees F.	Temperature transmitter TT-201 or electrical wiring failure.	Continue operation by manually setting heater switch to OFF. Notify Unit Maintenance.
		Temperature transmitter TT-201 or Slot 12 input card failure.	Notify Unit Maintenance.
9	Reject or Product Flow display shows zeros when flow is observed.	Reject or Product Flow Measurement loop failure.	Open the Instrument/Solenoid Panel door and check the appropriate Flow Transmitter (WP 0043). 1) If the display is blank, shutdown, set the Main breaker to OFF and then back to ON. If this does not correct the problem, Re-program the transmitter (WP 0043). If this still does not correct the problem, notify Unit Maintenance. 2) If the error message “E-PROM ERROR (LOAD DEFAULTS?)” is displayed, re-program the transmitter (WP 0043). 3) Continue operation. Estimate the product flow by subtracting the reject flow from 56. Notify Unit Maintenance.

Table 8. High Pressure Pump, Turbocharger Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	HP pumps do not start when start button is pushed. Green light does not come on. Red light does not come on. Feed Pressure Low alarm is not on.	Failure of High Pressure Pumps Start button or PLC Slot #1 Input card. Failure of PLC Slot #4 Output card or failure of the P-5 motor contactor M504 actuating coil failure. Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	Notify Unit Maintenance. Notify Unit Maintenance. Notify Unit Maintenance.
2	HP Pump P-5 starts and then stops. HP Pump P-6 does not start. Red stop push button light is not on.	Failure of PLC Slot #4 Output card or failure of motor contactor M505 actuating coil. Failure of PLC Slot #2 Input card or failure of motor contactor M505 auxiliary contacts.	Notify Unit Maintenance. Notify Unit Maintenance.
3	HP Pump #1 starts, HP pump #2 begins to start, both pumps stop and red stop push button light comes on. Or HP Pumps will not start, or stop after running. Red stop push button light is on.	HP Pump 5 or 6 circuit breaker has tripped. Contactor M504 or 505 Thermal Overload has tripped.	Open PDP and check CB122 and CB125 circuit breakers (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to check for shorts. Shut down to standby. Open the PDP and locate contactors M504 and 505 (WP 0011). Push in the Blue overload reset button. Close the PDP and start the pumps again. If the failure repeats, notify Unit Maintenance.
4	One HP Pump will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB122 or CB125 manually set to OFF position (black handle down). Failure of motor contactor M504 or M505 – main contacts corroded. Electrical wiring or motor failure.	Set CB to On position (black handle up) (WP 0011). Notify Unit Maintenance. Notify Unit Maintenance.
5	Operating RO Feed Flow less than 52 gpm but over 48 gpm.	Worn HP Pump valves. Worn HP Pump pistons and or seals.	- Fully open Main Pressure Control Valve HCV-401 and Auxiliary Pressure Control Valve HCV-401A - Press the High Pressure Pump STOP button. - Press the High Pressure Pump START button. - Fully close HCV-401A then slowly close HCV-401 to obtain the normal product flow rate - If RO Feed Flow is not corrected, repeat the previous steps. - Do not stop and start the High Pressure Pumps more than 4 times in one hour - If the RO Feed Flow is still not corrected, notify Unit Maintenance.

Table 8. High Pressure Pump, Turbocharger Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6	Operating RO Feed Flow less than 48 gpm.	Failed reject flow sensor FE-401 or transmitter FT-401. Failed product flow sensor FE-501 or transmitter FT-501.	Reconfigure the transmitter (WP 0043). If this does not correct the problem, notify Unit Maintenance.
7	RO Feed Pressure and product flow are low even with Main Pressure Control Valve HCV-401 and Auxiliary Pressure Control Valve HCV-401A closed.	Failed Turbocharger thrust bearing.	Check HP pump discharge pressure PI-301. If this pressure is higher than the RO Feed Pressure, the turbocharger bearing has failed. Notify Unit Maintenance.
8	HP Pumps run rough, increased pulsation.	Worn valves. Worn pistons and/or seals.	- Fully open Main Pressure Control Valve HCV-401 and Auxiliary Pressure Control Valve HCV-401A - Press the High Pressure Pump STOP button. - Press the High Pressure Pump START button. - Fully close HCV-401A then slowly close HCV-401 to obtain the normal product flow rate - If pulsation is still observed, repeat the previous steps. - Do not stop and start the High Pressure Pumps more than 4 times. - If pulsation is still observed, notify Unit Maintenance.
9	Leakage from HP pump body segment.	Worn O-rings.	Notify Unit Maintenance.
10	Leakage from the HP pump/motor adaptor drain tubing exceeds 200 ml/min (measure with antiscalant measuring cup)	Worn shaft seal.	Continue operation. Notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

THIS SECTION COVERS:
Air System

INITIAL SETUP:
TWPS Operating
Maintenance Level
Operator

AIR SYSTEM MALFUNCTIONS

Table 9. General Air System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	System pressure gauge PI-901 reading less than 975 psig and compressor continues to run without increasing the pressure to the shut-off pressure or compressor fails to reach shut-off pressure between backwashes.	High-pressure air (PI-901) set too high. Excessive air consumption.	If PI-901 reads over 110 psig, adjust PRV-901 to reduce pressure to about 100 psig (WP 0042).
		System Air leakage	Shut down to standby. Stop air compressor and listen for leaks. Note: Leakage at Filtrate Flow Control Valve V-202 Positioner and at IP Transducer FY-102 on the Feed Flow Control Panel is normal.
		Oil/Water Coalescer CO1 Automatic Drain Valve XV-911 leaking.	Continue operation using manual Coalescer C-O1 Drain Shutoff Valve V-902. Open and close at 15-minute intervals. Notify Unit Maintenance to replace XV-911 solenoid valve during next routine maintenance cycle.
		Compressor Intermediate Filter Automatic Drain Valve XV-910 leaking.	Continue operation using manual Compressor Intermediate Filter Drain Valve V-901. Open and close at 15-minute intervals. Notify Unit Maintenance to replace XV-910 solenoid valve during next routine maintenance cycle.
		HP Air Vent Valve V-904 (on Air Purification Filter AF-2) leaking.	Ensure HP Air Vent Valve V-904 is completely closed. Notify Unit Maintenance to replace HP Air Vent Valve V-904 if still leaking.
		Relief valve RV-901 (on Coalescer CO-1) leaking	Relief valve is factory set. Notify Unit Maintenance to replace relief valve if found to be leaking.
		Relief valve RV-902 (in Air System Section 1) leaking.	Manually vent RV-902 and release to see if it resets and seals. If this doesn't work, check PRV-901 adjustment (WP 0042). If this still doesn't correct the problem, notify Unit Maintenance to replace RV-902.
		LP Air Vent Valve V-910 (in Air System Section 6) leaking.	Ensure LP vent valve is completely closed. Notify Unit Maintenance to replace LP Air Vent Valve V-910 if closed and leaking.
		Leaking air tubing or connections	Check tubing for leaks at connections. Push tubes in to re-establish connection. If unable to repair leak, bleed the entire air system (WP 0042) then replace leaking tubing and fittings (WP 0045).

Table 9. General Air System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1 cont		Leaking air piping or hoses	Bleed the entire air system (WP 0042) then remove the leaking fitting, replace the thread tape and re-install. Replace leaking hose (WP 0045).
		Leaking tubing or connections inside the Instrument Panel.	Open the instrument panel outer and inner doors. Check for leaks. Repair as needed.
		Leaking solenoid valve XV-901 (in Air System Section 3), XV-902 (in Air System Section 4), or XV-903 (in Air System Section 3).	Stop the air compressor. Feel each of the three solenoid valves. If vibrating, it may be leaking. Notify Unit Maintenance.
		Air compressor safety valve on the second stage head is relieving.	Feel for air flow from the safety valve on top of the second stage head with the compressor on. If flow is noted, Notify Unit Maintenance to replace all three compressor valve assemblies.
		Leaking air compressor valves.	Notify Unit Maintenance.
2	Air system pressure regulation pressure gauge PI-902 is reading less than 90 psig. Pressure gauge PI-901 readings are normal.	Defective pressure gauge PI-902.	Open V-910 to bleed system air pressure. If the gauge reading does not move, or does not return to zero, Notify Unit Maintenance to replace the gauge .
		Pressure Regulating Valve PRV-901 (in Air System Section 1) out of adjustment or malfunctioning.	Adjust the pressure regulating valve to provide a100 psig reading at PI-902 (WP 0042). Notify Unit Maintenance to replace PRV-901 if unable to correct.
3	Pressure gauge PI-903 pressure reading is not 15 psig.	Defective pressure gauge PI-903.	Open V-910 to bleed system air pressure. If the gauge reading does not move, or does not return to zero, Notify Unit Maintenance to replace the gauge.
		Pressure regulating valve PRV-902 out of adjustment.	Adjust pressure-regulating valve PRV-902 to provide a 15 psig reading at PI-903 (WP 0042). Notify Unit Maintenance to replace PRV-902 If unable to correct.
4	Compressor stops below 950 psig. Compressor switch light is OFF.	Defective pressure gauge PI-901.	Open V-910 to bleed system air pressure. If the gauge reading does not move, or does not return to zero, Notify Unit Maintenance to replace the gauge.
		Pressure Switch PSL/PSH-901 high-pressure shut-off setting out of adjustment.	Adjust Pressure Switch PSL/PSH-901 high-pressure shut-off setting (WP 0042).
5	At startup, air pressure increases quickly and compressor cycles on/off.	Air Receiver Tank Outlet Valve V-907 closed.	Open Air Receiver Tank Outlet Valve V-907.
6	At first start-up or start-up after replacing Air Purification Filter AF-2, severe air leak noise is heard at the bottom of the filter.	Filter not installed or not pushed down to seat the O-ring.	Stop the air compressor. Open High Pressure Air Vent Valve V-904 to release the pressure. Remove the AF-2 filter cover. Install filter if missing (WP 0042). Make sure the filter is pushed down and you feel a definite engagement of the O-ring.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0033 00**
TROUBLESHOOTING PROCEDURES
OPERATOR/CREW TROUBLESHOOTING PROCEDURES

Table 10. Air Compressor Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Compressor does not start with switch in Auto and no pressure. Switch light is ON. Or Compressor was running and stopped at a pressure well below 975 psig. Switch light is ON.	CB133 circuit breaker tripped.	Open PDP and check CB133 circuit breaker (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to check for shorts.
		Thermal overload on contactor M510 tripped.	Push in blue button on contactor M510 (WP 0011). If it trips repeatedly, notify Unit Maintenance.
		Compressor high temperature switch has tripped.	Allow compressor to cool. Be sure that the airflow is not obstructed. Check the oil level. After cooling, toggle RESET and start compressor. 1) Check the oil sight glass for air. Bleed the lubrication system as needed (WP0042). 2) If this occurs after motor replacement, check rotation. Notify Unit Maintenance if not correct.
		Compressor high temperature switch has failed.	If the Reset does not clear the light after the compressor has cooled to the touch, the temperature switch has failed. Notify Unit Maintenance.
		Oil pump or oil pressure regulator has failed.	If the Reset does clear the light after cooling, Notify Unit Maintenance to check the lubricating oil pressure and replace the pressure regulator and oil pump if necessary.
2	Compressor does not start with switch in Auto and no pressure. Switch light is OFF. Or Compressor was running and stopped at a pressure well below 975 psig. Switch light is OFF.	Failure of Pressure Switch PSL/PSH-901 low pressure turn-on switch or PLC Slot #2 Input card.	Notify Unit Maintenance.
		Failure of PLC Slot #4 Output card or failure of motor contactor M510 actuating coil.	Notify Unit Maintenance.
		Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	Notify Unit Maintenance.
		At first start up, circuit breaker CB133 manually set to OFF position (black handle down).	Set CB to On position (black handle up) (WP 0011).
		Motor contactor M510 failure – corroded main contacts.	Notify Unit Maintenance.
		Electrical wiring or motor failure.	Notify Unit Maintenance.
3	Safety valves between individual stages releasing pressure.	Stage head valves not closing properly.	Notify Unit Maintenance.
4	No flow observed in pressurized oil sight glass after oil change.	Air trapped in oil pump.	Bleed lubrication system (WP 0042).

Table 10. Air Compressor Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5	Pressurized oil sight glass exhibits air bubbles after oil change.	Air trapped in pressurized oil system.	Bleed lubrication system (WP 0042).
6	Oil is foamy and milk colored.	Water in the oil from worn cylinder rings.	Notify Unit Maintenance to change the oil. Continue operation. Notify Unit Maintenance to replace compressor when time allows.
7	High oil consumption.	Cylinder rings worn.	Continue operation. Notify Unit Maintenance to replace compressor when time allows.
8	Air compressor has no oil pressure.	Air trapped in oil pump.	Bleed lubrication system (WP 0042).
9	Drive belt has rolled over	Loose or worn belt or loose motor mount	Notify Unit Maintenance

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0033 00
TROUBLESHOOTING PROCEDURES
OPERATOR/CREW TROUBLESHOOTING PROCEDURES

THIS SECTION COVERS:

Chemical System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Operator

CHEMICAL SYSTEM MALFUNCTIONS

Table 11. Chemical System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Chemical pump runs but will not prime.	Output dials not set properly.	Always prime pump with speed at 80% and stroke at 80%.
		Four-function valve not set properly.	Black priming knob must be turned 1/4 – turn to pull it outward.
		Foot valve not in semi-vertical position on the bottom of the chemical tank.	Foot valve must be in vertical or semi-vertical position.
		Suction or discharge fittings are over-tightened into pump head.	Loosen fittings slightly. If still not working, replace notify Unit Maintenance to replace the suction or discharge valve assemblies.
		Suction cartridge valve leaking or pump diaphragm ruptured.	If spare pump is available, interchange with inoperable pump (WP 0016). Notify Unit Maintenance to replace the suction valve assembly or the pump diaphragm.
2	Chemical pump loses prime.	Chemical bucket level has dropped below the suction screen.	Refill container with solution and re-prime (WP 0014).
		Foot valve not in semi-vertical position on the bottom of the chemical tank.	Foot valve must be in vertical or semi-vertical position.
		Suction or discharge fittings are over-tightened into pump head.	Loosen fittings slightly. If still not working, replace notify Unit Maintenance to replace the suction or discharge valve assemblies.
		Suction cartridge valve leaking or pump diaphragm ruptured.	If spare pump is available, interchange with inoperable pump (WP 0016). Notify Unit Maintenance to replace the suction valve assembly or the pump diaphragm.
3	Leakage at tubing.	Worn tubing ends.	Cut about one inch off tubing and reconnect.
		Loose or cracked coupling nut.	Notify Unity Maintenance to replace suction, discharge, or four-function valve assembly.
		Worn valve O-ring.	Notify Unit Maintenance to replace suction, discharge, or four-function valve assembly.

Table 11. Chemical System Troubleshooting. – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4	Low output or failure to pump against pressure.	Incorrect stroke length.	Check zero on pump/re-zero pump.
		Clogged foot valve screen.	Remove foot valve screen and clean.
		Pump suction tube plugged or loose.	Check suction tube. If plugged, replace. If loose, tighten.
		Discharge tube or injection check valve assembly plugged.	Check and clean as needed. Notify Unit Maintenance to replace tube or clean or replace the injection check valve assembly.
		Plugged or defective four-function valve.	Notify Unit Maintenance to check the four function valve and replace if necessary.
		Worn chemical pump suction or discharge O-rings or cartridge valves or Ruptured pump diaphragm.	Notify Unit Maintenance to replace suction or discharge valve assemblies. Notify Unit Maintenance to replace pump diaphragm.
5	Bisulfite Pump CP-1 will not run with the selector switch set to either ON or AUTO.	Speed switch is in OFF position.	Set speed switch to 70%.
		Electrical failure.	Notify Unit Maintenance.
6	Antiscalant Pump CP-2 or Hypochlorite Pump CP-3 will not run with the selector switch to either ON or AUTO.	Speed switch is in OFF position.	Set speed switch to 70%.
		Electrical failure.	Notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

THIS SECTION COVERS:

Product Water System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Operator

PRODUCT WATER SYSTEM MALFUNCTIONS

Table 12. Product Water System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Pump is rotating but is not pumping water.	Pump is air bound.	Remove the distribution hose at the Adaptor A-08 valve and open the valve to release the air.
		Worn pump impeller or wear plate.	Notify Unit Maintenance to adjust clearance between the impeller and the wear plate or replace if worn.
2	Pump P-7 runs noisy or rough.	Noise is at the pump: shaft clamp is loose, impeller is rubbing on wear plate.	Notify Unit Maintenance to check clearance between impeller and wear plate and adjust as needed.
		Noise is at the motor: worn bearings.	Notify Unit Maintenance to replace the motor.
3	Distribution Pump P-7 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB128 manually set to OFF position (black handle down).	Set CB to On position (black handle up) (WP 0011).
		CB128 ground fault breaker has tripped. **WARNING** **Electrical Safety. The TWPS unit must be shut down and the Main Circuit Breaker set to OFF prior to disconnecting the power cable. Failure to observe this warning may result in serious injury or death.**	Open the PDP. Locate the distribution pump P-7 CB128 ground fault breaker (WP 0011). If the blue lever is down, push it up to reset. If the breaker trips again, isolate the fault as follows: 1) Set the Main Circuit Breaker to OFF. Remove the power cable at the PDP. Check and clean the PDP connector pins. Install the connector cap. Set the Main Circuit Breaker to ON. Push the Start button. If the breaker trips, notify Unit Maintenance to replace the circuit breaker.

Table 12. Product Water System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3 cont	Distribution Pump P7 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on (continued).	CB128 ground fault breaker has tripped (continued).	2) Set the Main Circuit Breaker to OFF. Disconnect the power cable at the pump. Reconnect the cable at the PDP. Cap the cable connector and lay the cable end over the pump frame. Set the Main Circuit Breaker to ON. Push the start button. If the breaker trips, the power cable or one of the connectors is damaged. Notify unit maintenance. Operation may be continued using another power cable if available. 3) Notify unit maintenance for further troubleshooting if the fault is not found.
		Damaged or corroded power cable connections.	Notify Unit Maintenance
		Damaged pump power cable.	Notify Unit Maintenance.
		Corroded pump skid junction box connectors, loose wire inside junction box.	Notify Unit Maintenance.
		Failure of M506 motor contactor – main contacts corroded.	Notify Unit Maintenance.
		Motor windings have failed.	Notify Unit Maintenance.
4	Distribution Pump P-7 will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on.	Failure of Distribution Pump Start button or PLC Slot #1 Input card.	Notify Unit Maintenance.
		Failure of PLC Slot #4 Output card or failure of motor contactor M508 actuating coil.	Notify Unit Maintenance.
		Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	Notify Unit Maintenance.
5	Distribution Pump P-7 was running, but stops and the RED stop button light is ON.	CB128 motor circuit breaker is tripped.	Open PDP and check circuit breaker CB128 (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to troubleshoot for short circuits.
		Contactor M506 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactor M506 (WP 0011). Push in the Blue overload reset button. Close the PDP and start the pump. If noise is heard, refer to #2 above. If the failure repeats, check for binding of the motor or pump. If shaft cannot be turned freely by hand, remove the hoses and adaptors. Check for and remove any debis in the pump. If debris is not found, notify Unit Maintenance.

Table 12. Product Water System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6	Distribution Pump P-7 leaks water along the shaft.	Worn shaft seal assembly.	Notify Unit Maintenance.
7	Distribution Pump P-7 leaks water at the inlet or outlet flange.	Deteriorated inlet flapper assembly or outlet flange gasket.	Notify Unit Maintenance.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES OPERATOR/CREW TROUBLESHOOTING PROCEDURES

0033 00

THIS SECTION COVERS:
Cold Weather System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Operator

COLD WEATHER SYSTEM MALFUNCTIONS

Table 13. Cold Weather System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Diesel heater motor does not start.	Safety control locked out.	Push and hold red reset button for 120 seconds.
		No power or low voltage at heater.	Check that the heater is plugged in.
		Remote thermostat (if used) improperly set or defective.	Adjust remote thermostat to a higher setting. If heater still does not start, switch the thermostat switch on the electric control box to the “OFF” position. If the heater then functions properly, notify Unit Maintenance to replace the remote thermostat assembly.
		Fan obstructed by mechanical damage or dirt.	Notify Unit Maintenance.
		Dirty or defective photocell.	Notify Unit Maintenance.
		Defective overheat switch.	Notify Unit Maintenance.
		Defective Safety Control.	Notify Unit Maintenance.
		Defective motor relay.	Notify Unit Maintenance.
		Defective motor.	Notify Unit Maintenance.
2	Heater will not ignite, but motor runs for a short time.	Fuel tank empty.	Check level of fuel in tank. A minimum of one gallon is required for proper operation.
		Wrong fuel type.	Make sure fuel is one of the following: DF2, DL2, or JP8.
		Water in the fuel.	Check for water in the fuel tank. If water is found, drain the tank and rinse with clean fuel. Fill the tank with fresh, clean fuel.
		Air leak at fuel filter.	Notify Unit Maintenance.
		Defective or damaged spark plug.	Notify Unit Maintenance.
		Defective transformer.	Notify Unit Maintenance.

Table 13. Cold Weather System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3	Heater burns but puffs of smoke can be seen; heater will not burn steady; heater burns with odor; heater smokes continuously.	Heater running out of fuel.	Check level of fuel in tank. A minimum of about one gallon is required for proper operation.
		Wrong fuel.	Make sure fuel is one of the following: DF2, DL2, or JP8.
		Water in fuel.	Check for water in the fuel tank. If water is found, drain the tank and rinse with clean fuel. Fill the tank with fresh, clean fuel.
		Dirty air filters causing reduced air pressure through nozzle resulting in low fuel flow.	Make sure the air intake is not blocked. Remove and clean air filters (WP 0044).
		Dirty fuel filter.	Notify Unit Maintenance.
		Fuel filter loose.	Notify Unit Maintenance.
		Dirty fuel nozzle.	Notify Unit Maintenance.
		Loose output airline between pump and burner head.	Notify Unit Maintenance.
4	Flames and/or black smoke come out of stack.	Dirty fan.	Clean the fan (WP 0044).
		Air passageway through the heater is blocked.	Make sure that the air passageway through the heater is clear.
		Pump output too high causing too much fuel to be supplied.	Notify Unit Maintenance.
		Fan loose or improperly located on shaft.	Notify Unit Maintenance.
		Bent or damaged fan.	Notify Unit Maintenance.
5	Heater cycles intermittently.	Remote thermostat (if used) set too low.	Set remote thermostat to a higher temperature for more even operation.
		Defective remote thermostat (if used).	Set the thermostat switch on the electric control box to the “ON” position. If the heater runs evenly, notify Unit Maintenance to replace the remote thermostat assembly.
		Defective electrical supply or defective electrical connections.	Make sure the power cord is in good condition.
		Defective overheat switch.	Notify Unit Maintenance.
6	Heater ignites but safety control trips.	Dirty or defective photocell.	Notify Unit Maintenance.
		Defective overheat switch.	Notify Unit Maintenance.

Table 13. Cold Weather System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
7	All hose blankets and pump heat collars remain cold with Hose/Pump Heaters switch ON.	Failure of Hose/Pump Heaters switch or PLC slot #1 input card. Failure of PLC Slot #4 Output card or failure of contactor K513 actuating coil.	Notify Unit Maintenance. Notify Unit Maintenance.
8	All hose blankets and pump heat collars connected to the raw water pump junction boxes remain cold.	Circuit breaker CB211or ground fault breaker 211 tripped.	Open PDP and check circuit breaker CB211 (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to troubleshoot for short circuits or ground fault.
9	All hose blankets and pump heat collars connected to the distribution pump junction boxes remain cold.	Circuit breaker CB207or ground fault breaker 207 tripped. Open circuit in power cable or connector. Corroded connector.	Open PDP and check circuit breaker CB207 (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to troubleshoot for short circuits or ground fault. Notify Unit Maintenance.
10	All hose blankets and pump heat collars connected to the MF Feed Pump P-3 junction box remain cold.	Circuit breaker CB209or ground fault breaker 209 tripped. Open circuit in power cable or connector. Corroded connector.	Open PDP and check circuit breaker CB209 (WP 0011). Reset as needed. If it trips again, notify Unit Maintenance to troubleshoot for short circuits or ground fault. Notify Unit Maintenance.
11	One heat blanket or pump heating collar remains cold. All others connected to the same junction box are hot.	Failed connector or heat trace cable.	Notify Unit Maintenance.

END OF WORK PACKAGE

**TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)** **0034 00**

This work package covers malfunctions of the various TWPS systems including the related electrical control provided by the OCP and the power provided by the PDP. The malfunctions and troubleshooting procedures are presented in tables as listed.

RAW WATER SYSTEM MALFUNCTIONS

TABLE 1: RAW WATER SYSTEM TROUBLESHOOTING

TABLE 2: DIESEL ENGINE TROUBLESHOOTING

MF SYSTEM MALFUNCTIONS

TABLE 3: MF FEED PUMP P-3 TROUBLESHOOTING

TABLE 4: AUTOMATIC VALVES, AIR SOLENOID VALVES TROUBLESHOOTING

TABLE 5: GENERAL MF SYSTEM TROUBLESHOOTING

TABLE 6: FEED FLOW CONTROL PANEL TROUBLESHOOTING

RO SYSTEM MALFUNCTIONS

TABLE 7: GENERAL RO SYSTEM TROUBLESHOOTING

TABLE 8: HIGH PRESSURE PUMP, TURBOCHARGER TROUBLESHOOTING

AIR SYSTEM MALFUNCTIONS

TABLE 9: GENERAL AIR SYSTEM TROUBLESHOOTING

TABLE 10: AIR COMPRESSOR TROUBLESHOOTING

CHEMICAL SYSTEM MALFUNCTIONS

TABLE 11: CHEMICAL SYSTEM TROUBLESHOOTING

PRODUCT WATER SYSTEM MALFUNCTIONS

TABLE 12: PRODUCT WATER SYSTEM TROUBLESHOOTING

COLD WEATHER SYSTEM MALFUNCTIONS

TABLE 13: COLD WEATHER SYSTEM TROUBLESHOOTING

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

0034 00

THIS SECTION COVERS:
Raw Water System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Unit

RAW WATER SYSTEM MALFUNCTIONS

Table 1. Raw Water System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Raw Water Pump P1 or P2 (if deployed as the only raw water pump) is rotating but is not pumping water.	Startup:	
		Missing suction hose coupling gasket.	Check all couplings that are out of water for coupling gasket. Install gasket in any couplings that are missing a gasket.
		Loss of prime.	Open vent valve until primed again. Add water if needed.
		During operation:	
		Water intake out of water and sucking air.	Reset intake under water.
		Clogged floating inlet strainer.	Pull in, clean, redeploy.
		Pump (suction lift) is more than 23 feet above the raw water.	Reconfigure pump closer to water source.
		Check valve not closing tightly.	Stop engine. Remove suction hose and Adaptor A-01 from pump. Inspect check valve V-101 valve seat. Remove any material preventing tight closure.
		Leaking shaft seal assembly.	With pump stopped and primed, look for leakage at the back of the pump. Replace pump seal assembly if leak found (WP 0048).
		Worn pump impeller or wear plate	Adjust clearance between the impeller and the wear plate (WP 0048). If severely worn, replace impeller and wear plate.
2	Raw Water Pump P1 or P2 runs noisy or rough.	Noise is at the pump: shaft clamp is loose, impeller is rubbing on wear plate	Check clearance between impeller and wear plate. Adjust as needed. Be sure shaft clamp is tight (WP 0048).
		P-2 only: Noise is at the motor: worn bearings.	Replace the motor (WP 0048).
3	Raw Water Pump P2 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB106 manually set to OFF position (black handle down).	Set CB to On position (black handle up). (WP 0011)

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

0034 00

Table 1. Raw Water System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3 cont.	Raw Water Pump P2 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on. (Continued)	CB106 ground fault breaker has tripped. **WARNING** **Electrical Safety. The TWPS unit must be shut down and the Main Circuit Breaker set to OFF prior to disconnecting the power cable. Failure to observe this warning may result in serious injury or death.**	Open the PDP. Locate the raw water pump P-2 CB106 ground fault breaker (WP 0011). If the blue lever is down, push it up to reset. If the breaker trips again, isolate the fault as follows: 1) Set the Main Circuit Breaker to OFF. Remove the power cable at the PDP. Check and clean the PDP connector pins. Install the connector cap. Set the Main Circuit Breaker to ON. Push the Start button. If the breaker trips, replace the circuit breaker. 2) Set the Main Circuit Breaker to OFF. Disconnect the power cable at the pump. Reconnect the cable at the PDP. Cap the cable connector and lay the cable end over the pump frame. Set the Main Circuit Breaker to ON. Push the start button. If the breaker trips, replace the cable or notify Direct Support to inspect and repair the failed connector. 3) Set the Main Circuit Breaker to OFF. With the power cable connected, disconnect the cable from the junction box to the motor. Repeat the test. If the breaker trips, clean the junction box connector pins and the inside of the box. Remove any deposits and corrosion. 4) Clean the motor cable connector pins and connect to the junction box. 5) If the breaker continues to trip, replace the motor (WP0048).
		Damaged or corroded power cable connections.	Remove power cable. Notify Direct Support to replace the connector if damage found. Clean connector pins if corroded.
		Damaged pump power cable.	Test electrical continuity between connector ends. Replace cable if continuity is not observed.
		Corroded pump skid junction box connectors, loose wire inside junction box.	Clean corroded connectors; repair loose wires.
		Failure of M501 motor contactor – main contacts corroded.	Open the PDP. Set the Main breaker to ON. Push the raw water pump start button. Check the voltage between the contactor output terminals and ground. If one or more do not show voltage, replace the contactor (WP 0063).
		Motor windings have failed.	Continuing, if voltage is found, replace motor (WP 0048).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 1. Raw Water System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4	Raw Water Pump P2 will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on.	Failure of Raw Water Pump #2 Start button or PLC Slot #1 Input card	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Push and hold raw water pump start. Check the slot #1 LED lights. If channel 1 is not ON: 1) Open the slot #1 wire-way cover. Locate the IN1 terminal. Check for AC 110-volts between IN1 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #1 Input card (WP 0060). 3) If voltage is not found, replace the Raw Water Pump #2 Start button (WP 0059).
		Failure of PLC Slot #4 Output card or failure of the motor contactor – actuating coil failure.	Open the PDP door and turn the Main Circuit Breaker to the ON position (WP0011). Locate the contactor and push the start button. If the contactor does not pull in: 1) Open the slot #4 wire-way cover. Locate the O0 terminal. Check for AC 110 volts between O0 and ground while pushing and holding the start button. 2) If voltage is not found, replace the Slot #4 output card (WP0060). 3) If voltage is found, replace the contactor (WP 0063).
		Failure of PLC Slot #2 Input card or M501 motor contactor auxiliary relay	If the contactor pulls in, find the PLC slot #2 card. If channel 8 is OFF: 1) Open the slot #2 wire-way cover. Locate the IN8 terminal. Check for AC 110-volts between IN8 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #2 Input card (WP0060). 3) If voltage is not found, replace the motor contactor (WP 0063).
5	Raw water pump P-2 was running, but stops, or fails to start and the RED stop button light is ON.	CB106 motor circuit breaker is tripped.	Open PDP and check CB106 circuit breaker (WP 0011). Reset as needed. If it trips again, secure the power source and troubleshoot for short circuits as follows: 1) Remove the pump power cable at both ends. Check for shorts between pins in the PDP connector and ground. If found, use the wiring diagram to check back along the shorted wire for the source of the short. 2) Check for shorts between power cable connector pins. Replace cable if found, or notify Direct Support to inspect and repair the connectors.

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Table 1. Raw Water System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5 cont.	Raw water pump P-2 was running, but stops, or fails to start and the RED stop button light is ON (continued).	CB106 motor circuit breaker is tripped (continued).	3) Disconnect the cable between the motor and the junction box. Check for shorts between pump junction box connector pins. If found, repair the junction box. 4) Check the motor cable connector pins for shorts. If found, disconnect the cable from the motor wires and check the pins again. If a short is found, replace the cable. 5) Check the motor wires for shorts. If found, replace the motor (WP0048). 6) If no shorts are found, replace the circuit breaker (WP0063).
		Contactor M501 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactor M501 (WP 0011). Push in the Blue overload reset button. Close the PDP and start the pump. If noise is heard from the pump, refer to #2 above. If the failure repeats, 1) Check for binding of the motor or pump. • If shaft cannot be turned freely by hand, remove the pump from the motor. If the motor shaft will not turn, replace the motor. If the motor shaft turns, complete the dissassembly of the pump, clean the pump, and replace worn parts. After assembly, be sure that the motor shaft turns freely (WP 0048). • If the shaft turns freely, check for loose wires. 2) Open the PDP. Leave the main breaker off. Check for loose wires: • At the top of the contactor • At the bottom of the thermal overload. • At EMP shunts V106, 107 and 108. 3) Push the contactor in by hand. Check for continuity between the top and bottom connections. If not found on all legs, replace the contactor and thermal overload (WP 0063) 4) Open the connection box on the motor and check for loose wires. 5) Open the junction box on the pump skid and check for loose wires. 6) If the fault is not identified, replace the motor.

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Table 1. Raw Water System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6	Raw Water Pump P1 or P2 leaks water along the shaft.	Worn shaft seal assembly.	Replace pump seal assembly (WP 0048).
7	Raw Water Pump P1 or P2 leaks water at the inlet or outlet flange.	Deteriorated inlet flapper assembly or outlet flange gasket.	Replace inlet flapper assembly or outlet flange gasket (WP 0048).
8	Cyclone separator has no flow through the drain or raw water flow through the cyclone is restricted.	Cyclone is overloaded with too much sand. Cyclone is plugged with sand. Cyclone has an internal failure.	Operate cyclone with valve V-104 fully open. Close Raw Water Flow Valve V-107 and fully open the Cyclone Blowdown Flow Valve V-104 to blow sand out of the cyclone. If this fails to clear the cylcone, remove cyclone drain adaptor A-03. If this doesn't work, poke into the cyclone drain using a piece of wire to clear sand out of the cyclone. If the cyclone is still plugged, pump clean water, such as product water from the distribution tanks, into the cyclone discharge and out the cyclone inlet to the ground. Remove the cyclone from service. Continue operation. Replace the cyclone.
9	Insufficient raw water flow to maintain MF Feed Tank level even with flow control valve fully open.	Partially clogged floating inlet strainer. P1/P2 pump is not running or air leakage through hose coupling gaskets. Clogged cyclone separator. Air leakage at Adaptor A01 Suction lift is too high. Elevation from pumps is greater than allowed. Debris caught in pump suction, pump impeller, or Adaptor A-05 check valve V-107. Worn pump impeller or wear plate.	Clean the floating inlet strainer. See corrective action for P1/P2 pump malfunction. See corrective action for cyclone separator malfunction. Check gaskets and replace as needed. Be sure the support strap takes the hose weight and keeps the adaptor horizontal. Reconfigure pump closer to water. Establish new site in accordance with WP 0004. Remove hoses and adpators. Check for debris. Remove as needed. Adjust the clearance between the impeller and the wear plate. If no longer able to adjust, replace the impeller and wear plate (WP 0048).

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Table 2. Diesel Engine Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Diesel engine will not turn over using recoil starter	Recoil starter broken.	Continue operation using the electric starter. Replace recoil starter (WP 0050).
		Engine has seized.	Remove the pump from the engine (WP 0048). If the engine will not turn over, replace the diesel engine (WP0050).
		Pump has seized.	Disassemble and clean the pump (WP 0048). Replace worn parts. Mount the pump on the engine. Make sure the pump turns freely.
2	Diesel engine will not turn over using electric starter.	Power cable not connected at the diesel engine or at the power source.	Ensure that the power cable is firmly connected at the diesel engine and at the power source.
		Power source not energized.	Ensure that power source is energized.
		Loose electrical connections to the starter magnetic switch.	Tighten electrical connections.
		Corroded electrical connections to the starter magnetic switch.	Clean electrical connections.
		Malfunction of starter.	Replace electric starter assembly (WP 0050).
		Malfunction of starter switch.	Replace the junction box (WP 0048).
		Engine has seized.	See item 1 above.
		Pump has seized.	See item 1 above.
3	Diesel engine is hard to turn over using recoil starter.	Decompression lever not pushed down.	Push the decompression lever down.
		Lubricating oil has deteriorated.	Change the oil (WP 0050).
		Engine beginning to seize.	Remove the pump from the engine (WP 0048). If the engine still show signs of seizing, replace the diesel engine (WP 0050).
4	Diesel engine turns over but will not start.	New engine or first start after storage.	May take up to 15 pulls to vent fuel lines. Bleed fuel system if required (WP 0050).
		Fuel cock is closed.	Open fuel cock.
		Fuel tank empty.	Add fuel and re-start.
		Throttle was not set to START.	Move the throttle to the START position.
		Fuel lines incorrectly connected.	Check for proper connection (WP 0007)
		Air cleaner filter element is dirty.	Check/replace air cleaner filter element. (WP 0039).
		Fuel filter is clogged.	Clean or replace fuel filter (WP 0050).

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Table 2. Diesel Engine Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4 cont.	Diesel engine turns over but will not start (continued)	Fuel injection pump has failed.	Remove fuel injection pipe from the fuel injection valve and pull the recoil starter. If fuel does not come out the pipe, replace the fuel injection pump (WP0050).
		Fuel injection valve is clogged.	Remove the fuel injection valve and reconnect it to the fuel injection pipe. Pull the recoil starter. If fuel does not come out of the tip of the fuel injection valve, clean or replace the fuel injection valve (WP 0050).
5	Diesel engine turns over easily, but does not start or starts with difficulty.	Fuel injection valve loose.	Tighten nuts to the fuel injection valve retaining plate (WP 0050).
		Incorrect valve head clearance.	Check/adjust intake/exhaust valve clearance (WP0050).
6	Diesel engine stops during operation.		**WARNING** **Never add fuel when the engine is running. Failure to observe this warning may result in fuel igniting causing severe burns.**
		Fuel tank empty.	Add fuel and bleed air from the fuel injection pump (WP0050).
		Water in fuel.	Drain fuel tank. Refill with new fuel (WP0050).
		Lube oil level low and engine seized.	Allow engine to cool. Add lube oil, then try to start the engine. If the engine remains seized with the pump decoupled from the engine, replace the engine (WP 0050).
		Air cleaner filter element is dirty.	Clean or replace the air cleaner filter element (WP 0039).
		Fuel filter is clogged.	Clean or replace the fuel filter (WP 0050).
		Fuel injection pump has failed.	See item 4 above.
		Fuel injection valve is clogged.	See item 4 above.
7	Diesel engine exhaust continuously emits black smoke after warming up or engine output drops.	Poor fuel quality.	Drain fuel tank. Refill with new fuel. (WP0050)
		Clogged air cleaner filter element.	Clean or replace air cleaner filter element. (WP0039)
		Fuel injection valve is clogged.	See item 4 above.

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Table 2. Diesel Engine Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
8	Diesel engine exhaust continuously emits bluish white smoke after warming up or engine output drops.	Poor fuel quality.	Drain fuel tank. Refill with new fuel.
		Too much engine oil.	Drain oil to proper level (WP 0050).
		Oil viscosity is too low (oil is too thin).	Change the engine oil (WP 0050).
		Carbon deposits on intake/exhaust valves.	Notify Direct Support Maintenance.
		Defective valve stem seal.	Notify Direct Support Maintenance.
		Leaking cylinder head gasket.	Notify Direct Support Maintenance to replace the cylinder head gasket (WP 0068).
		Broken or worn piston rings.	Notify Direct Support Maintenance to replace the piston rings (WP 0068).

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THIS SECTION COVERS:
MF System

INITIAL SETUP:
TWPS Operating
Maintenance Level
Unit

MF SYSTEM MALFUNCTIONS

Table 3. MF Feed Pump P-3 Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	MF feed pump P-3 does not come on for Fill/Hold, but valve V111 cycles OPEN and green Run light comes on. Red stop light is NOT on.	At first start up, circuit breaker CB111 manually set to OFF position (black handle down). CB111 ground fault breaker has tripped **WARNING** **Electrical Safety. The TWPS unit must be shut down and the Main Circuit Breaker set to OFF prior to disconnecting the power cable. Failure to observe this warning may result in serious injury or death.**	Set CB to On position (black handle up) (WP 0011). Open the PDP. Locate the MF Feed pump P-3 CB111ground fault breaker (WP 0011). If the blue lever is down, push it up to reset (WP0063). If the breaker trips again, isolate the fault as follows: 1) Set the Main Circuit Breaker to OFF. Remove the power cable at the PDP. Check and clean the PDP connector pins. Install the connector cap. Set the Main Circuit Breaker to ON. Perform MF Fill/Hold, then set the Mode to RUN. Push the Start button. If the breaker trips, replace the circuit breaker. 2) Set the Main Circuit Breaker to OFF. Disconnect the power cable at the pump. Reconnect the cable at the PDP. Cap the cable connector and lay the cable end over the pump frame. Set the Main Circuit Breaker to ON. Perform MF Fill/Hold, then set the Mode to RUN. Push the Start button. Push the start button. If the breaker trips, clean the cable connector pins. Repeat the test. If the breaker trips, replace the cable or notify Direct Support to inspect and repair the connectors. 3) Set the Main Circuit Breaker to OFF. With the power cable connected, disconnect the cable from the junction box to the motor. Repeat the test. If the breaker trips, clean the junction box connector pins and the inside of the box. Remove any deposits and corrosion. 4) Clean motor cable connector pins and connect to the junction box. 5) If the breaker continues to trip, replace the motor (WP0051).

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Table 3. MF Feed Pump P-3 Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1 cont.	MF feed pump P-3 does not come on for Fill/Hold, but valve V111 cycles OPEN and green Run light comes on. Red stop light is NOT on (continued).	Damaged or corroded power cable connections.	Remove power cable. Inspect connectors for damage and corrosion. Notify Direct Support to replace the connector if damage found. Clean connector pins if corroded.
		Damaged pump power cable.	Test electrical continuity between connector ends. Replace cable if continuity is not observed.
		Corroded junction box connectors, loose wire inside junction box.	Clean corroded connectors; repair loose wires.
		Failure of M502 motor contactor – main contacts corroded.	Open the PDP. Set the Main breaker to ON. Set the System Mode Switch to FILL/HOLD. Check the voltage between the contactor output terminals and ground. If one or more do not show voltage, replace the contactor (WP0063).
		Motor windings have failed.	Continuing, if voltage is found, replace motor (WP0051).
2	MF feed pump P-3 does not come on for Fill/Hold, valve V111 cycles OPEN, but green MF Feed Pump Run light does not come on.	Failure of PLC #4 Slot Output card or failure of the motor contactor – actuating coil failure.	Open OCP display panel to expose the sub-panel (WP 0060). Open the PDP door and turn the Main Circuit Breaker to the ON position. Locate the contactor and set the System Mode Switch to FILL/HOLD. If the contactor does not pull in: 1) Open the slot #4 wire-way cover. Locate the O1 terminal. Check for AC 110 volts between O1 and ground (WP0060). 2) If voltage is not found, replace the Slot #4 output card (WP0060). 3) If voltage is found, replace the contactor (WP 0063).
		Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	If the contactor pulls in, find the PLC slot #2 card. If channel 9 is OFF: 1) Open the slot #2 wire-way cover. Locate the IN9 terminal. Check for AC 110-volts between IN9 and ground (WP0060). 2) If voltage is found, replace the Slot #2 Input card (WP0060). 3) If voltage is not found, replace the motor contactor (WP 0063).

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Table 3. MF Feed Pump P-3 Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3	MF feed pump P-3 does not come on for Fill/Hold, valve V-111 remains CLOSED and green Run light does not come on.	Failure of System Mode Switch or PLC Slot #3 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Set mode switch to Fill/Hold. Check the slot #3 LED lights. If channel 0 is OFF: 1) Open the slot #3 wire-way cover. Locate the IN0 terminal. Check for AC 110-volts between IN0 and ground. 2) If voltage is found, replace the Slot #3 Input card (WP 0060). 3) If voltage is not found, replace the System Mode Switch (WP 0059 Rotary Switch).
4	MF Feed Pump will not start in RUN. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on. If at startup, the Fill/Hold cycle was completed correctly.	Failure of MF Feed Pump Start button or PLC Slot #1 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Complete the Fill/Hold step and set the Mode Switch to RUN. Push and hold MF feed pump start. Check the slot #1 LED lights. If channel 3 is not ON: 1) Open the slot #1 wire-way cover. Locate the IN1 terminal. Check for AC 110-volts between IN3 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #1 Input card (WP0060). 3) If voltage is not found, replace the MF Feed Pump Start button (WP 0059).
		Failure of PLC Slot #4 Output card or failure of the motor contactor – actuating coil failure.	Open the PDP door and turn the Main Circuit Breaker to the ON position. Complete the Fill/Hold step and set the Mode Switch to RUN. Locate the contactor and push the start button. If the contactor does not pull in: 1) Open the slot #4 wire-way cover. Locate the O1 terminal. Check for AC 110 volts between O1 and ground while pushing and holding the start button. 2) If voltage is not found, replace the Slot #4 output card (WP0060). 3) If voltage is found, replace the contactor (WP 0063).
		Failure of PLC Slot #2 Input card or M502 motor contactor auxiliary relay.	If the contactor pulls in, find the PLC slot #2 card. If channel 9 is OFF: 1) Open the slot #2 wire-way cover. Locate the IN9 terminal. Check for AC 110-volts between IN8 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #2 Input card (WP0060). 3) If voltage is not found, replace the motor contactor (WP 0063).

Table 3. MF Feed Pump P-3 Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5	MF Feed Pump P-3 comes on for Fill/Hold but there is no MF Feed Flow reading on the OCP Feed Flow indicator and flow is not observed flowing from the waste hose.	Automatic valves have not cycled properly. If pump was drained, the pump may be air bound.	Complete the BIT self test (WP 0013) to identify which valve is not functioning properly. See Automatic Valve Troubleshooting for correction. With the MF Feed Tank at least 50% full, loosen the MF Feed Discharge Hose (F07) coupling at the TWPS inlet connection until water flows freely. Reconnect and repeat the start up procedures.
6	MF Feed Pump was running, but stops and the RED stop button light is ON.	CB111 motor circuit breaker is tripped.	Open PDP and check CB111 circuit breaker. Reset as needed. If it trips again, troubleshoot for short circuits. With the power source secured proceed as follows: 1) Remove the power pump cable at both ends. Check for shorts between pins in the PDP connector. If found, use the wiring diagram to check back along the shorted wire for the source of the short. (WP 0067). 2) Check for shorts between power cable connector pins. If found, replace cable. 3) Disconnect the cable between the motor and the junction box. Check for shorts between pump junction box connector pins. If found, repair the junction box. 4) Check the motor cable connector pins for shorts. If found, disconnect the cable from the motor wires and check the pins again. If a short is found, replace the cable or notify Direct Support to inspect and repair the connector.. 5) Check the motor wires for shorts. If found, replace the motor (WP 0048). 6) If no shorts are found, replace the circuit breaker (WP 0063).

Table 3. MF Feed Pump P-3 Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6 (cont.)	MF Feed Pump was running, but stops and the RED stop button light is ON (continued).	Contactor M502 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactor M502. Push in the Blue overload reset button (WP 0063). Close the PDP, complete normal startup. If the failure repeats, 1) Check for binding of the motor or pump. • If shaft cannot be turned freely by hand, remove the pump from the motor. If the motor shaft will not turn, replace the motor. If the motor shaft turns, complete the dissassembly of the pump, clean the pump, and replace worn parts. After assembly, be sure that the motor shaft turns freely (WP 0051). • If the pump turns freely, check for loose wires. 2) Open the PDP. Check for loose wires • At the top of the contactor • At the bottom of the thermal overload. • At EMP: shunts V111, 112 and 113.
		Contactor M502 Thermal Overload has tripped (continued).	3) Push the contactor in by hand and hold. Check for continuity between the top and bottom connections. If not found on all legs, replace the contactor and thermal overload (WP 0063) 4) Open the connection box on the motor and check for loose wires. 5) Open the junction box on the pump skid and check for loose wires. 6) If the fault is not identified, replace the motor (WP0051).
7	MF Feed Pump P-3 leaks water along the shaft.	Worn or damaged shaft seal.	Replace shaft seal (WP 0051).
8	MF Feed Pump P-3 runs noisy or rough.	Worn motor bearings.	Replace motor (WP 0051).

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Table 4. Automatic Valves, Air Solenoid Valves Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Backwash Fail Alarm comes on during backwash.	Automatic valve failed to operate.	Shut down to standby. Conduct BIT self test procedure (WP 0013). See below for troubleshooting any valve which does not operate as required.
		Backwash air supply solenoid valve XV-901 solenoid coil failure.	Continue with BIT and verify operation of solenoid valve XV-901. If it does not operate, refer to Item 5 below.
		Pressure transmitter PT-102 failure.	Open the OCP display panel to expose the sub-panel. Locate the slot 12 card. If the channel 1 light is blinking, replace PT-102 (WP 0062).
		If Feed Flow Control is set to Manual, XV-912 failure, cable failure or PLC Slot 6 Output card failure.	Disconnect the MS connector. Start backwash. Check for 120 volts between hot pin and ground. If present, reconnect and feel the coil for 60 Hz buzz. If the coil does not buzz, replace the solenoid coil. (WP0061). If coil buzz is noted, replace the valve (WP0061). If 120-volt power is not noted, open the OCP display panel to expose the sub-panel. Find the slot #6 output card. Open the wire-way and locate terminal O11. Start backwash. If voltage is not measured between terminal 11 and ground, replace the slot #6 card. If voltage is measured, troubleshoot the wiring and MS connector for open circuits.
2	Automatic valve (except V-202) fails to cycle when tested during BIT self test.	Valve actuator.	Repeat the BIT test (WP 0013) and stop at the test for the failed valve. Stop the air compressor if on. Listen for air noise at the valve actuator vent. Noise indicates a failed piston seal. Repair or replace the actuator (WP 0066).
		PLC output card #5 relay failure.	Open the OCP display panel to expose the subpanel. Find the slot #5 card. Open the wire-way cover and locate the output terminal for the failed valve. Repeat the BIT test and stop at the test for the failed valve. If 110v is not measured between the terminal and ground, replace the slot #5 card (WP 0060). V-111 Channel/terminal 8 V-112 Channel/terminal 3 V-113 Channel/terminal 4 V-201 Channel/terminal 7 V-201 Skip V-401 Channel/terminal 5 V-402 Channel/terminal 6

Table 4. Automatic Valves, Air Solenoid Valves Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
2 cont.	Automatic valve (except V-202) fails to cycle when tested during BIT self test (continued).	Solenoid coil or solenoid valve failure.	Repeat the BIT test. Push the button only once stopping at "1" with all indicator lamps lit. All valves are de-energized. Open the instrument/solenoid panelbox door and the inner panel to expose the solenoid valve manifold assembly. Locate the solenoid valve which operates the failed automatic valve. Push the white button on the solenoid. You should hear air flow and the automatic valve should cycle. 1) If the valve cycles, replace the solenoid coil (WP 0051). 2) If the valve does not cycle, replace the individual solenoid valve (WP 0051).
3	Automatic valve does not cycle fully to the de-energized or BIT energized position.	Damaged valve liner or failed shaft bearing.	Remove valve and inspect the liner. Remove the actuator and be sure that the valve can be turned easily with a wrench. Replace the valve if damaged (WP 0066).
4	Filtrate Flow Control Valve V-202 fails to operate during BIT test. Or	Valve actuator failure.	Repeat the BIT test and stop at the test for valve V-202. Stop the air compressor if on. Listen for air noise at the valve actuator vent. Noise indicates a failed piston seal. Repair or replace the actuator (WP 0066).
	RO feed tank fills rapidly and overflows. The RO Feed Tank % Level indicator properly reads the increasing level and shows a level of approximately 110% at overflow.	Valve positioner failure.	Set the Feed Flow Control Panel Feed Control Selector Valve V-914 to Manual. If the valve V-202 indicator does not show a movement as the pressure regulator is adjusted, remove the cover. Check the indicator wheel. If it has come loose, set the selector valve to Automatic and tighten the wheel in the full open position. If the wheel is tight, replace the Positioner (WP 0066).
		I/P transducer FY-102 or Slot # 8 Analog output card failure.	With the power on and the TWPS in Standby, open the OCP inner panel and locate the PLC Slot #8 card. Open the wire terminal cover. Locate terminal O0 and remove the wire from the terminal. Connect a milli-ammeter between the terminal screw and the wire. If the reading is not approximately 20 mA, replace the Slot #8 card (WP 0060). If the reading is approximately 20 mA, replace the I/P transducer (WP 0061).

Table 4. Automatic Valves, Air Solenoid Valves Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5	Solenoid valve XV-901, XV-902 or XV-903 fails to operate during BIT test.	Failed solenoid coil.	Replace coil with spare coil provided in the BII (WP 0043). If the failure is not corrected, continue.
		PLC Slot 5 output card failure, cable wiring failure, or valve failure.	Open the OCP display panel to expose the sub-panel. Locate the PLC Slot 5 card and open the wire way. Check for AC voltage between the terminal (see end of Table 4 next page) and ground when the BIT is stepped to the test for the valve. 1) If there is no voltage, replace the Slot 5 output card (WP 0060). 2) If there is voltage, disconnect the electrical connector at the valve. Repeat the BIT and check for voltage between the AC+ pin (pin A) and ground. If no voltage, troubleshoot the wiring and connector for an open circuit. 3) If voltage is measured, replace the valve (WP 0055).
		PLC Slot 5 output card failure, cable wiring failure, or valve failure (continued)	Reference: The voltage will be noted for 5-seconds, then off and then on again three times. The Slot 5 terminals are as follows: XV-901 terminal 0 XV-902 terminal 1 XV-903 terminal 2

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Table 5. General MF System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Backwash does not initiate.	Failure to push MF Backwash Start button during startup procedures.	Follow procedures (WP 0014).
		Failure of MF Backwash Start button or PLC Slot #2 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Push and hold Backwash start. Check the Slot #2 LED lights. If channel 4 is not ON: 1) Open the Slot #2 wire-way cover. Locate the IN4 terminal. Check for AC 110-volts between IN4 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the MF Backwash Start button (WP 0059).
2	RO Feed Tank Level Low alarm with RO Feed Tank Level display reading correctly. Operator has performed corrective actions in WP 16 and WP 33 and system is operable in manual mode. System passes BIT test and there are no Backwash Flow Low alarms.	Leaking or clogged air tubing at Feed Flow Control Panel.	Check tubing connections. Disconnect tubing with V-909 closed. Open V-909 to verify air flow. Close V-909 and reconnect tubing.
		Inadequate air pressure to Feed Flow Control Panel.	Check pressure gauge PI-902 for 100 psig. Adjust PRV-901 to provide a 100 psig reading at PI-902 (WP 42).
		V-202 actuator, positioner or I/P transmitter failure.	Troubleshoot according to table 4, item 4.
		Mechanical problem with internals of V-202.	Remove valve from piping and inspect liner and disc for wear (WP 66).
		Mechanical problem with internals of V-201.	Remove valve from piping and inspect liner and disc for wear (WP 66).
		Feed TDS not properly set or functioning.	Have operator set correct TDS. If TDS cannot be set, troubleshoot according to WP 35, table 2, item 5. 4 -20mA corresponds to a 0-100,000 mg/liter range.
		Temperature transmitter not operating correctly.	Refer to table 7, item 8. 4-20 mA corresponds to a 0-250 degree F range.
3	RO Feed Tank % Level reads 0 with level in the tank, reads a level other than actual by observation, or the reading changes up and down rapidly.	Level measurement loop failure.	See OCP and Instrument System Malfunctions (WP 0035).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 5. General MF System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4	MF Backwash Flow Low alarm comes on during backwash (less than 190 gpm). Clean Strainer alarm comes on during backwash (less than 210 gpm, but more than 190 gpm)	Dirty MF Feed Strainer S-2. MF Main Feed Valve V-111, Shell Lower Feed Valve V-113 or Shell Backwash Upper Outlet Valve V-401 fails to fully open. Debris in the MF feed pump. Flow measurement loop failure. Worn MF feed pump impeller or wear ring.	Check and clean the strainer (WP 0040). Conduct BIT (WP 0013). Be sure that these valves cycle fully open. If not, refer to Table 4. Remove the pump from the system and check for debris clogging the inlet or stuck in the impeller. See OCP and Instrument System Malfunctions (WP 0035). Dissassemble pump, inspect and replace the impeller and wear ring as indicated (WP 0051).
5	MF TMP High Alarm is not confirmed by operational checks.	Pressure transmitter PT-101 or PT-102 failure.	See OCP and Instrument System Malfunctions (WP 0035).
6	MF does not drain when the System Mode Switch is set to MF Drain.	Solenoid Valve XV-903 or PLC Slot 5 output card failure. System Mode Switch or PLC Slot 3 input card failure.	Step though the BIT test and verify that XV-903 operates. If it does not operate, refer to Table 4 Item 5. Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the mode switch to MF Drain. 1) If the channel 2 light is ON, replace the Slot 3 input card (WP 0060). 2) If the channel 2 light is OFF, open the wire way and check for 110 VAC between terminal IN2 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 3) If there is no voltage, replace the System Mode Switch (WP 0059 Rotary Switch).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 6. Feed Flow Control Panel Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	V-202 does not respond in manual mode, but functions properly in automatic mode.	Pressure regulating valve PRV-904 defective.	Replace Pressure regulating valve PRV-904 (WP 0061).
2	Pressure gauge PI-904 reading does not increase or decrease as PRV-904 is adjusted, but V-202 moves as expected.	Feed flow control panel gauge PI-904 defective.	Replace pressure gauge PI-904 (WP 0061).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

0034 00

THIS SECTION COVERS:
RO System

INITIAL SETUP:
TWPS Operating
Maintenance Level
Unit

RO SYSTEM MALFUNCTIONS

Table 7. General RO System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	RO Feed Pump P4 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB116 manually set to OFF position (black handle down).	Set CB to On position (black handle up).
		Failure of the motor contactor – main contacts corroded.	Open the PDP. Set the Main breaker to ON. Push the RO feed pump start button. Check the voltage between the contactor output terminals and ground. If one or more do not show voltage, replace the contactor (WP 0063).
		Electrical wiring or motor failure.	Set the Main Circuit Breaker to OFF. Open the motor junction box and remove the insulators from the wire connections. With the wires spread apart, set the Main Circuit Breaker to ON and push the RO feed pump Start button. Measure the voltage from each phase wire to ground. 1) If voltage is found at all three, replace the motor (WP 0052). 2) If voltage is not found at a wire, troubleshoot the wire run for the location of the open circuit.
2	RO Feed Pump will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on.	Failure of RO Feed Pump Start button or PLC Slot #1 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Push and hold RO feed pump start. Check the Slot #1 LED lights. If channel 5 is not ON: 1) Open the Slot #1 wire-way cover. Locate the IN5 terminal. Check for AC 110-volts between IN5 and the AC Com terminal while pushing and holding the start button. 2) If voltage is found, replace the Slot #1 Input card (WP 0060). 3) If voltage is not found, replace the RO Feed Pump Start button (WP 0059).
		Failure of PLC Slot #4 Output card or failure of the M503 motor contactor – actuating coil failure.	Open the PDP door and turn the Main Circuit Breaker to the ON position. Locate the contactor. Make sure the low level alarm is not ON. Push and hold the start button.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 7. General RO System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
2 cont.	RO Feed Pump will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on (continued).	Failure of PLC Slot #4 Output card or failure of the M503 motor contactor – actuating coil failure (continued).	If the contactor does not pull in: 1) Open the Slot #4 wire-way cover. Locate the O2 terminal. Check for AC 110 volts between O2 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060). 3) If voltage is found, replace the contactor (WP 0063).
		Failure of PLC Slot #2 Input card or M503 motor contactor auxiliary relay.	If the contactor pulls in, find the PLC Slot #2 card. If channel 10 is OFF: 1) Open the Slot #2 wire-way cover. Locate the IN10 terminal. Check for AC 110-volts between IN10 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the motor contactor (WP 0063).
3	RO Feed Pump P-4 was running, but stops, or fails to start and the RED stop button light is ON.	CB116 circuit breaker has tripped.	Open PDP and check CB116 circuit breaker. Reset as needed. If it trips again, check for shorts. Be sure that the power source is secured. 1) Open the P-4 motor terminal box and disconnect the power cable wires. Check for short in the wires and in the motor. If in the motor, replace the motor (WP0052). 2) If in a wire, pull all of the wires and inspect. Replace the shorted wire and any wire showing signs of damage. 3) If the motor or wires do not show a short, replace the circuit breaker (WP 0063).
		Contactor M503 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactor M503. Push in the Blue overload reset button (WP 0063). Close the PDP and start the pump. If the failure repeats, 1) Check for binding of the motor or pump. • If shaft cannot be turned freely by hand, remove the pump from the motor. If the motor shaft will not turn, replace the motor. If the motor shaft turns, complete the dissassembly of the pump, clean the pump, and replace worn parts. After assembly, be sure that the motor shaft turns freely (WP 0052).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 7. General RO System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3 (cont.)	RO Feed Pump P-4 was running, but stops, or fails to start and the RED stop button light is ON (continued).	Contactor M503 Thermal Overload has tripped (continued).	• If the pump turns freely, check for loose wires. 2) Open the PDP. Leave the main CB OFF. Check for loose wires • At the top of the contactor • At the bottom of the thermal overload. • At EMP shunts V116, 117 and 118. 3) Push the contactor in by hand and hold. Check for continuity between the top and bottom connections. If not found on all legs, replace the contactor and thermal overload (WP0063) 4) Open the connection box on the motor and check for loose wires. 5) Open the junction box on the pump skid and check for loose wires. 6) If the fault is not identified, replace the motor.
4	RO Feed Pump P-4 leaks between pump and motor.	Worn or damaged shaft seal.	Replace the pump seal (WP 0052).
5	RO Feed Tank Low Level Alarm and HP pump stops.		Reset the PLC as follows: - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON)
		1) MF Feed Tank almost empty.	(1) Check level in MF Feed Tank. It should never be less than one-third full. If it is, troubleshoot raw water system as described in Table 1.
		(2) Level measurement loop failure	(2) Open the RO Feed Tank cover. If the actual level is not almost empty, the level measure loop has failed. Refer to WP 0035.
6	RO Feed Pressure Low Alarm.		Reset the PLC as follows: - Set Mode to Standby. - Drain RO feed tank. - Open the MAIN circuit breaker at the PDP (OFF position) - Then close the MAIN circuit breaker (ON) - Follow normal startup procedures. - Watch HP Pump Feed Pressure gage PI-202. If the system was in backwash and the RO tank level is low, see response for RO feed tank low level alarm, item 5.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 7. General RO System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6 (cont.)	RO Feed Pressure Low Alarm (continued).	Random low pressure occurrence.	Start up following normal procedures. If the alarm does not repeat and the RO feed pressure reading on PI-202 is at least 40 psig, resume normal operation.
		Pressure transmitter PT-201 or electrical wiring has failed.	Attempt start up again and watch Pressure Gauge PI-202. If the alarm comes on, but the pressure does not drop below 35 psig: 1) Open the OCP display panel to expose the sub-panel. Locate the Slot #12 card. If the channel 2 light is blinking, replace PT-201 with the spare located in the BII (WP 0041). 2) Check again after installing. If the channel 2 light is still blinking, troubleshoot the wiring for an open circuit or failed connector.
		Pressure transmitter PT-201 or PLC Slot 12 Analog Input Card has failed.	Replace the Pressure Transmitter with the spare located in the BII. If this does not correct the problem, replace the PLC Slot 12 Card (WP 0060).
			If Pressure Gauge PI-202 reads less than 35 psig when the alarm comes on proceed as follows:
		In-line strainer S-4 is plugged.	Remove, inspect and clean as needed (WP 0041).
		RO Feed Tank Strainer S-3 is plugged.	Remove tank cleanout cover. Remove strainer and clean if plugged (WP 0041).
		Pump impeller and wear ring are corroded.	Dissassemble pump and repair (WP 0052).
7	Cleaning solution does not heat up with heater switch set to AUTO 2. Or The solution does not heat up at least 30 degrees in 30 minutes with the heater switch in AUTO 2.	High temperature alarm light is on.	Refer to WP 0035, table 2 for troubleshooting.
		CB201 or CB204 Circuit Breaker Tripped.	Open PDP and check circuit breakers CB201 and CB204. Reset as needed. If it trips again, check for shorts in the circuit for the heater protected by the breaker. Be sure that the power source is secured. 1) Open the heater terminal box and disconnect the power cable wires. Check for short in the cable and in the heating elements. If in a heating element, replace the heater (WP 0052). 2) If in the cable, pull all of the wires and inspect. Replace the shorted wire and any wire showing signs of damage. 3) If the heater or cable do not show a short, replace the circuit breaker (WP 0063).

Table 7. General RO System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
7 (cont.)	Cleaning solution does not heat up with heater switch set to AUTO 2. Or The solution does not heat up at least 30 degrees in 30 minutes with the heater switch in AUTO 2. (Continued)	Tank Heater Switch or PLC Slot #1 Input card failure.	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Make sure there is water in the RO feed tank. Set the switch to AUTO 2. Check the Slot #1 LED lights. If channel 12 is not ON: 1) Open the Slot #1 wire-way cover. Locate the IN12 terminal. Check for AC 110-volts between IN12 and ground. 2) If voltage is found, replace the Slot #1 Input card (WP 0060). 3) If voltage is not found, replace the Tank Heater Switch (WP 0059). 4) Repeat for the IN12 terminal.
		Failure of PLC Slot #4 Output card or failure of the heater contactor – actuating coil failure.	Open the PDP. Set the main breaker to ON. Make sure there is water in the RO feed tank. Set the heater switch to AUTO 2. If one or both contactors fail to pull in: 1) Open the Slot #4 wire-way cover. Locate the O10 and 11 terminals Check for AC 110 volts between O10 and ground and O11 and ground. 2) If voltage is not found at both terminals, replace the Slot #4 output card (WP 0060). 3) If voltage is found, replace the related contactor. For terminal O10 replace contactor K511. For terminal O11 replace contactor K512 (WP 0063).
		Broken heating element(s).	Open the heater terminal boxes. Remove the power cable wires. Check each heater element for resistance. If an open circuit is found, replace the heater (WP 0052).
8	Heaters do not turn off when RO Feed Tank temperature rises above 110 degrees F	Temperature transmitter TT-201 or electrical wiring failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot #12 card. If the channel #5 light is blinking: 1) Replace the temperature transmitter (WP 0062). 2) If the light blinks after replacing TT-201, troubleshoot the wiring.
		Temperature transmitter TT-201 or Slot #12 input card failure.	If the light is not blinking, remove the wire from terminal IN5 and measure DC mA between the wire and the terminal. 1) If the reading with the RO Feed Tank temperature at 110 degrees F is approximately 11 mA, replace the Slot #12 input card (WP 0060). 2) If the reading is less, replace the temperature transmitter (WP 0062).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

THIS SECTION COVERS:
High Pressure Pump

INITIAL SETUP:
TWPS Operating
Maintenance Level
Unit

HIGH PRESSURE PUMP AND TURBOCHARGER MALFUNCTIONS

Table 8. High Pressure Pump, Turbocharger Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	HP pumps do not start when start button is pushed. Green light does not come on. Red light does not come on. Feed Pressure Low alarm is not on.	Failure to follow start-up procedures.	Be sure all steps have been completed.
		Failure of High Pressure Pumps Start button or PLC Slot #1 Input card.	With the RO Feed Pump ON and the reject flow over 10 gpm, open OCP display panel to expose sub-panel (WP 0060). Push and hold HP Pump Start. Check the Slot #1 LED lights. If channel 7 is not ON: 1) Open the Slot #1 wire-way cover. Locate the IN7 terminal. Check for AC 110-volts between IN7 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #1 Input card (WP 0060). 3) If voltage is not found, replace the High Pressure Pumps Start button (WP 0059).
		Failure of PLC Slot #4 Output card or failure of the P-5 motor contactor M504 - actuating coil failure.	Open the PDP door and turn the Main Circuit Breaker to the ON position. Follow normal start-up steps up to starting the High Pressure Pumps. Locate contactor M504 and push the start button. Do not hold in. If the contactor does not pull in: 1) Open the Slot #4 wire-way cover. Locate the O3 terminal. Push the button and check for AC 110 volts between O3 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060). 3) If voltage is found, replace the contactor (WP 0063).
		Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	If the contactor pulls in but immediately drops back out when the push button is released, find the PLC Slot #2 card. Push the start button again and hold in. If the channel 11 light is OFF: 1) Open the Slot #2 wire-way cover. Locate the IN11 terminal. Check for AC 110-volts between IN11 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the motor contactor (WP 0063).

Table 8. High Pressure Pump, Turbocharger Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
2	HP Pump P-5 starts and then stops. HP Pump P-6 does not start. Red stop push button light is not on.		Open the PDP. Set the main breaker to ON. Open the OCP display panel to expose the sub-panel (WP 0060). Start up normally. Push HP Pump start (do not hold).
		Failure of PLC Slot #4 Output card or failure of motor contactor M505 - actuating coil.	If contactor M505 does not pull in after a 10-second delay: 1) Open the Slot #4 wire-way cover. Locate the O4 terminal. Push the start button again. Check for AC 110 volts between O4 and ground after a 10-second delay 2) If voltage is not found at terminal, O4, replace the Slot #4 output card (WP 0060). 3) If voltage is found, replace the M505 contactor (WP 0059).
		Failure of PLC Slot #2 Input card or failure of motor contactor M505 auxiliary contacts.	If the contactor pulls in momentarily and then drops out, find the PLC Slot #2 card. 1) Open the Slot #2 wire-way cover. Locate the IN12 terminal. Push the HP Pump start button. Check for AC 110 volts between IN12 and ground during the momentary time when the contactor pulls in. 2) If voltage is not found at terminal IN12, replace the M505 contactor (WP 0059). 3) If voltage is found, replace the Slot #2 card (WP 0060).
3	HP Pump P-5 starts, HP pump P-6 begins to start, both pumps stop and red stop push button light comes on. or HP Pumps will not start, or stop after running. Red stop push button light is on.	HP Pump P-5 or P-6 circuit breaker has tripped.	Open PDP and check CB122 and CB125 circuit breakers. Reset as needed. If it trips again, check for shorts. Be sure that the power source is secured (WP 0063). 1) Open the motor terminal box and disconnect the power cable wires. Check for short in the cable and in the motor. If in the motor, replace the HP Pump motor (WP 0053). 2) If in the cable, pull all of the wires and inspect. Replace the shorted wire and any wire showing signs of damage. 3) If the motor or cable do not show a short, replace the circuit breaker (WP 0063).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 8. High Pressure Pump, Turbocharger Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3 cont.	HP Pump P-5 starts, HP pump P-6 begins to start, both pumps stop and red stop push button light comes on. or HP Pumps will not start, or stop after running. Red stop push button light is on (continued).	Contactor M504 or 505 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactors M504 and 505. Note which overload is tripped by the small red indicator next to the blue reset button. Push in the Blue overload reset button (WP 0063). Close the PDP and start the pumps again. If the failure repeats: 1) Open the PDP. Leave the main CB OFF. Check for loose wires. Check by pulling on the wire with nose plyers. • At the top of the contactor • At the bottom of the thermal overload. • At EMP shunts V122, 123 and 124 for pump P-5 or V125, 126 and 127 for pump P-6. 2) Push the contactor in by hand and hold. Check for continuity between the top and bottom connections. If not found on all legs, replace the contactor and thermal overload (WP0063) 3) Open the connection box on the motor and check for loose wires. 4) If the fault is not identified, loosen the pump/motor coupling halves and dissengage the couplings from the rubber driver (WP0053). • If the motor does not turn freely, replace the motor (WP 0053). • If it does, remove the pump, dissassemble and inspect for damage (WP 0053) 5) If no other fault is found, replace the motor associated with the tripped overload. (WP0053).
4	One HP Pump will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB122 or CB125 manually set to OFF position (black handle down). Failure of motor contactor M504 or M505 – main contacts corroded.	Set CB to On position (black handle up). Open the PDP. Set the Main breaker to ON. Follow the normal start-up steps up to starting the HP pumps. Push the High Pressure Pump start button. Check the voltage between the contactor output terminals and ground. If one or more do not show voltage, replace the contactor (WP 0063).

Table 8. High Pressure Pump, Turbocharger Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4 cont.	One HP Pump will not run or stops after running. Green Run light is on. Red stop push button light is NOT on (continued).	Electrical wiring or motor failure.	Set the Main Circuit Breaker to OFF. Open the motor terminal box and remove the insulators from the wire connections. With the wires spread apart, set the Main Circuit Breaker to ON. Follow the normal start-up steps up to starting the HP pumps. Push the HP Pump Start button. Measure the voltage from each phase wire to ground. 1) If voltage is found at all three, replace the motor (WP 0053). 2) If voltage is not found at a wire, troubleshoot the wire run for the location of the open circuit.
5	Operating RO Feed Flow less than 52 gpm but over 48 gpm.	Worn HP Pump valves. Worn HP Pump pistons and or seals.	Replace valves (WP 0053). Replace pistons and seals (WP 0053).
6	Operating RO Feed Flow less than 48 gpm.	Failed reject flow sensor FE-401 or transmitter FT-401. Failed product flow sensor FE-501 or transmitter FT-501.	See instrument troubleshooting (WP 0035).
7	RO Feed Pressure and product flow are low even with Main Pressure Control Valve V401 closed.	Failed Turbocharger thrust bearing, turbocharger not rotating.	Check HP pump discharge pressure PI-301. If this pressure is significantly higher than the RO Feed Pressure, the turbocharger bearing has failed. Replace the bearing and rotor (WP 0052).
8	HP Pumps Run Rough, increased pulsation.	Worn valves. Worn pistons and/or seals.	Replace HPP valves (WP 0053). Replace HPP pistons and seals (WP 0053 2000 Hour High Pressure Pump PMCS).
9	Leakage from HP pump body segment.	Worn O-rings.	Replace HPP defective O-rings (WP 0053 2000 Hour High Pressure Pump PMCS).
10	Excessive leakage from the HP pump/motor adapter drain tubing.	Worn shaft seal or damaged cam surfaces.	Replace worn HPP shaft seal and/or cam (WP 0053 2000 Hour High Pressure Pump PMCS).
11	HP pump relief valve RV-301 is relieving or leaking.	Failed turbocharger thrust bearing, turbocharger not rotating. Relief valve out of adjustment or leaking seat.	Check HP pump discharge pressure PI-301. If this pressure is significantly higher than the RO feed pressure, the turbocharger bearing has failed. Replace the bearing and rotor (WP 0052). Replace.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

0034 00

THIS SECTION COVERS:
Air System

INITIAL SETUP:
TWPS Operating
Maintenance Level
Unit

AIR SYSTEM MALFUNCTIONS

Table 9. General Air System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	System pressure gauge PI-902 reading less than 975 psig and compressor continues to run without increasing the pressure to the shut-off pressure or compressor fails to reach shut-off pressure between backwashes.	High-pressure air (PI-902) set too high. Excessive air consumption.	If PI-902 reads over 110 psig, adjust PRV-901 to reduce pressure to about 100 psig (WP 0042).
		System air leakage.	Shut down to standby. Stop air compressor and listen for leaks. Note: Leakage at Filtrate Flow Control Valve V-202 Positioner and at IP Transducer FY-102 on the Feed Flow Control Panel is normal.
		Oil/Water Coalescer C-O1 automatic drain solenoid valve XV-911 leaking.	Continue operation using manual Coalescer C-O1 Drain Shutoff Valve V-902. Open and close at 15-minute intervals. Replace XV-911 solenoid valve during next routine maintenance cycle (WP 0054).
		Compressor Intermediate Filter Automatic Drain Valve XV-910 leaking.	Continue operation using manual Compressor Intermediate Filter Drain Valve V-901. Open and close at 15-minute intervals. Replace XV-910 solenoid valve during next routine maintenance cycle (WP 0054).
		HP Air Vent Valve V-904 (on Air Purification Filter AF-2) leaking.	Ensure HP Air Vent Valve V-904 is completely closed. Replace HP Air Vent Valve V-904 if still leaking (WP 0054).
		Relief valve RV-901 (on Coalescer CO-1) leaking	Relief valve is factory set. Replace relief valve if found to be leaking (WP 0054).
		Relief valve RV-902 (in Air System Section 1) leaking.	Manually vent RV-902 and release to see if it resets and seals. If this doesn't work, check PRV-901 adjustment (WP 0042). If this still doesn't correct the problem, replace RV-902 (WP 0054).
		LP Air Vent Valve V-910 (in Air System Section 6) leaking.	Ensure LP Air Vent Valve V-910 is completely closed. Replace LP Air Vent Valve V-910 if closed and leaking (WP 0055).
		LP Air Vent Valve V-915 (in Air System Section 3) leaking.	Ensure LP Air Vent Valve V-915 is completely closed. Replace valve if closed and still leaking.

Table 9. General Air System Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1 cont	System pressure gauge PI-901 reading less than 975 psig and compressor continues to run without increasing the pressure to the shut-off pressure or compressor fails to reach shut-off pressure between backwashes (continued).	Leaking air tubing or connections.	Check tubing for leaks at connections. Push in to re-establish connection. If unable to repair leak, bleed the air system (WP 0042) then replace leaking tubing and fittings (WP 0045 or WP0066).
		Leaking air piping or hoses.	Bleed the air system (WP 0042) then remove the leaking fitting, replace the thread tape and re-install. Replace leaking hose (WP0045 or WP0066).
		Leaking tubing or connections inside the Instrument/Solenoid Panel Box.	Open the instrument panel outer and inner doors. Check for leaks. Repair as needed.
		Leaking solenoid valve XV-901, XV-902 or XV-903.	Stop the air compressor. Feel each of the three solenoid valves. If vibrating, it may be leaking. Replace the valve (WP 0055).
		Air compressor safety valve on the second stage head is relieving.	Feel for air flow from the safety valve on top of the second stage head with the compressor on. If flow is noted, replace all three compressor valve assemblies (WP 0056).
		Leaking air compressor valves.	Replace valve assemblies (WP 0056).
2	Air system pressure regulation pressure gauge PI-902 is reading less than 90 psig. Pressure gauge PI-901 readings are normal.	Defective pressure gauge PI-902.	Bleed system air pressure (V-910) with V-907 closed. If the gauge reading does not move, or does not return to zero, replace the gauge (WP 0054).
		Pressure regulating valve PRV-901 (in Air System Section 1) out of adjustment or malfunctioning.	Adjust the pressure regulating valve to provide a 100 psig reading at PI-902 (WP 0042). If unable to correct by adjusting valve, replace the valve (WP 0055).
3	Pressure gauge PI-903 pressure reading is not 15 psig.	Defective pressure gauge PI-903.	Bleed system air pressure (V-915). If the gauge reading does not move, or does not return to zero, replace the gauge (WP 0055).
		Pressure regulating valve PRV-902 out of adjustment.	Open V-915 slightly to bleed low pressure air. While bleeding low pressure air, adjust pressure-regulating valve PRV-902 to provide a 15 psig reading at PI-903 (WP 0042). If unable to correct by adjusting valve, replace the PRV-902 (WP 0055).
4	Compressor stops below 950 psig. Compressor switch light is OFF.	Defective pressure gauge PI-901.	Bleed system air pressure (V-910) with V-907 closed. If the gauge reading does not move, or does not return to zero, replace the gauge (WP 0055).
		Pressure Switch PSL/PSH-901 high pressure shut-off setting out of adjustment.	Adjust Pressure Switch PSL/PSH-901 high-pressure shut-off setting (WP 0042).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 9. General Air System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5	At startup, air pressure increases quickly and compressor cycles on/off.	Air Receiver Tank Outlet Valve V-907 closed.	Open Air Receiver Tank Outlet Valve V-907.
6	At first start-up or start-up after replacing air purification filter AF-2, severe air leak noise is heard at the bottom of the filter.	Filter not installed or not pushed down to seat the O-ring.	Stop the air compressor. Close Receiver Tank Outlet Valve V-907. Open High Pressure Air Vent Valve V-904 to release the pressure. Remove the AF-2 filter cover. Install filter if missing. Check to make sure the filter is pushed down and you feel a definite engagement of the O-ring (WP 0042).

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Table 10. Air Compressor Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Compressor does not start with switch in Auto and no pressure. Switch light is ON. or Compressor was running and stopped at a pressure well below 975 psig. Switch light is ON.	CB133 circuit breaker tripped.	Open PDP and check CB133 circuit breaker. Reset as needed. If it trips again, check for shorts. Be sure that the power source is secured. 1) Open the compressor motor terminal box and disconnect the power cable wires. Check for short in the cable and in the motor. If in the motor, replace the motor (WP 0056). 2) If in the cable, pull all of the wires and inspect. Replace the shorted wire and any wire showing signs of damage. 3) If the motor or cable do not show a short, replace the circuit breaker (WP 0063).
		Thermal overload on contactor M510 tripped.	Push in blue button on contactor M510. If the red switch light is still on when the main circuit breaker is switched back to ON, the compressor high temperature switch has tripped (see below). If cleared and the thermal overload continues to trip: 1) Check the compressor oil. If low, the compressor may be beginning to seize. 2) Loosen the drive belt (WP0056). • If the compressor shaft turns hard, replace the compressor (WP 0056). • If the motor shaft turns hard, replace the motor. 3) Open the PDP. Check for loose wires • At the top of the contactor • At the bottom of the thermal overload. • At EMP shunts V133, 134 and 135 4) Push the contactor in by hand and hold. Check for continuity between the top and bottom connections. If not found on all legs, replace the contactor and thermal overload (WP 0063) 5) Open the connection box on the motor and check for loose wires. 6) If the fault is not identified, replace the motor.
		Compressor high temperature switch has tripped.	Allow compressor to cool. Be sure that the air flow is not obstructed. Check the oil level. After cooling, toggle RESET and start compressor. 1) Check the oil sight glass for air. Bleed as needed (WP 0042). 2) If this occurs after motor replacement, check rotation.

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Table 10. Air Compressor Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1 cont.	Compressor does not start with switch in Auto and no pressure. Switch light is ON. or Compressor was running and stopped at a pressure well below 975 psig. Switch light is ON. (Continued)	Compressor high temperature switch has failed.	If the Reset does not clear the light after the compressor has cooled to the touch, the temperature switch has failed. Remove the wire from terminal IN7 on the Slot #2 input card. Tape the end of the wire and leave disconnected. Replace the switch and reconnect the wire when available (WP 0056)
		Oil pump or oil pressure regulator has failed.	If the Reset does clear the light after cooling, check the lubricating oil pressure. If pressure is low, replace the pressure regulator and oil pump (WP 0056).
2	Compressor does not start with switch in Auto and no pressure in the air system. Switch light is OFF. Or Compressor was running and stopped at a pressure well below 975 psig. Switch light is OFF.	Failure of Pressure Switch PSL/PSH-901 low pressure turn-on switch or PLC Slot #2 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Check that Slot #2 LED lights. If channel 15 is not ON: 1) Open the Slot #2 wire-way cover. Locate the IN15 terminal. Check for AC 110-volts between IN15 and ground. 2) If voltage is found, replace the Slot #2 Input card. 3) If voltage is not found, replace the pressure switch (WP 0054).
		Failure of PLC Slot #4 Output card or failure of motor contactor M510 actuating coil.	Open OCP display panel to expose the sub-panel (WP 0060). Open the PDP door and turn the Main Circuit Breaker to the ON position. Locate the contactor and set the compressor switch to OFF and then to ON. If the contactor does not pull in: 1) Open the Slot #4 wire-way cover. Locate the O9 terminal. Check for AC 110-volts between O9 and ground (WP 0060). 2) If voltage is found, replace the motor contactor (WP 0063). 3) If voltage is not found, replace the Slot #2 Input card (WP 0060).
		Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	If the contactor pulls in, find the PLC Slot #2 card. If channel 14 is OFF: 1) Open the Slot #2 wire-way cover. Locate the IN14 terminal. Check for AC 110-volts between IN14 and ground. 2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the motor contactor (WP 0063).

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TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 10. Air Compressor Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
2 cont.	Compressor does not start with switch in Auto and no pressure. Switch light is OFF. Or Compressor was running and stopped at a pressure well below 975 psig. Switch light is OFF (continued).	At first start up, circuit breaker CB133 manually set to OFF position (black handle down). Motor contactor M510 failure – corroded main contacts. Electrical wiring or compressor motor failure.	Continuing, if channel 14 is ON: Set CB to On position (black handle up). Open the PDP. Set the Main breaker to ON. Set the air compressor switch to Auto. Check the voltage between the contactor output terminals and ground. If one or more do not show voltage, replace the contactor (WP0063). Set the Main Circuit Breaker to OFF. Open the motor terminal box and remove the insulators from the wire connections. With the wires spread apart, set the Main Circuit Breaker to ON and set the Air Compressor switch to AUTO. Measure the voltage from each phase wire to ground. 1) If voltage is found at all three, replace the compressor motor (WP 0056). 2) If voltage is not found at a wire, troubleshoot the wire run for the location of the open circuit.
3	Safety valves between individual stages releasing pressure.	Stage head valves not closing properly.	If the safety valve on the 2nd stage head is releasing, replace the 1st stage valve head. If the safety valve on the intermediate filter is releasing, replace the 2nd stage valve head (WP 0056).
4	No flow observed in pressurized oil sight glass after oil change.	Air trapped in oil pump.	Bleed lubrication system (WP 0042).
5	Pressurized oil sight glass exhibits air bubbles after oil change.	Air trapped in pressurized oil system.	Bleed lubrication system (WP 0042).
6	Oil is foamy and milk colored.	Water in the oil from worn cylinder rings.	Change the oil. Continue operation. Replace compressor when time allows (WP 0056).
7	High oil consumption.	Cylinder rings worn.	Continue operation. Replace compressor when time allows (WP 0056).
8	Air compressor has no oil pressure.	Air trapped in oil pump.	Bleed lubrication system (WP 0042).
9	Drive belt has rolled over	Loose or worn belt Loose motor mount	Replace belt and tighten (WP 0056). Check motor mount. Check motor mounting plate bolts. Be sure they are tight. If loose, be sure that the motor and compressor sheaves are aligned (WP 0056).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

0034 00

THIS SECTION COVERS:

Chemical Injection System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Unit

CHEMICAL SYSTEM MALFUNCTIONS

Table 11. Chemical System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Chemical pump runs but will not prime.	Output dials not set properly.	Always prime pump with speed at 80% and stroke at 80%.
		Four-function valve not set properly.	Black priming knob must be turned 1/4 – turn to pull it outward.
		Foot valve not in semi-vertical position on the bottom of the chemical tank.	Foot valve must be in vertical or semi-vertical position.
		Clogged foot valve screen.	Remove and clean foot valve screen (WP 0057)
		Suction or discharge fittings are over-tightened into pump head.	Loosen fittings slightly. If still not working, replace suction or discharge valve assemblies (WP 0057).
		Suction cartridge valve leaking.	Replace suction valve assembly (WP 0057).
		Pump diaphragm ruptured.	Replace pump diaphragm (WP 0057).
2	Chemical pump loses prime.	Chemical bucket level has dropped below the suction screen.	Refill container with solution and re-prime (WP 0014).
		Foot valve not in semi-vertical position on the bottom of the chemical tank.	Foot valve must be in vertical or semi-vertical position.
		Clogged foot valve screen.	Remove and clean foot valve screen (WP 0057).
		Suction or discharge fittings are over-tightened into pump head.	Loosen fittings slightly. If still not working, replace O-rings.
		Suction cartridge valve leaking.	Replace suction valve assembly (WP 0057).
		Pump diaphragm ruptured.	Replace pump diaphragm (WP 0057).
3	Leakage at chemical pump suction, discharge, or return tubing.	Worn tubing ends.	Cut about one inch off tubing and reconnect.
		Loose or cracked coupling nut.	Replace suction, discharge, or four-function valve assembly (WP 0057).
		Worn valve O-rings.	Replace suction, discharge, or four-function valve assembly (WP 0057).

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TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 11. Chemical System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4	Low output or failure to pump against pressure.	Worn chemical pump suction or discharge O-rings or cartridge valves.	Replace suction or discharge valve assembly (WP 0057).
		Ruptured Liquifram diaphragm.	Replace Liquifram diaphragm (WP 0057).
		Incorrect stroke length.	Increase stroke until the correct flow it noted.
		Clogged foot valve screen.	Remove foot valve screen and clean (WP 0057).
		Pump suction tube plugged or loose	Check suction tube. If plugged, replace. If loose, tighten.
		Discharge tube or Injection check valve assembly plugged	Check discharge tube. If plugged, replace. Inspect check ball, seat, and O-ring. If dirty, clean. Replace injection check valve assembly if necessary. (WP 0057)
		Plugged or defective four function valve	Remove four function valve and run pump. If pump works satisfactorily, replace four function valve (WP 0057).
5	Bisulfite Pump CP-1 will not run with selector switch in ON position.	Speed switch is in OFF position.	Set speed switch to 70%.
		Failure of Bisulfite Pump selector switch or PLC Slot #2 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Check the Slot #2 LED lights. If channel 2 is not ON: 1) Open the Slot #2 wire-way cover. Locate the IN2 terminal. Check for AC 110-volts between IN2 and ground. 2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the Bisulfite Pump selector switch (WP 0059).
		Failure of the PLC Slot #4 output card.	Continuing. If the Slot #2 Channel 2 light is ON: 1) Open the slot #4 wire-way cover. Locate the O6 terminal. Check for AC 110-volts between O6 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060).

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TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 11. Chemical System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5 cont.	Bisulfite Pump CP-1 will not run with selector switch in ON position (continued).	Failure of the PLC Slot #4 output card (continued).	If voltage is found, continue: 1) Check the connections in the junction box. Repair as needed. 2) With electrical power and the pump selector switch ON, check for voltage at the junction box. If voltage is not found, troubleshoot the wiring for open circuits. 3) If voltage is found, replace the pump (WP 0057).
		Chemical pump motor, wiring or connector failure.	
6	Bisulfite Pump CP-1 will not run with selector switch in AUTO position.	Speed switch is in OFF position.	Set speed switch to 70%.
		Failure of Bisulfite Pump selector switch or PLC Slot #2 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Check the Slot #2 LED lights. If channel 1 is not ON: 1) Open the slot #2 wire-way cover. Locate the IN1 terminal. Check for AC 110-volts between IN1 and ground. 2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the Bisulfite Pump selector switch (WP 0059.)
		Failure of the PLC Slot #4 output card.	Continuing. Raw water pump P-2 must be ON. If the Slot 2 Channel 1 light is ON: 1) Open the Slot #4 wire-way cover. Locate the O6 terminal. Check for AC 110-volts between O6 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060).
		Chemical pump motor, wiring or connector failure.	If voltage is found, continue: 1) Check the power connector on the cord and in the junction box. Repair as needed. 2) With electrical power and the pump selector switch ON, check for voltage at the junction box pins. If voltage is not found, troubleshoot the wiring for open circuits. 3) If voltage is found, replace the pump (WP 0036).
7	Antiscale Pump CP-2 or hypochlorite Pump CP-3 will not run with the selector switch in the ON position.	Speed switch is in OFF position.	Set speed switch to 70%.
		Failure of Antiscale/Chlorine Pump selector switch or PLC Slot #2 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Check the Slot #2 LED lights. If channel 3 is not ON: 1) Open the Slot #2 wire-way cover. Locate the IN3 terminal. Check for AC 110-volts between IN3 and ground.

Table 11. Chemical System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
7 cont	Antiscalant Pump CP-2 or hypochlorite Pump CP-3 will not run with the selector switch in the ON position (continued).	Failure of Antiscale/Chlorine Pump selector switch or PLC Slot #2 Input card (continued).	2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the Antiscale/Chlorine Pump selector switch (WP 0059).
		Failure of the PLC Slot #4 output card.	Continuing. If the Slot 2 Channel 3 light is ON: 1) Open the Slot #4 wire-way cover. Locate the O7 terminal (CP-2 failure) or the O8 terminal (CP-3 failure). Check for AC 110-volts between O7 or O8 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060).
		Chemical pump motor, wiring or connector failure.	If voltage is found, continue. 1) Check the power connector on the cord and in the junction box. Repair as needed. 2) With electrical power and the pump selector switch ON, check for voltage at the junction box pins. If voltage is not found, troubleshoot the wiring for open circuits. 3) If voltage is found, replace the pump (WP 0057).
8	Antiscalant Pump CP-2 or hypochlorite Pump CP-3 will not run with the selector switch in the AUTO position.	Failure of the PLC Slot #4 output card.	With the TWPS operating normally with the HP pumps on, open the OCP display panel to expose the sub-panel (WP 0060). 1) Open the Slot #4 wire-way cover. Locate the O7 terminal (CP-2 failure) or the O8 terminal (CP-3 failure). Check for AC 110-volts between IO7 or O8 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060).
		Chemical pump motor, wiring or connector failure.	If voltage is found, continue. 1) Check the power connector on the cord and in the junction box. Repair as needed. 2) With electrical power and the pump selector switch ON, check for voltage at the junction box pins. If voltage is not found, troubleshoot the wiring for open circuits. 3) If voltage is found, replace the pump (WP 0057).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

0034 00

THIS SECTION COVERS:

Product Water Distribution System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Unit

PRODUCT WATER SYSTEM MALFUNCTIONS

Table 12. Product Water System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	P-7 or P-8 Pump is rotating but is not pumping water.	Pump is air bound.	Remove the distribution hose at the Adaptor A-08 valve and open the valve to release the air.
		Worn pump impeller or wear plate.	Adjust clearance between the impeller and the wear plate. If severely worn, replace impeller and wear plate (WP 0058).
2	Pump P-7 or P-8 runs noisy or rough.	Noise is at the pump: shaft clamp is loose, impeller is rubbing on wear plate.	Check clearance between impeller and wear plate. Adjust as needed. Be sure shaft clamp is tight (WP 0058).
		Noise is at the motor (P-7 only): worn bearings.	Replace the motor (WP 0058).
3	Distribution Pump P-7 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on.	At first start up, circuit breaker CB128 manually set to OFF position (black handle down).	Set CB to On position (black handle up).
		CB128 ground fault breaker has tripped. **WARNING** **Electrical Safety. The TWPS unit must be shut down and the Main Circuit Breaker set to OFF prior to disconnecting the power cable. Failure to observe this warning may result in serious injury or death.**	Open the PDP. Locate the distribution pump P-7 CB128 ground fault breaker. If the blue lever is down, push it up to reset. If the breaker trips again, isolate the fault as follows: 1) Set the Main Circuit Breaker to OFF. Remove the power cable at the PDP. Check and clean the PDP connector pins. Install the connector cap. Set the Main Circuit Breaker to ON. Push the Start button. If the breaker trips, replace the circuit breaker. 2) Set the Main Circuit Breaker to OFF. Disconnect the power cable at the pump. Reconnect the cable at the PDP. Cap the cable connector and lay the cable end over the pump frame. Set the Main Circuit Breaker to ON. Push the start button. If the breaker trips, clean the cable connector pins. Repeat the test. If the breaker trips, replace the cable.

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TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 12. Product Water System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3 cont	Distribution Pump P7 will not run or stops after running. Green Run light is on. Red stop push button light is NOT on (continued).	CB128 ground fault breaker has tripped (continued).	3) Set the Main Circuit Breaker to OFF. With the power cable connected, disconnect the cable from the junction box to the motor. Repeat the test. If the breaker trips, clean the junction box connector pins and the inside of the box. Remove any deposites and corrosion. 4) Clean the motor cable connector pins and connect to the junction box. 5) If the breaker continues to trip, replace the motor (WP 0058).
		Damaged or corroded power cable connections.	Remove power cable. Inspect connectors for damage and corrosion. Replace entire cable if damage found. Clean connector pins if corroded.
		Damaged pump power cable.	Test electrical continuity between connector ends. Replace cable if continuity is not observed.
		Corroded pump skid junction box connectors, loose wire inside junction box.	Clean corroded connectors; repair loose wires.
		Failure of M506 motor contactor – main contacts corroded.	Open the PDP. Set the Main breaker to ON. Push the distribution pump start button. Check the voltage between the contactor output terminals and ground. If one or more do not show voltage, replace the contactor (WP 0063).
		Motor windings have failed.	Continuing, if voltage is found, replace motor (WP 0058).
4	Distribution Pump P-7 will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on.	Failure of Distribution Pump Start button or PLC Slot #1 Input card.	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Push and hold distribution pump start. Check the Slot #1 LED lights. If channel 9 is not ON: 1) Open the Slot #1 wire-way cover. Locate the IN9 terminal. Check for AC 110-volts between IN9 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #1 Input card (WP 0060). 3) If voltage is not found, replace the Distribution Pump start button (WP 0059).

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UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 12. Product Water System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
4 cont.	Distribution Pump P-7 will not run. Green Run light does not come on or pump stops while operating. Red stop push button light is NOT on (continued).	Failure of PLC Slot #4 Output card or failure of motor contactor M506 actuating coil.	Open the PDP door and turn the Main Circuit Breaker to the ON position. Locate the contactor and push and hold the distribution pump start button. If the contactor does not pull in: 1) Open the Slot #4 wire-way cover. Locate the O5 terminal. Check for AC 110 volts between O5 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060). 3) If voltage is found, replace the contactor (WP 0059).
		Failure of PLC Slot #2 Input card or motor contactor auxiliary relay.	If the contactor pulls in, find the PLC Slot #2 card. If channel 13 is OFF: 1) Open the Slot #2 wire-way cover. Locate the IN13 terminal. Check for AC 110-volts between IN13 and ground while pushing and holding the start button. 2) If voltage is found, replace the Slot #2 Input card (WP 0060). 3) If voltage is not found, replace the motor contactor (WP 0063).
5	Distribution pump P-7 was running, but stops, or fails to start and the RED stop button light is ON.	CB128 motor circuit breaker is tripped.	Open PDP and check circuit breaker CB128 (WP 0011). Reset as needed. If it trips again, troubleshoot for short circuits. With the power source secured proceed as follows: 1) Remove the pump power cable at both ends. Check for shorts between pins in the PDP connector. If found, refer to PDP troubleshooting. 2) Check for shorts between power cable connector pins. Replace cable if found. 3) Disconnect the cable between the motor and the junction box. Check for shorts between pump junction box connector pins. If found, repair the junction box. 4) Check the motor cable connector pins for shorts. If found, disconnect the cable from the motor wires and check the pins again. If a short is found, replace the cable 5) Check the motor wires for shorts. If found, replace the motor (WP 0058). 6) If no shorts are found, replace the circuit breaker (WP 0063).

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TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 12. Product Water System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5 cont.	Distribution pump P-7 was running, but stops and the RED stop button light is ON (continued).	Contactor M506 Thermal Overload has tripped.	Shut down to standby. Open the PDP and locate contactor M506 (WP 0011). Push in the Blue overload reset button (WP 0063). Close the PDP and start the pump. If noise is heard from the pump, refer to #2 above. If the failure repeats, 1) Check for binding of the motor or pump. If shaft cannot be turned freely by hand, remove the pump from the motor. If the motor shaft will not turn, replace the motor. If the motor shaft turns, complete the dissassembly of the pump, clean the pump, and replace worn parts. After assembly, be sure that the motor shaft turns freely (WP 0058). 2) Open the PDP. Leave the Main CB off. Check for loose wires: • At the top of the contactor • At the bottom of the thermal overload. • At EMP shunts V128, 129 and 130. 3) Push the contactor in by hand and hold. Check for continuity between the top and bottom connections. If not found on all legs, replace the contactor and thermal overload (WP 0063) 4) Open the connection box on the motor and check for loose wires. 5) Open the junction box on the pump skid and check for loose wires. 6) If the fault is not identified, replace the motor (WP0058).
6	Distribution Pump P-7 leaks water along the shaft.	Worn shaft seal assembly.	Replace pump seal assembly (WP 0058).
7	Distribution Pump P-7 leaks water at the inlet or outlet flange.	Deteriorated inlet flapper assembly or outlet flange gasket.	Replace inlet flapper assembly or outlet flange gasket (WP 0058).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

0034 00

THIS SECTION COVERS:
Cold Weather System

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Unit

COLD WEATHER SYSTEM MALFUNCTIONS

Table 13. Cold Weather System Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Diesel heater motor does not start at first start-up.	CB-137 is set to the OFF position.	Open PDP door and locate CB-137. Set the CB to ON if in the OFF position.
		Safety control locked out.	Push and hold red reset button for 120 seconds.
		No power or low voltage at heater.	Check that the heater is plugged in.
		Remote thermostat (if used) improperly set or defective.	Adjust remote thermostat to a higher setting. If heater still does not start, switch the thermostat switch on the electric control box to the “OFF” position. If the heater then functions properly, replace the remote thermostat assembly.
		Fan obstructed by mechanical damage or dirt.	Check fan for dirt. Clean if needed. Check for bent or damaged fan blades. Replace fan blades if damage found (WP 0064).
		Dirty or defective photocell.	Clean the photocell if dirty. Test the photocell and replace if defective. (WP 0064).
		Defective overheat switch.	Test the overheat switch and replace if defective (WP 0064).
		Defective Safety Control	Test the safety control and replace if defective (WP 0064).
		Defective motor relay.	Test the motor relay and replace if defective (WP 0064).
		Defective motor	Replace the motor (WP0064).
2	Heater will not ignite, but motor runs for a short time.	Fuel tank empty.	Check level of fuel in tank. A minimum of one gallon is required for proper operation.
		Wrong fuel type.	Make sure fuel is one of the following: DF2, DL2, or JP8.
		Water in the fuel.	Check for water in the fuel tank. If water is found, drain the tank and rinse with clean fuel. Remove and rinse the fuel filter with clean fuel (WP 0064). Fill the tank with fresh, clean fuel.

Table 13. Cold Weather System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
2 cont.	Heater will not ignite, but motor runs for a short time (continued).	Air leak at fuel filter.	Check fuel filter for air leaks and tightness of fittings where filter joins fuel line.
		Defective or damaged spark plug.	Remove spark plug from burner head. Visually inspect spark plug for cracks or worn electrodes. Adjust spark plug gap. If the heater still will not ignite, test the spark plug and replace if defective (WP 0064).
		Defective transformer.	Test the transformer and replace if defective (WP 0064).
3	Heater burns but puffs of smoke can be seen; heater will not burn steady; heater burns with odor; heater smokes continuously.	Heater running out of fuel.	Check level of fuel in tank. A minimum of about one gallon is required for proper operation.
		Wrong fuel.	Make sure fuel is one of the following: DF2, DL2, or JP8.
		Water in fuel.	Check for water in the fuel tank. If water is found, drain the tank and rinse with clean fuel. Remove and rinse the fuel filter with clean fuel (WP 0064). Fill the tank with fresh, clean fuel.
		Dirty air filters causing reduced air pressure through nozzle resulting in low fuel flow.	Make sure the air intake is not blocked. Remove and clean air filters (WP 0044).
		Dirty fuel filter.	Replace fuel filter (WP 0064).
		Fuel filter loose.	Check fuel filter for air leaks and for tightness of fittings where filter joins fuel line (WP 0064).
		Dirty fuel nozzle.	Remove and clean the burner head and fuel nozzle (WP 0064).
		Loose output airline between pump and burner head.	Tug airline at both connections to ensure that they are tight (WP 0064).
4	Flames and/or black smoke come out of stack.	Dirty fan.	Clean the fan (WP 0044).
		Air passageway through the heater is blocked.	Make sure that the air passageway through the heater is clear.
		Pump output too high causing too much fuel to be supplied.	Check and adjust pump output pressure (WP 0064).
		Fan loose or improperly located on shaft.	Check and tighten hex screw located on rear of fan hub. Make sure that the fan is in the correct location (WP 0064).
		Bent or damaged fan.	Inspect fan for damage. If damaged, replace the fan (WP 0064).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 13. Cold Weather System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5	Heater cycles intermittently.	Remote thermostat (if used) set too low.	Set remote thermostat to a higher temperature for more even operation.
		Defective remote thermostat (if used).	Set the thermostat switch on the electric control box to the "ON" position. If the heater runs evenly, replace the remote thermostat assembly.
		Defective electrical supply or defective electrical connections.	Make sure the power cord is in good condition.
		Defective overheat switch.	Test the overheat switch and replace if defective (WP 0064).
6	Heater ignites but safety control trips.	Dirty or defective photocell.	Clean the photocell if dirty. Test the photocell and replace if defective (WP 0064).
		Duct overheat switch tripped	Push and hold Red Reset button for 2 minutes. Allow TWPS inside space to cool. Restart. If the heater does not immediately stop, but stops later due to a trip of the safety control, reduce the thermostat setting until the safety no longer trips. Do not run the heater with outside temperature over 40 degrees F.
		Defective overheat switch.	Test the overheat switch and replace if defective (WP 0064).
7	All hose blankets and pump heat collars remain cold with Hose/Pump Heaters switch ON.	Failure of Hose/Pump Heaters switch or PLC slot #1 input card.	Open OCP display panel to expose the sub-panel (WP 0060). Set Main CB to ON. Set the Hose/Pump Heaters switch to ON. Check the Slot #1 LED lights. If channel 13 is not ON: 1) Open the Slot #1 wire-way cover. Locate the IN13 terminal. Check for AC 110-volts between IN13 and ground. 2) If voltage is found, replace the Slot #1 Input card (WP 0060). 3) If voltage is not found, replace the Hose/Pump Heaters switch (WP 0059).
		Failure of PLC Slot #4 Output card or failure of contactor K513 actuating coil.	Set the Hose/Pump Heaters switch OFF and then ON. Listen for the contactor to pull in. If not heard: 1) Open the Slot #4 wire-way cover. Locate the O12 terminal. Check for AC 110 volts between O12 and ground. 2) If voltage is not found, replace the Slot #4 output card (WP 0060). 3) If voltage is found, replace the contactor (WP 0063).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 13. Cold Weather System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
8	All hose blankets and pump heat collars connected to the raw water pump junction boxes remain cold.	Circuit breaker CB211or ground fault breaker 211 tripped.	Open PDP and check circuit breaker CB 211 (WP 0011). Reset as needed. If it trips again, troubleshoot for short circuits or ground fault. With the Main Circuit breaker OFF, proceed as follows:
		Circuit breaker CB211or ground fault breaker 211 tripped (continued).	1) Remove P-1 pump junction box power cable (if in use). Set breaker to ON and Hose/Pump Heaters switch to ON. If the heater circuit breaker does not trip, troubleshoot the P-1 pump heat trace system for short circuit or ground fault as applicable. Isolate fault as follows: a) Set Pump/Hose Heater switch to OFF. Reconnect power cable. Remove all heater cables. Set switch to ON. If circuit breaker trips, check to junction box and the power cable. b) Connect each of the hose heaters and the pump heating collar in turn to identify the failed heater. For each, set the Pump/Hose Heater switch to OFF. Make the connection. Set the switch to ON. When the circuit breaker trips, the last connected heater is the failed heater. 2) If the heater circuit breaker trips, troubleshoot the P-2 pump heat trace system for short circuit or ground fault as applicable. Isolate fault as follows: a) Set Pump/Hose Heater switch to OFF. Reconnect power cable. Remove all heater cables. Set switch to ON. If circuit breaker trips, check to junction box and the power cable. b) Connect each of the hose heaters and the pump heating collar in turn to identify the failed heater. For each, set the Pump/Hose Heater switch to OFF. Make the connection. Set the switch to ON. When the circuit breaker trips, the last connected heater is the failed heater.
		Open circuit in power cable or connector. Corroded connector.	Check for open circuit or corrosion. Repair/replace as needed.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 13. Cold Weather System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
9	All hose blankets and pump heat collars connected to the distribution pump junction boxes remain cold.	Circuit breaker CB207or ground fault breaker 207 tripped.	Open PDP and check circuit breaker CB207. Reset as needed. If it trips again, troubleshoot for short circuits or ground fault. With the Main Circuit breaker OFF, proceed as follows: 1) Remove P-8 pump junction box power cable (if in use). Set breaker to ON and Hose/Pump Heaters switch to ON. If the heater circuit breaker does not trip, troubleshoot the P-8 pump heat trace system for short circuit or ground fault as applicable. Isolate fault as follows: a) Set Pump/Hose Heater switch to OFF. Reconnect power cable. Remove all heater cables. Set switch to ON. If circuit breaker trips, check to junction box and the power cable. b) Connect each of the hose heaters and the pump heating collar in turn to identify the failed heater. For each, set the Pump/Hose Heater switch to OFF. Make the connection. Set the switch to ON. When the circuit breaker trips, the last connected heater is the failed heater. 2) If the heater circuit breaker trips, troubleshoot the P-7 pump heat trace system for short circuit or ground fault as applicable. Isolate fault as follows: a) Set Pump/Hose Heater switch to OFF. Reconnect power cable. Remove all heater cables. Set switch to ON. If circuit breaker trips, check to junction box and the power cable. b) Connect each of the hose heaters and the pump heating collar in turn to identify the failed heater. For each, set the Pump/Hose Heater switch to OFF. Make the connection. Set the switch to ON. When the circuit breaker trips, the last connected heater is the failed heater.
		Open circuit in power cable or connector. Corroded connector.	Check for open circuit or corrosion. Repair/replace as needed.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0034 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING PROCEDURES – TACTICAL WATER PURIFICATION SYSTEM (TWPS)

Table 13. Cold Weather System Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
10	All hose blankets and pump heat collars connected to the MF Feed Pump P-3 junction box remain cold.	Circuit breaker CB209 or ground fault breaker 209 tripped.	Open PDP and check circuit breaker CB209. Reset as needed. If it trips again, troubleshoot for short circuits or ground fault. With the Main Circuit breaker OFF, proceed as follows: 1) Remove P-3 pump junction box power cable (if in use). 2) Set breaker to ON and Hose/Pump Heaters switch to ON. 3) If the heater circuit breaker does not trip, troubleshoot the P-3 pump heat trace system for short circuit or ground fault as applicable. Isolate fault as follows: a) Set Pump/Hose Heater switch to OFF. Reconnect power cable. Remove all heater cables. Set switch to ON. If circuit breaker trips, check to junction box and the power cable. b) Connect each of the hose heaters and the pump heating collar in turn to identify the failed heater. For each, set the Pump/Hose Heater switch to OFF. Make the connection. Set the switch to ON. When the circuit breaker trips, the last connected heater is the failed heater.
		Open circuit in power cable or connector. Corroded connector.	Check for open circuit or corrosion. Repair/replace as needed.
11	One heat blanket or pump heating collar remains cold. All others connected to the same junction box are hot.	Failed connector or heat trace cable.	Check the cable for open circuit. Replace if found. Check the junction box connector for open circuit. Check both connectors for corrosion. Repair as needed.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0035 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING - TWPS CONTROL SYSTEMS

This work package covers malfunctions of the PLC, displays and instrument systems and miscellaneous control failures not covered in WP 0034 under the various TWPS systems. The malfunctions and troubleshooting procedures are presented in tables as listed.

TABLE 1: PLC PROCESSOR AND POWER SUPPLY MALFUNCTIONS

TABLE 2: OCP DISPLAY AND INSTRUMENT LOOP MALFUNCTIONS

TABLE 3: OCP MISCELLANEOUS CONTROL MALFUNCTIONS

TACTICAL WATER PURIFICATION SYSTEM (TWPS) TROUBLESHOOTING PROCEDURES UNIT TROUBLESHOOTING - TWPS CONTROL SYSTEMS

0035 00

THIS SECTION COVERS:
PLC Processor and Power Supply

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Unit .

PLC AND POWER SUPPLY MALFUNCTIONS

Table 1. PLC Processor and Power Supply Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	All lights and displays are OFF. Power ON light is OFF. Main circuit breaker is ON. E-stop is pulled put. Generator power is established to the TWPS.	Transformer primary or secondary circuit breaker is tripped.	Check primary circuit breaker CB214 and secondary circuit breaker CB216. Reset if tripped. If the breaker trips again after resetting, troubleshoot the 120 VAC circuits for a short.
2	OCP power light is ON. All other lights are OFF. Displays show zeros.	PLC rack power supply fuse blown, or power supply failure.	Open the OCP display panel to expose the sub-panel. Locate the PLC Processor at the left end of the PLC rack. If the POWER light is out, replace the 13-Slot Chassis power supply (WP 0060).
		PLC Processor, power supply or chassis failure.	If the POWER light is ON, the RUN light is OFF and the FLT light is OFF: 1) Turn the Main Breaker to OFF and then to ON. If the problem remains, continue. 2) Insert the PLC Processor key. Toggle from RUN to PROG and back to RUN. 3) If this clears the problem, return to operation. 4) If this does not clear the problem or if the failure repeats, replace the PLC Processor. If replacing the PLC Processor does not clear the problem, replace the 13-Slot Chassis power supply (WP 0060). 5) If the failure still exists, replace the chassis (WP 0060).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0035 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING - TWPS CONTROL SYSTEMS

Table 1. PLC Processor and Power Supply Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
2 cont.	Power light is ON. All other lights are OFF. Displays show zeros (continued).	Failure of analog input slot card 11 or 12 to program.	If the POWER light is ON, the RUN light is OFF and the FLT (fault) light is blinking: 1) Turn the Main Breaker to OFF and then to ON. If the problem remains, continue. 2) Insert the PLC Processor key. Toggle from RUN to PROG and back to RUN. 3) If this clears the problem, return to operation. 4) If this does not clear the problem, check the STATUS LED light on each of the analog input slot cards. If a light is found to be OFF: • Remove the card from the chassis and re-install to be sure proper connection has been made (WP 0060). • If the STATUS LED light remains off, replace the slot card.
		Memory module failure.	If the POWER light is ON, the RUN light is OFF and the FLT light is ON: 1) Turn the Main Breaker to OFF and then to ON. If the problem remains, continue. 2) Insert the PLC Processor key. Toggle from RUN to PROG and back to RUN. 3) If this clears the problem, return to operation. If the failure repeats, continue. 4) Turn the power off. Remove the memory module. Turn the power on. If the FLT light now flashes, replace the memory module (WP 0060). 5) If the FLT (fault) light does not flash, replace the PLC Processor, the 13-Slot Chassis power supply and the chassis one at a time in sequence until the failure is corrected (WP 0060).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0035 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING - TWPS CONTROL SYSTEMS

THIS SECTION COVERS:
OCP Display and Instrument Loop

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Unit .

OCP DISPLAY AND INSTRUMENT LOOP MALFUNCTIONS

Table 2. OCP Display and Instrument Loop Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Pilot light fails to light for BIT test. Or Pilot light fails to light when expected.	PLC Slot 6 Output card or light failure.	Open OCP inner panel to expose the sub-panel. Locate the Slot #6 card and the output terminal for the failed light. Perform BIT test "1" where all indicator lamps are lit. Check for AC 110 volts between the terminal and ground. 1) If voltage is not found, replace the Slot #6 output card (WP 0060). 2) If voltage is found, replace the light (WP 0059). Output terminal reference: Standby 0 Run 1 MF Clean 2 Check MF 3 MF Integrity 4 Clean Strainer 5 MF Backwash Cycle Fail 6 MF Backwash Flow Low 7 Air Pressure Low 8 MF TMP High 9 RO Tank Level Low 10 RO Temp High 11 RO Feed Pressure Low 12 RO Operating Pressure High 13 Product TDS High 14 MF Backwash 15 3) If not corrected by light replacement, check the wiring for open circuit.

Table 2. OCP Display and Instrument Loop Troubleshooting - Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
2	Display reads zeros and fails to count up for BIT test (applies to any display except the total product water display. For this display, refer to item 15 below) (continued).	PLC Slot 8, 9 or 10 output card failure or display failure.	With the BIT set to the display test, open the OCP display panel to expose the sub-panel. Locate the output card and output terminal for the failed display. Remove the red wire from the appropriate output terminal and measure the mA (0-20mA range) between the terminal and the wire (WP 0060). 1) If the reading is steadily increasing, replace the display (WP 0059). 2) If the reading is zero or near zero mA, check the wiring for open circuit. If not found, replace the output card (WP 0060). Reference: <u>Slot 8</u> Feed Water TDS O1 MF Flow O2 MF TMP O3 <u>Slot 9</u> RO Feed Flow O0 RO Feed Pressure O1 RO Reject Flow O2 RO Feed Tank Level O3 <u>Slot 10</u> RO % Salt Rejection O0 Product Flow O1 Product TDS O2
3	Display is blank.	Display failure.	Replace display (WP 0059).
4	All displays are blank. All lights function normally in BIT test.	24 VDC circuit breaker CB230 is tripped. 24 VDC instrumentation power supply failure. Power supply on time delay relay K236 failure	Reset if tripped. If it trips again, troubleshoot 24 VDC circuit for shorts (WP 0060). Check the power supply for output voltage. If not at least 20 VDC, replace the instrumentation power supply (WP 0060). Check for voltage between K236 relay socket terminal #1 and ground. If voltage is not found, replace the relay (WP 0060).
5	Feed Water TDS Display does not change as the Feed Water TDS Set dial is changed.	PLC Slot 8 output card failure or display failure. PLC Slot 11 input card or TDS Set dial failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above. Open the OCP display panel to expose the sub-panel. Locate the Slot 11 input card. Open the wire way cover and locate terminal IN2+ and IN2-. Check for VDC (0-10 VDC) between the terminals (WP 0060). 1) If voltage is noted and it changes as the TDS Set is adjusted, (but the TDS display does not change) replace the Slot 11 input card (WP 0060).

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
5 cont.	Feed Water TDS Display does not change as the Feed Water TDS Set dial is changed (continued).	PLC Slot 11 input card or TDS Set dial failure (continued).	2) If voltage is noted but it does not change as the TDS Set is adjusted, replace the TDS Set Adjust (Precision 10-Turn) potentiometer (WP 0059). 3) If there is no voltage, set the Main breaker to OFF. Remove the wires and check for resistance. 4) If there is an open circuit, replace the TDS Set Adjust (Precision 10-Turn) potentiometer (WP0059). 5) If resistance is measured and changes as the TDS Set is changed, replace the Slot 11 input card (WP 0060).
6	MF Feed Flow loop measurement error (referenced from WP0034 Table 5, Item 3 and Item 5).	PLC Slot 8 output card failure or display failure. Flow transmitter FT-101or flow sensor FE-101 failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above. Reconfigure the transmitter if the display is not blank (WP 0043). If this doesn't correct the problem perform the following. With the TWPS operating normally, open the Instrument/Solenoid Panel to observe the flow transmitter. 1) If the display is blank, shutdown to standby. Set the Main breaker to OFF and then back to ON. If the display remains blank after repeating this procedure several times, replace the transmitter (WP 0062). 2) If the WARNING CHECK STATUS message flashes on the display, refer to Flow Loop Status Checking in WP 0062. 3) If the STATUS: ANALIZER screen indicates FAIL, replace the transmitter (WP 0062). 4) If the STATUS: SENSOR screen indicates FAIL, replace the sensor (WP 0062). 5) If the EPROM ERROR (LOAD DEFAULTS?) message is displayed, follow the procedure to configure the transmitter. (WP 0062). 6) If the display does not change as the MF Feed Flow controls automatically to maintain the RO Feed Tank level, replace the flow sensor. If the problem continues, replace the flow transmitter (WP 0062). 7) If the display is very unsteady while the TWPS is operating normally, replace the flow sensor (WP 0062). 8) If during the shell sweep backwash step the display does not show a rapid increase in flow, or if the flow is less than 200 gpm, replace the flow sensor (WP 0062).

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
6 cont.	MF Feed Flow loop measurement error (referenced from WP 0034 Table 5, Item 3 and Item 5) (cont.).	PLC Slot 11 input card or Flow Transmitter FT-101 output failure.	With the TWPS in STANDBY, open the Instrument/Solenoid Panel and set the flow transmitter output as follows (WP0062): 1) Press the MAIN MENU key. Use the up/down arrows to display the TEST/MAINT screen. 2) Press ENTER key to display the STATUS screen. 3) Press the down arrow until the OUTPUT screen appears. 4) Press ENTER key to display OUTPUT? XX.XX mA 5) Use the arrows to change the display to 20.00 mA. When the steps below are completed, press MENU and then ESC to return to the normal display screen. Open the OCP display panel to expose the sub-panel. Locate the Slot 11 input card (WP 0060). Open the wire way cover and locate terminal IN 3+. Remove the wire and turn the terminal screw back in. Measure the mA (4-20 mA range) between the terminal and the wire (WP 0060). 1) If the mA reading is 20 mA, and the OCP MF Feed Flow display does not read approximately 390 gpm, replace the Slot 11 input card (WP 0060). 2) If the mA reading is not 19.5 to 20.5, replace Flow Transmitter FT-101(WP 0062).
7	TMP cannot be adjusted to zero (with TWPS properly in STANDBY). Or TMP reading is suddenly very high and the TMP High alarm is on.	PLC Slot 8 output card failure or display failure. Pressure transmitter PT-101 or 102 failure, or open circuit Short circuit, Pressure Transmitter PT-101 failure or Slot 12 Input card failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above. With the TWPS operating normally, open the OCP display panel to expose the sub-panel. Locate the Slot 12 input card (WP 0060). 1) Locate the channel “0” status light. If blinking, check the PT101 cable and connector for open circuit. If an open circuit is not found, replace PT-101. 2) Locate the channel “1” status light. If blinking, check the PT-102 cable and connector for open circuit. If an open circuit is not found, replace PT-102. Open OCP display panel. Locate the Slot 12 input card on the sub-panel (WP 0060). If module status light is not lit, replace card. 1) Remove IN0+ wire and turn terminal screw back in. Measure the mA (4-20mA range) between the wire and the terminal.

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
7 cont	TMP cannot be adjusted to zero (with TWPS properly in STANDBY). Or TMP reading is suddenly very high and the TMP High alarm is on (continued).		2) If reading is approximately 20mA, perform continuity checks with PDP main breaker OFF. Perform continuity check on wiring from input card to connector pins. Check for short circuit between pins A and B with connector disconnected from transducer and both wires disconnected from input card. Replace cable if short circuit found.If short circuit not found, replace PT-101. 3) If problem re-occurs replace Slot 12 input card.
		Pressure Transmitter PT-102 failure or open circuit failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 12 input card (WP 0060). If module status light is not lit, replace card. 1) Remove IN1+ wire and turn terminal screw back in. Measure the mA (4-20mA range) between the wire and the terminal 2) If reading is approximately 20mA, perform continuity checks with PDP main breaker OFF. Perform continuity check on wiring from input card to connector pins. Check for short circuit between pins A and B with connector disconnected from transducer and both wires disconnected from input card. Replace cable if short circuit found. 3) If short circuit not found, replace PT-102. 4) If problem re-occurs replace Slot 12 input card.
		PLC Slot 11 input card or MF Transmembrane Zero Adjust dial failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 11 input card. Open the wire way cover and locate terminal IN1+ and IN1-. Check for VDC between the terminals (WP 0060). 1) If voltage is noted and it changes as the TMP Zero is adjusted, (but the TMP display does not change) replace the Slot 11 input card (WP 0060). 2) If voltage is noted but it does not change as the TMP Zero is adjusted, replace the MF Transmembrane Zero Adjust (1000 Ohm) potentiometer (WP 0059).

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
7 cont	TMP cannot be adjusted to zero (with TWPS properly in STANDBY). Or TMP reading is suddenly very high and the TMP High alarm is on (continued).		3) If there is no voltage, set the Main breaker to OFF. Remove the wires and check for resistance. If there is an open circuit, replace the MF Transmembrane Zero Adjust (1000 Ohm) potentiometer (WP 0059). If resistance is measured and it changes as the MF Transmembrane Zero Adjust is changed, replace the Slot 11 input card (WP 0060).
		PLC Slot 12 input card failure	If other faults have not been indicated, replace the Slot 12 input card (WP 0060).
8	RO Feed Pressure display does not change as the Main Pressure control valve is closed.	PLC Slot 9 output card failure or display failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above.
		Pressure transmitter PT-302 or PLC Slot 12 input card failure, RO feed pressure reading high.	Open the OCP display panel to expose the sub-panel. Locate the Slot 12 input card (WP 0060). If module status light is not lit, replace card. 1) Remove IN2+ wire and turn terminal screw back in. Measure the mA (4-20mA range) between the wire and the terminal. 2) If reading is approximately 20mA, perform continuity checks with PDP main breaker OFF. Perform continuity check on wiring from input card to connector pins. Check for short circuit between pins A and B with connector disconnected from transducer and both wires disconnected from input card. Replace cable if short circuit found. 3) If short circuit not found, replace PT-302. 4) If problem re-occurs replace Slot 12 input card.
		Pressure transmitter PT-302 or PLC Slot 12 input card failure, RO feed pressure reading low.	Open the OCP display panel to expose the sub-panel. Locate the Slot 12 input card (WP 0060). If module status light is not lit, replace card. 1) Remove IN2+ wire and turn terminal screw back in. Measure the mA (4-20mA range) between the wire and the terminal. 2) If reading is still less than 3.75mA, replace the transmitter (WP 0062). 3) If reading is still less thank 3.75mA after replacing the transmitter, check the connector, cable, and panel wiring for open circuits. Perform these checks with the PDP OFF.

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
8 cont.	RO Feed Pressure display does not change as the Main Pressure control valve is closed (continued).		4) If no open circuits are found and the current reading is still less than 3.75mA with the PDP ON, replace Slot 12 input card.
9	Reject flow reading is not as expected from previous operational data.	PLC slot 9 output card failure or display failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above.
		Flow transmitter FT-401or flow sensor FE-401 failure.	Reconfigure the transmitter if the display on the instrument panel is not blank (WP 0043). If this doesn't correct the problem perform the following. With the TWPS operating normally, open the Instrument Panel to observe the flow transmitter. 1) If the display is blank, shutdown to standby. Set the Main breaker to OFF and then back to ON. If the display remains blank after repeating several times, replace the transmitter (WP 0062). 2) If the WARNING CHECK STATUS message flashes on the display, refer to Flow Loop Status Checking in WP 0062. 3) If the STATUS: ANALIZER screen indicates FAIL, replace the transmitter (WP 0062). 4) If the STATUS: SENSOR screen indicates FAIL, replace the sensor (WP 0062). 5) If the EPROM ERROR (LOAD DEFAULTS?) message is displayed, follow the procedure to configure the transmitter (WP0062). 6) If the reject display on the flow transmitter does not change as the as the product flow is changed, replace the flow sensor (WP 0062). If the problem is not corrected, replace the flow transmitter (WP 0062). 7) If the display is very unsteady while the TWPS is operating normally, replace the flow sensor (WP 0062).
		PLC slot 11 input card or Flow Transmitter FT-401 output failure.	With the TWPS in STANDBY, open the Instrument/Solenoid Panel and set the flow transmitter output as follows (WP 0062): Press the MAIN MENU key. Use the up/down arrows to display the TEST/MAINT screen. 1) Press ENTER key to display the STATUS screen. 2) Press the down arrow until the OUTPUT screen appears. 3) Press ENTER key to display OUTPUT? XX.XX mA

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
9 cont.	Reject flow reading is not as expected from previous operational data (continued).		4) Use the arrows to change the display to 20.00 mA. 5) When the steps below are completed, press MENU and then ESC to return to the normal display screen.
		PLC slot 11 input card or Flow Transmitter FT-401 output failure (continued).	Open the OCP display panel to expose the sub-panel. Locate the Slot 11 input card. Open the wire way cover and locate terminal IN4+. Remove the wire and turn the terminal screw back in. Measure the mA (4-20mA) between the terminal and the wire (WP 0060). 1) If the mA reading is 20 mA, and the flow meter display does not read approximately 50 gpm, replace the slot 11 input card (WP 0060). 2) If the mA reading is not 19.5 to 20.5, replace the transmitter (WP 0062).
10	RO Feed Tank % Level reads 0 with level in the tank, reads a level other than actual by observation, or the reading changes up and down rapidly.	PLC Slot 9 output card failure or display failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above.
		Level transmitter LT-201 or PLC Slot 12 input card failure, RO feed tank level high.	Open the OCP display panel to expose the sub-panel. Locate the Slot 12 input card (WP 0060). If module status light is not lit, replace card. 1) Remove IN3+ wire and turn terminal screw back in. Measure the mA (4-20mA range) between the wire and the terminal. 2) If reading is approximately 20mA, perform continuity checks with PDP main breaker OFF. Perform continuity check on wiring from input card to connector pins. Check for short circuit between pins A and B with connector disconnected from transducer and both wires disconnected from input card. Replace cable if short circuit found. 3) If short circuit not found, replace LT-201. 4) If problem re-occurs replace Slot 12 input card.
		Level transmitter LT-201 or PLC Slot 12 input card failure, RO feed tank level low.	Open the OCP display panel to expose the sub-panel. Locate the Slot 12 input card (WP 0060). If module status light is not lit, replace card. 1) Remove IN3+ wire and turn terminal screw back in. Measure the mA (4-20mA range) between the wire and the terminal.

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
10 cont.	RO Feed Tank % Level reads 0 with level in the tank, reads a level other than actual by observation, or the reading changes up and down rapidly (continued).	Level transmitter LT-201 or PLC Slot 12 input card failure, RO feed tank level low.	2) If reading is still less than 3.75mA, replace the transmitter (WP 0062). 3) If reading is still less thank 3.75mA after replacing the transmitter, check the connector, cable, and panel wiring for open circuits. Perform these checks with the PDP OFF. 4) If no open circuits are found and the current reading is still less than 3.75mA with the PDP ON, replace Slot 12 input card.
11	RO % Salt Rejection display is very low or very high compared to previous operational data.	Conductivity measurement loop failure. Product flow loop failure. RO Feed Temperature loop failure. Feed TDS loop failure.	The RO % Rejection is calculated from the TDS input, measured conductivity, the product flow and RO Feed Temperature. One or more of these measurement loops has failed. Refer to individual troubleshooting items. Refer to Item 5.
12	Product flow reading is not as expected from previous operational data.	PLC Slot 10 output card failure or display failure. Flow transmitter FT-501or flow sensor FE-501 failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above. Reconfigure the transmitter if the display inside the instrument panel is not blank (WP 0043). If this doesn't correct the problem perform the following. With the TWPS operating normally, open the Instrument Panel to observe the flow transmitter. 1) If the display is blank, shutdown to standby. Set the Main breaker to OFF and then back to ON. If the display remains blank after repeating several times, replace the transmitter (WP 0062). 2) If the WARNING CHECK STATUS message flashes on the display, refer to Flow Loop Status Checking in WP0062. 3) If the STATUS: ANALIZER screen indicates FAIL, replace the transmitter (WP 0062). 4) If the STATUS: SENSOR screen indicates FAIL, replace the sensor (WP 0062). 5) If the EPROM ERROR (LOAD DEFAULTS?) message is displayed, follow the procedure to configure replace the transmitter (WP 0062). 6) If the reject display on the flow transmitter does not change as the product flow is changed, replace the flow sensor (WP 0062). If the problem is not corrected, replace the flow transmitter.

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
12 cont.	Product flow reading is not as expected from previous operational data (continued).		7) If the display is very unsteady while the TWPS is operating normally, replace the flow sensor (WP 0062).
		PLC slot 11 input card or Flow Transmitter FT-501 output failure.	With the TWPS in STANDBY, open the Instrument/Solenoid Panel and set the flow transmitter output as follows (WP 0062): 1) Press the MAIN MENU key. Use the up/down arrows to display the TEST/MAINT screen. 2) Press ENTER key to display the STATUS screen. 3) Press the down arrow until the OUTPUT screen appears. 4) Press ENTER key to display OUTPUT? XX.XX mA 5) Use the arrows to change the display to 20.00 mA. 6) When the steps below are completed, press MENU and then ESC to return to the normal display screen.
		PLC slot 11 input card or Flow Transmitter FT-501 output failure (continued).	Open the OCP display panel to expose the PLC. Locate the slot 11 input card. Open the wire way cover and locate terminal C4+. Remove the wire and turn the terminal screw back in. Measure the mA (4-20mA) between the terminal and the wire (WP 0060). 1) If the mA reading is 20 mA and the flow meter display does not read approximately 32, replace the Slot 11 input card (WP 0060). 2) If the mA reading is not 19.5 to 20.5, replace the transmitter (WP 0062).
13	Product TDS reading is not as expected from previous operational data or not in agreement with portable TDS meter.	Conductivity switch in the OFF position.	Set conductivity switch (on Instrument/ Solenoid Panel) to the ON position.
		Conductivity switch failure.	Check for 110 VAC between the switch outer terminal screw and ground. If not found, replace the switch.
		PLC Slot 10 output card failure or display failure.	Conduct BIT test and stop at the display test. If the display does not count up, refer to Item 2 above.
		Conductivity transmitter CT-501or conductivity sensor CE-501A or 501B failure.	Reconfigure the transmitter if the display is not blank inside the Instrument Panel (WP 0043). If this doesn't correct the problem perform the following. With the TWPS operating normally, open the Instrument/Solenoid Panel to observe the conductivity transmitter. 1) If the display is blank, replace the transmitter (WP 0062). 2) If the WARNING CHECK STATUS message flashes on the display, refer to Conductivity Loop Status Checking in WP0062.

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
13 cont.	Product TDS reading is not as expected from previous operational data or not in agreement with portable TDS meter (continued).	Conductivity transmitter CT-501or conductivity sensor CE-501A or 501B failure (continued).	3) If the STATUS: ANALIZER screen indicates FAIL, replace the transmitter (WP 0062). 4) If the STATUS: SENSOR screen indicates FAIL, replace the sensor (WP 0062).
		Conductivity sensor CE-501A or CE-501B failure.	Shut down to STANDBY and drain the product piping. 1) Remove the CE-501A sensor and rinse and place in the low range calibration solution. Note the reading on the transmitter display. 2) Remove the CE-501B sensor and rinse and place in the high range calibration solution. Note the reading on the transmitter display. 3) If the transmitter fails to display the calibration solution conductivity value for both tests, replace the transmitter (WP 0062). 4) If the transmitter fails to display the calibration solution conductivity value for one sensor only, replace the sensor (WP 0062).
		PLC Slot 11 input card or Conductivity Transmitter CT-501 output failure.	With the TWPS in STANDBY, open the Instrument Panel and set the conductivity transmitter output as follows (WP0062): 1) Press the MAIN MENU key. Use the up/down arrows to display the TEST/MAINT screen. 2) Press ENTER key to display the STATUS screen. 3) Press the down arrow until the OUTPUT 1 screen appears. 4) Press ENTER key to display OUTPUT? XX.XX mA. 5) Use the arrows to change the display to 20.00 mA. 6) When the steps below are completed, press MENU and then ESC to return to the normal display screen. Open the OCP display panel to expose the sub-panel. Locate the slot 11 input card. Open the wire way cover and locate terminal C6+. Remove the wire and turn the terminal screw back in. Measure the mA between the terminal and the wire (WP 0060). 1) If the mA reading is 20mA, replace the Slot 11 input card (WP 0060). 2) If the mA reading is not between 19.5 and 20mA, replace the transmitter (WP 0062). 3) Repeat the complete procedure starting back at the Main Menu for Output 2 and using C7+ for mA measurements.

Table 2. OCP Display and Instrument Loop Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
14	Product totalizer fails to count up when product flow is indicated, or does not display properly during BIT test.	PLC Slot 5 output card, solid state relay display failure.	Conduct BIT test and stop at the display test. If the display does not count up, open the OCP display panel to expose the PLC. Locate the slot 5 output card. Open the wire way cover and locate terminal 14. Measure for 120 VAC between the terminal and ground. WP0060 1) IF a momentary voltage is not measured every 2 to 3 seconds during the BIT test, replace the slot 5 output card. 2) If a momentary voltage is measured, locate the R535 and R536 solid state relays. Remove the R535 relay and replace it with the R536 relay. Repeat the BIT test. If the totalizer works properly, replace the relay. 3) If replacing the relay does not correct the fault, replace the Slot 5 output card.
15	Hour meter fails to run when the HP pumps are running.	Hour meter failure.	Check for voltage at terminal 14 on M504 and M505 with the HP pump running. If not found, replace the hour meter (WP 0059).
16	High Temperature Alarm with temperature at RO Feed Tank temperature gauge (TI-201) much less than 110 degrees F.	Temperature transmitter TT-201 or PLC. Slot 12 Input card failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 12 input card. Open the wire way cover and locate terminal IN5+. Remove the wire and turn the terminal screw back in. Measure the mA (4-20mA) between the terminal and the wire (WP 0060) 1) If the reading is greater than 9mA, check the cable and panel wiring for short circuits. 2) If no short circuits, replace the temperature transmitter. (WP 0062) 3) If the reading is less than 9mA, replace the Slot 12 card (WP 0060).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0035 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING - TWPS CONTROL SYSTEMS

THIS SECTION COVERS:
OCP MISCELLANEOUS CONTROL MALFUNCTIONS

INITIAL SETUP:
TWPS Set Up
Maintenance Level
Unit .

OCP MISCELLANEOUS CONTROL MALFUNCTIONS

Table 3. OCP Miscellaneous Control Troubleshooting.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
1	Pushing the TEST button does not start the BIT (display shows 1) after 10-seconds.	(BIT) TEST push button or PLC Slot 3 input card failure.	Open the OCP display panel to expose the sub-panel. Locate the PLC Slot 3 card. Push and hold the Test button. 1) If the channel 8 light comes ON, replace the Slot 3 input card (WP 0060). 2) If the channel 8 light does not come on, check for AC-Volts between terminal 8 and ground. If voltage is found, replace the Slot 3 input card (WP 0060). 3) If voltage is not found, replace the Test push button (WP 0059).
2	Air compressor will not start. Pumps will not start. Green power light is ON. Displays and lights are working.	Emergency Stop 3-Pole Relay K235 or Emergency Stop push button failure.	Open the OCP display panel to expose the sub-panel. Locate the 3-Pole Relay (WP 0060). With the Main Breaker set to ON and the Emergency Stop pulled out, check for AC-Volts between terminal 2 on the base of the relay and ground. 1) If voltage is found, replace the 3-pole relay (WP 0060). 2) If voltage is not found, replace the Emergency Stop push button (WP 0059).
3	MF Clean sequence failures: Failure to backwash with MF Clean switch set to Backwash.	PLC Slot 3 input card or MF Clean (Rotary) Switch failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the MF Clean switch to Backwash. 1) If the channel 3 light is ON, replace the Slot 3 input card (WP 0060). 2) If the channel 3 light is OFF, open the wire way and check for AC-Volts between terminal IN3 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 3) If there is no voltage, replace the MF Clean (Rotary) Switch (WP 0059).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0035 00**
TROUBLESHOOTING PROCEDURES
UNIT TROUBLESHOOTING - TWPS CONTROL SYSTEMS

Table 3. OCP Miscellaneous Control Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3 cont	Initial drain failures to occur when MF Clean Switch is set to Drain #1.	SV-903 failure.	Return to standby. Step through the BIT test to the test for SV-903. If the valve fails to operate, refer to WP0034, Table 4.
		PLC Slot 3 input card or MF Clean (Rotary) Switch failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the MF Clean switch to Drain #1. 1) If the channel 4 light is ON, replace the Slot 3 input card (WP 0060). 2) If the channel 4 light is OFF, open the wire way and check for AC-Volts between terminal IN4 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 3) If there is no voltage, replace the MF Clean (Rotary) Switch (WP 0059).
	Clean cycle does not automatically start the RO Feed Pump and fill the MF when the MF Clean Switch is set to Fill/Recirc.	PLC Slot 3 input card or MF Clean (Rotary) Switch failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the MF Clean switch to Fill/Recirc. 1) If the channel 3 and 4 lights are ON, replace the Slot 3 input card (WP 0060). 2) If the channel 3 or 4 light is OFF, open the wire way and check for AC-Volts between terminals IN3 or IN4 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 3) If there is no voltage, replace the MF Clean (Rotary) Switch (WP 0059).
	RO Feed Pump does not stop when the MF Clean Switch is set to Soak.	PLC Slot 3 input card or MF Clean (Rotary) Switch failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the MF Clean switch to Soak. 1) If the channel 5 light is ON, replace the Slot 3 input card (WP 0060). 2) If the channel 5 light is OFF, open the wire way and check for AC-Volts between terminal IN5 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 3) If there is no voltage, replace the MF Clean (Rotary) Switch (WP 0059).

Table 3. OCP Miscellaneous Control Troubleshooting – Continued.

ITEM	MALFUNCTION	POSSIBLE CAUSES	CORRECTIVE ACTION
3 cont.	Drain cycle fails to occur when MF Clean Switch is set to Drain #3.	SV-903 failure.	Return to standby. Step through the BIT test to the test for SV-903. If the valve fails to operate, refer to WP 0034, Table 4.
		PLC Slot 3 input card or MF Clean (Rotary) Switch failure	Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the MF Clean switch to Fill/Recirc. 1) If the channel 4 and 5 lights are ON, replace the Slot 3 input card (WP 0060).If the channel 4 or 5 light is OFF, open the wire way and check for AC-Volts between terminals IN4 or IN5 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 2) If there is no voltage, replace the MF Clean (Rotary) Switch (WP 0059).
	Rinse cycle fails to occur when MF Clean Switch is set to Rinse.	PLC Slot 3 input card or MF Clean (Rotary) Switch failure.	Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the MF Clean switch to Fill/Recirc. 1) If the channel 3, 4 and 5 lights are ON, replace the Slot 3 input card (WP 0060). 2) If the channel 3, 4 or 5 light is OFF, open the wire way and check for AC-Volts between terminals IN3, IN4 or IN5 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 3) If there is no voltage, replace the MF Clean (Rotary) Switch (WP 0059).
	Drain #2 fails to occur automatically 10-seconds after advancing the switch to the Drain #2 position.	PLC Slot 3 input card or MF Clean (Rotary) Switch failure	Open the OCP display panel to expose the sub-panel. Locate the Slot 3 card. Set the MF Clean Switch to Drain #2. 1) If the channel 3, 3 and 5 lights are ON, replace the Slot 3 input card (WP 0060). 2) If the channel 3, 3 or 5 light is OFF, open the wire way and check for AC-Volts between terminals IN3 or IN5 and ground. If there is voltage, replace the Slot 3 input card (WP 0060). 3) If there is no voltage, replace the MF Clean (Rotary) Switch (WP 0059).

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES SERVICE UPON RECEIPT

0036 00

INITIAL SETUP:

Maintenance Level
Operator/Crew
Tools
Operator's Tool Kit (3390116) (BII)
References:
TM 5-6115-545-12
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS received from long-term storage or initial issue.

GENERAL

This work package contains the information necessary for maintenance personnel to ensure that the TWPS is ready for use when issued from long-term storage or at initial issue. The procedures covered in this work package include:

- (Determine) Site Requirements
- Unpack
- Check Unpacked Equipment
- (Perform) Preliminary Servicing and Adjustment of Equipment
- RO Element Simulators Replacement
- Knot CAC Ropes
- Deprocess Unpacked Equipment

SITE REQUIREMENTS

When not in use, the TWPS, with the exception of temperature sensitive items, does not require special siting or shelter. If shelter is available, storing the TWPS under cover will minimize routine maintenance. Refer to WP 0002, Equipment Description and Data under the heading **EQUIPMENT DATA** for general storage temperature limitations. Refer to Preparation for Storage (WP 0031 and WP 0032) for specific storage instructions and storage of temperature sensitive items. For site requirements during operation, refer to WP 0004, Site Selection and Component Location.

UNPACK

1. For units received from initial issue, remove the stretch wrap from around the unit. This is provided to give evidence of tampering after the unit is prepared for storage. If the stretch wrap is missing or shows signs of tampering, notify a superior officer.
2. For units received from initial issue, remove wire ties installed around equipment tie-down strap latches. These are provided to give evidence of tampering after the unit is prepared for storage. If the wire ties are missing or the straps show signs of tampering, notify a superior officer.
3. Unload the TWPS. Refer to WP 0005, Equipment Off-Loading – Army Unit and WP 0006 Equipment Off-Loading – Marine Corps Unit.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0036 00**
OPERATOR MAINTENANCE PROCEDURES
SERVICE UPON RECEIPT

4. For units received from initial issue, remove the strap bands from the storage boxes. These are provided to give evidence of tampering after the unit is prepared for storage. If the straps are missing or show signs of tampering, notify a superior officer.
5. (A-TWPS only) For units received from initial issue, the cold weather hose blankets are stretched wrapped. These may be left in place until used on deployment.
6. (A-TWPS only) For units received from initial issue, remove the TQG sealing material to include, but not limited to, the following:
    a. Transport packaging.
    b. Air cleaner sealing tape.
    c. Generator sealing tape.
    d. Any other packing material as listed in TM 5-6115-545-12.
    e. Tie down cables, if installed.
7. AC-350 Sodium Hydroxide (caustic) and calcium hypochlorite are stored and issued separately.
8. The RO elements and the MF elements may be installed or may be stored and issued separately. A Tag attached to the handle of V-502 provides notice if the RO vessels are empty or if the RO simulators are installed. If there is no tag, the RO elements are installed and preserved. A tag attached to the main circuit breaker handle provides notice if the MF elements have been removed. If there is no tag, the MF elements are installed and preserved.

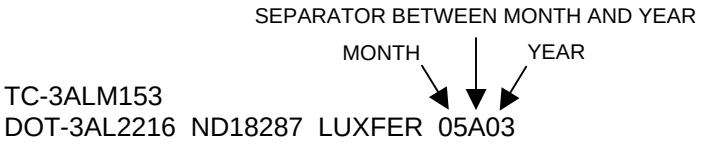
CHECK UNPACKED EQUIPMENT:

1. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on SF 361, Transportation Discrepancy Report.
2. Conduct a complete inventory against the COEI and BII lists. Report all discrepancies in accordance with applicable service instructions (e.g., for Army instructions, see DA PAM 738-750).
3. Check the general condition of the TWPS skid and all COEI and BII. Report all discrepancies in accordance with applicable service instructions.
4. (A-TPWS only) Check to see that NBC filter media is packed inside the NBC filter tank. Check the shelf life data for the ion exchange resin. Replace if expired or near expiration.

PRELIMINARY SERVICING AND ADJUSTMENT OF EQUIPMENT

1. Check the warnings at the front of this manual.
2. Lubricate the TWPS in accordance with the lubrication instructions in WP 0038, PMCS.
3. Adjust air compressor belt tension. Check the motor mount base bolts for tightness. Remove the caution tag from the belt guard.
4. Install the air compressor inlet air filter AF-1 housing and a new filter cartridge. The housing is removed and tied to the compressor for storage. The cartridge is stored in BII Box #1. Refer to WP 0042 00, Air System Operator Maintenance Procedures, under the headings **SERVICE** and **Intake Filter Element AF-1**. Remove the caution tag from the belt guard.
5. Open air purification filter AF-2 and install a new air purification cartridge. The cartridge is stored in BII Box #1. Refer to WP 0042 00, Air System Operator Maintenance Procedures, under the headings **SERVICE** and **AF-2 Purifier Filter Cartridge**. Remove the caution tag.
6. Check the charge on the fire extinguisher. Check the expiration date and replace if necessary.
7. Make sure that the eyewash station contains new un-opened bottles. Check the expiration date. Replace as necessary.

8. (A-TWPS only) Check the shelf life on the WQAS-P chemicals. Replace as necessary.
9. (MC-TWPS only) Check the shelf life of the TDS meter calibration standards. Replace as necessary.
10. (MC-TWPS only) Check the shelf life of the chlorine analysis kit chemicals. Replace as necessary
11. Install the MF elements if the caution tag tied to the main circuit breaker states that they are not installed. Refer to WP 0040, Micro-Filtration System Operator Maintenance Procedures, under the headings **REPLACE** and **Micro-Filter (MF) Element**.
12. Install the RO elements if the caution tag tied to valve V-502 states that they are not installed. Refer to the instructions in this WP under the heading **REPLACE RO SIMULATORS**. For training and for initial operational checks, the RO simulators may be left in place.
13. Check the hydro-test date on the air receiver tank. The date (month and year) is stamped into the metal near the top of the tank along with other numbers. An example is shown below. Notify Direct Support to have the air receiver tank hydro-tested if the date is close to or greater than 5 years old.



14. Service the TQG, install batteries and bolts. Refer to TM 5-6115-545-12.
15. Complete all preoperational PMCS

RO ELEMENT SIMULATORS REPLACEMENT:

Each TWPS is shipped to the user with an RO Element Simulator inside each of the RO vessels instead of two RO elements. Once an RO element is wetted (used) it must be shipped and/or stored with a chemical preservation solution to prevent the elements from deteriorating. For this reason, the elements are typically not installed in the RO vessels until the TWPS is deployed for the production of potable water.

The RO element simulators may be removed and replaced with RO elements upon receipt of the TWPS or they may be replaced just prior to deployment. The instructions that follow describe the steps for removing an RO element simulator and replacing it with two RO elements.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0036 00**
OPERATOR MAINTENANCE PROCEDURES
SERVICE UPON RECEIPT

Maintenance Level:
Operator
Parts (TM 10-4610-309-24P):
10 RO elements (fluid filter element) with one brine seal on each element
10 straight adapters with two o-rings and one seal on each adapter
5 solid interconnecters
20 o-rings (four for each solid interconnecter)
5 thrust rings
Materials:
Pad, scouring (WP 0079, Table 1, item 31)
Mild soap solution
Glycerin (WP 0079, Table 1, item 21)
Clean water
Antiseizing tape (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS shut down and fully drained

1. Remove the following piping (see Figure 1):
    a. For RO element 10:
        1) Remove the grooved coupling at the RO reject port.
        2) Remove the grooved coupling in the U-shaped RO reject pipe run.
        3) Disconnect the hose from Main Pressure Control Valve HCV-401.
        4) Disconnect the hose from Auxiliary Pressure Control Valve HCV-401A.
        5) Remove the flex strut pipe support that secures the RO reject pipe run to the floor.
        6) Remove the RO reject pipe run that includes Main Pressure Control Valve HCV-401, Auxiliary Pressure Control Valve HCV-401A, Pressure Indicator PI-401, and RO Vessel Drain Valve V-408.
    b. For RO Element 5:
        1) Disconnect the sample/drain hose from MF Filtrate Sample Valve V-204.
        2) Remove MF Filtrate Sample Valve V-204 to provide room to install the RO elements after the RO element simulator has been removed.
    c. For RO Element 8:
        1) Remove the two sanitary clamps from the MF lower shell backwash pipe run.
        2) Remove the pipe section that was secured by the two sanitary clamps and remove the two sanitary clamp gaskets.
    d. For all RO Elements:
        1) Tag and remove the black product water hoses from the 3-way valves.
        2) Tag and remove the clear sample/drain hoses from the 3-way valves.
        3) Tag and remove the grooved couplings and feed/reject pipes from the RO vessel feed/reject ports.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0036 00**
OPERATOR MAINTENANCE PROCEDURES
SERVICE UPON RECEIPT

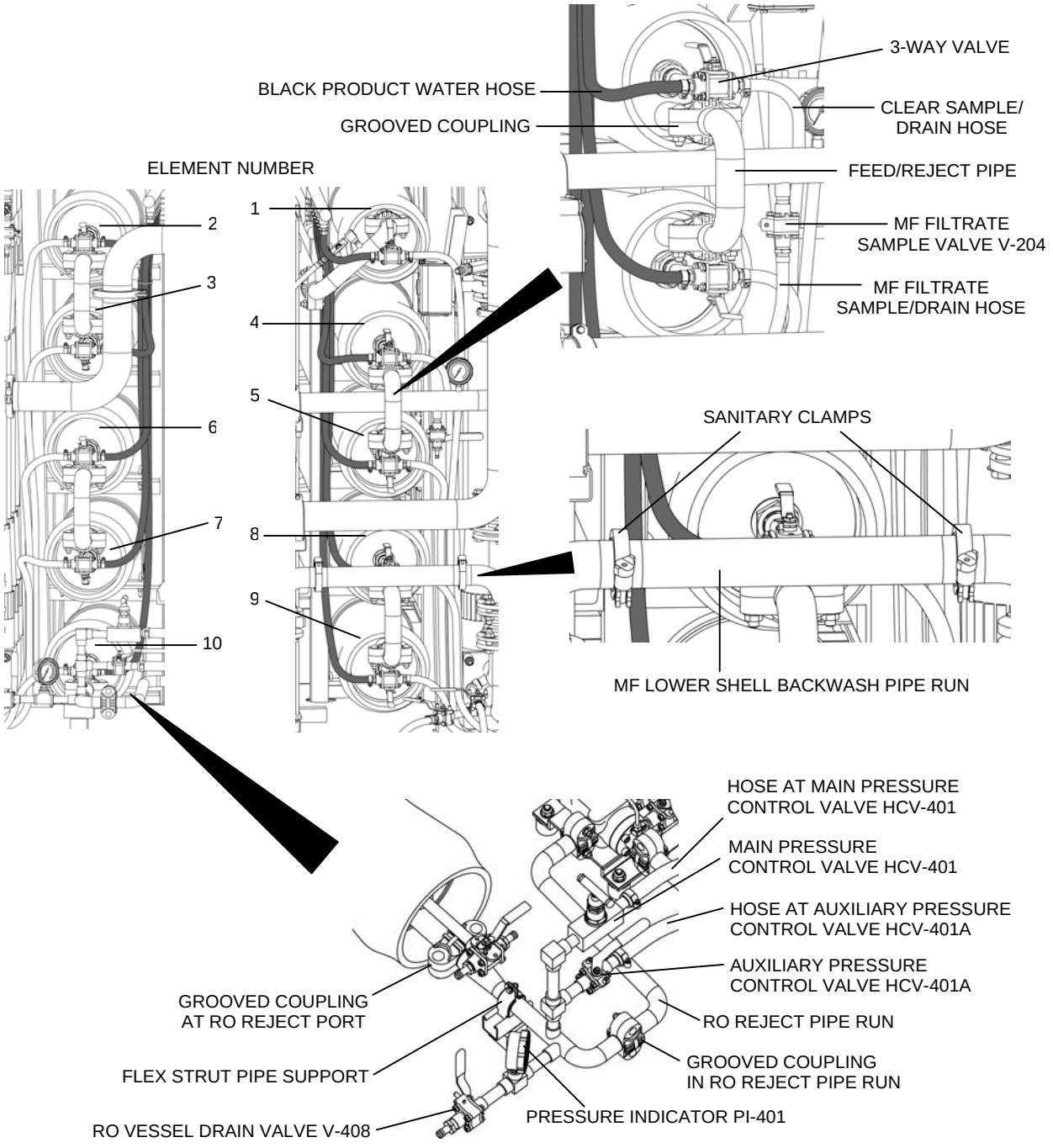


Figure 1. Parts to Remove in Order to Remove RO Element Simulators.

2. Remove the end cap from the vessel (see Figure 2).

CAUTION

Avoid hitting or levering against the vessel or applying undue force when removing the retaining ring and the end cap. Failure to observe this caution may damage the vessel that could lead to a catastrophic failure.

NOTE

Before removing the end cap a line must be marked from the end cap to the RO vessel. The line will be used to align the end cap with the vessel when the end cap is reinserted in the vessel. The end cap must be inserted so that the raw water pipes can be connected to it without having to rotate the end cap.

a. Using a grease pencil or other marker, draw a single orientation line from the end cap to the vessel.
b. Lift the end of the retaining ring up and out of the stainless steel groove.
c. After starting the ring out of the groove, ease it out.
d. Grasp the 3-way valve and pull the end cap straight out.

NOTE

A sharp forceful tug may be needed to start the end cap assembly moving. It may be helpful to rock the end cap slightly to break the end cap seal bond.

e. If the end cap seal remains in the vessel bore after the end cap is removed, remove the end cap seal.
f. Repeat the end cap removal steps for the end cap at the other end of the vessel.

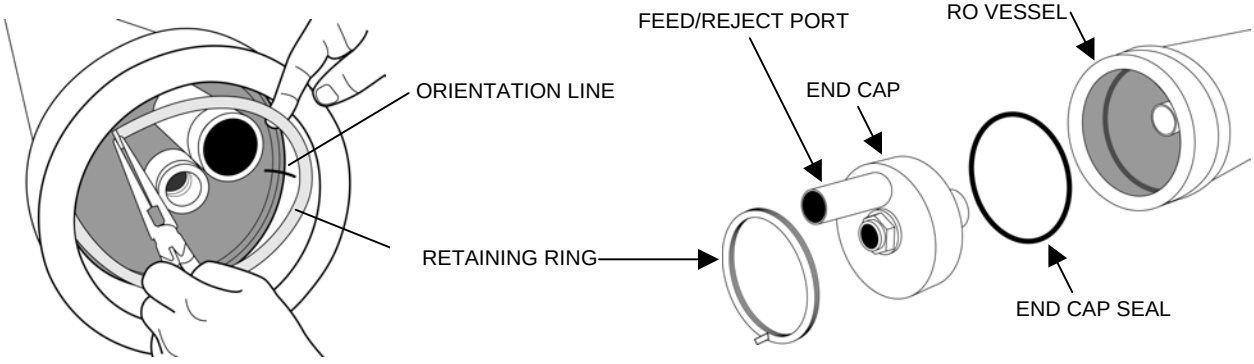


Figure 2. RO Vessel End Cap Removal.

3. Remove the RO element simulator from the vessel (see Figure 3).

WARNING

Damage or scratches deeper than the paint can result in failure of the vessel wall during operation. Do not scratch or damage the vessel bore when removing the simulator or installing elements. Failure to observe this warning can result in injury or death or damage to equipment from catastrophic failure of the vessel under high pressure during operation.

a. Clean off any excess lubricant from the inside of the vessel before removing the simulator.
b. Pull the simulator out of the vessel at the end closest to the operator station.

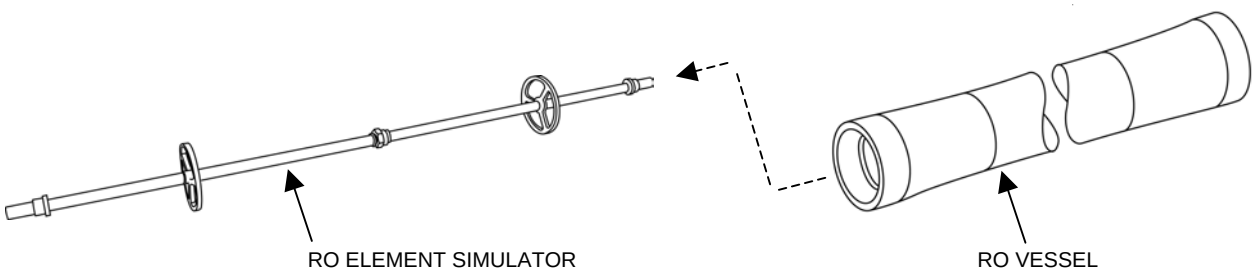


Figure 3. RO Element Simulator Removal.

4. Clean and inspect the inside of the vessel as follows:
   a. Flush out the vessel with clean water to remove any debris.
   b. Inspect the inside surface of the vessel for corrosion, deposits or other foreign matter. If any are found, clean the surface as follows:
      1) Using a scouring pad and a mild soap solution, clean each end of the vessel liner surface up to eight in. from each end of the vessel.
      2) Rinse away all loosened deposits from the inside of the vessel.

WARNING

Do not attempt to repair a fiberglass vessel. If a vessel has damage or scratches deeper than the paint, the vessel should be replaced. Failure to observe this warning can result in injury or death or damage to equipment from catastrophic failure of the vessel under high pressure during operation.

c. Examine the inside of the vessel for scratches or imperfections that may affect the sealing ability of the end cap or element seals. If severe scratches or damage are found, notify Direct Support to replace the vessel as described in WP 0070, Reverse Osmosis System Direct Support Maintenance Procedures under the heading **RO Vessel Replacement**.

5. Install the new elements as follows (see Figure 4 and Figure 5):
   a. Lubricate the inside of the vessel at the ends with a 50/50 glycerin/water mixture to ease the insertion of the elements and to reduce the chance of scratching the vessel bore. The mixture can be applied using a swab soaked in the mixture.

CAUTION

Be sure to install the thrust ring in the downstream end of the vessel. Failure to observe this caution can result in serious damage.

   b. Insert a clean thrust ring into the downstream end of the vessel. The thrust ring requires no orientation; simply push it into the downstream end of the vessel.
   c. Insert the end cap assembly, with the first element adapter, into the downstream end of the vessel as follows:
      1) Align the orientation mark that you put on the end cap assembly during removal with the orientation mark that you put on the vessel.

CAUTION

Do not rotate the end cap assembly after inserting it into the vessel. Failure to observe this caution may cause the end cap seal to bind or become detached.

      2) Hold the end cap assembly square to the axis of the vessel and slide it straight into the vessel until a slight resistance is felt.
      3) Install the retaining ring into the groove in the vessel.

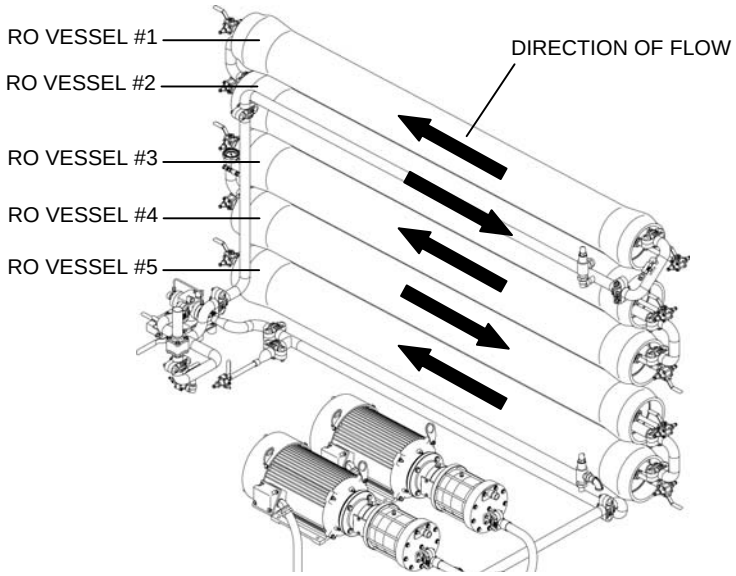


Figure 4. Direction of Flow Through RO Vessels.

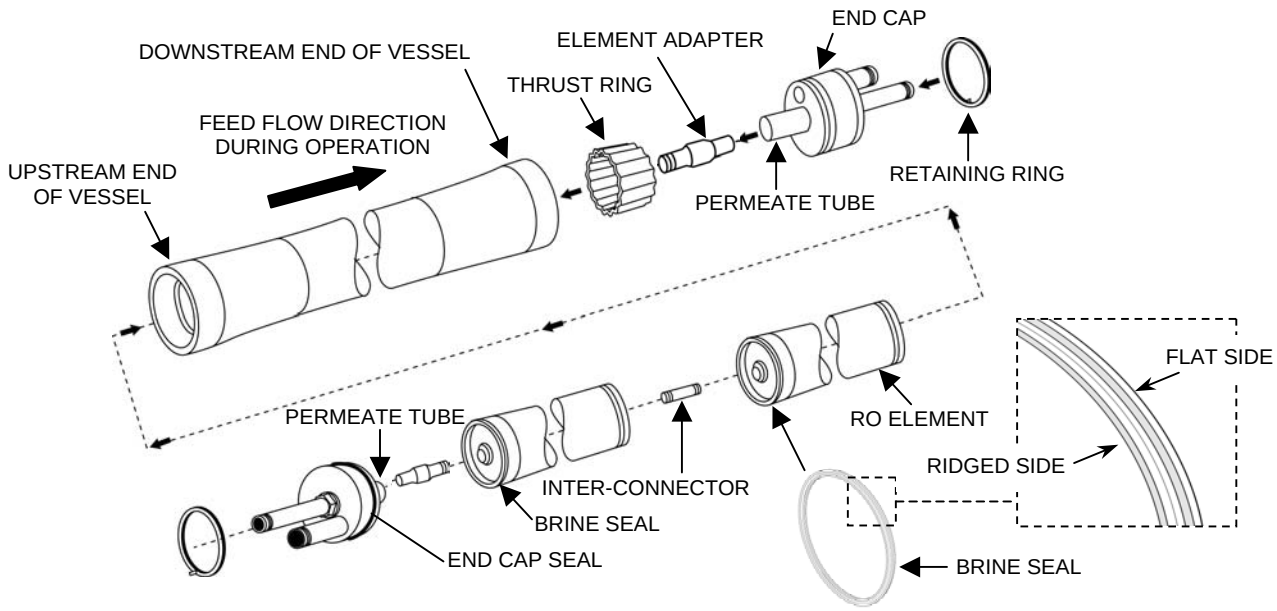


Figure 5. RO Element Installation.

d. Load the first element into the upstream end of the vessel, inserting the brine seal end of the element last. Leave a few inches of the element sticking out of the vessel to allow you to connect the next element to it.

NOTE

Apply only enough glycerin to the inter-connector O-ring to give the O-ring a luster. Excessive lubricant could contaminate the elements.

e. Apply a small amount of glycerin to the inter-connector O-ring.
f. Assemble the inter-connector to the element that was just loaded into the vessel.

CAUTION

Support the second element as it is assembled to the inter-connector and the first element. Do not allow the element weight to be supported by the inter-connector. Failure to observe this caution can result in damage to the inter-connector or the outer surface of the elements.

g. Line up the second element to be loaded and assemble the end without the brine seal to the inter-connector that is already assembled on the first element.
h. Push both elements into the vessel until only a few inches of the second element are left sticking out of the vessel.
i. Install an adapter to the element permeate (product water) tube at the upstream end of the vessel.
j. Push the elements into the vessel as far as they will go.

6. Install the upstream end cap assembly as follows (see Figure 6):
   a. Apply glycerin inside the vessel from behind the retaining ring groove to about one-half in. into the vessel.
   b. Cover the entire end cap seal with a thin layer of glycerin. Make sure no dirt contaminates the glycerin.
   c. Align the orientation mark that you put on the end cap assembly during removal with the orientation mark that you put on the vessel.

CAUTION

Do not rotate the end cap assembly after inserting it into the vessel. Failure to observe this caution may cause the end cap seal to bind or become detached.

   d. Hold the end cap assembly square to the axis of the vessel and slide it straight into the vessel until a slight resistance is felt.
   e. Using both hands, push the end cap in as far as it will go (a forceful thrust may be needed to push the end cap seal into the vessel bore.) When the end cap is in the correct position, the entire retaining ring groove will be exposed.

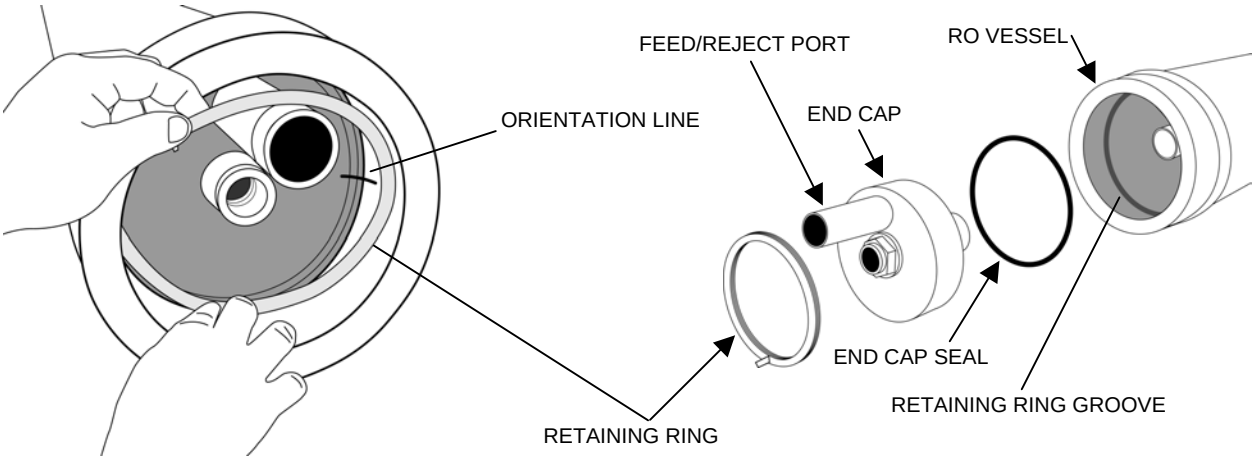


Figure 6. RO Vessel End Cap and Retaining Ring Installation.

WARNING

Potential catastrophic failure point. The retaining ring must be correctly installed. Failure to observe this warning can result in explosive end cap failure when the vessel is pressurized which, in turn, can cause death, serious injury, and/or severe equipment damage.

   f. Place the tip of the retaining ring into the groove, then slide your fingers around the ring pushing it into the groove as you go until the entire ring is in the groove (see Figure 6).
   g. Verify that the retaining ring is fully seated in the groove before proceeding.

7. Reinstall the following piping:
    a. Reinstall the feed/reject piping to the vessel feed/reject ports.
    b. Reinstall the black product water hoses and the clear sample/drain hoses to the vessel 3-way valves.
    c. Reinstall any TWPS piping that was removed in order to remove the RO elements.

WARNING

Potential for catastrophic failure. Improper assembly or corrosion damage can result in mechanical failure, property damage and serious injury or death. Perform the recommended pre-pressurization checks before pressurizing the RO vessels. Failure to observe this warning can result in severe equipment damage and serious injury or death.

8. Perform the following pre-pressurization checks:
    a. Make sure that all the elements were installed in each vessel.
    b. Make sure that the element inter-connector was installed in each vessel.
    c. Make sure that the thrust ring was installed in the downstream end of the vessels.
    d. Make sure that the element adapters were installed at each end of the vessels.
    e. Make sure that the port nut at each end of the vessels is snug.
    f. Make sure that the port retainers were correctly installed.
    g. Make sure that the retaining ring is properly seated in the groove at each end of the vessels.
    h. Make sure that all end cap assemblies are in good condition, with no evidence of damage or corrosion.
    i. Make sure that all piping connections will provide a leak-free seal.
    j. If you are unable to ensure all of the above checks, or if you do not understand what is required by any of the checks, do not pressurize the vessels until proper assembly can be assured. If this means disassembling and reassembling any or all of the vessels to ensure that maintenance and proper assembly is performed, then disassemble and reassemble as necessary.
9. Flush the RO elements at initial use as follows:
    a. **Slowly** fill the vessels with feed water to allow trapped air to escape.
    b. **Slowly** pressurize the vessels to avoid damage to the elements and vessel components.
    c. Discharge the product water to the ground for 2 hours to flush the new elements before connecting to the distribution system.
10. Package RO simulators for later use. The simulators may be used for training to save RO elements for mission deployments.

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OPERATOR MAINTENANCE PROCEDURES
SERVICE UPON RECEIPT

KNOT CAC ROPES

Tie a loop at one end of each of the three CAC ropes as shown in Figure 7.

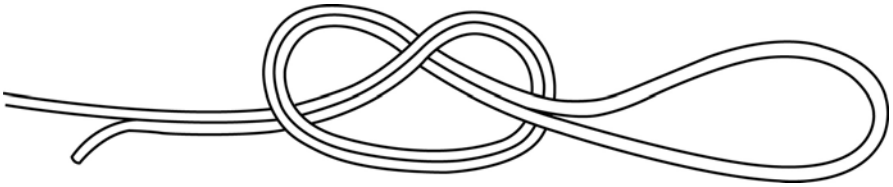

Figure 7. Loop Tied at End of a CAC Rope.

DEPROCESS UNPACKED EQUIPMENT:

1. Remove the vapor capsules from the OCP, PDP and Instrument Panel. Install new vapor capsules (WP 0079, Table 1, item 46).
2. Apply anti-corrosion compound to all areas listed in PMCS (WP 0079, Table 1, item 17).
3. Complete Before Operation PMCS.
4. Pack out the chemicals in the appropriate TWPS storage containers. Refer to WP 0031, Preparation for Storage – Army Unit and WP 0032, Preparation for Storage – Marine Corps Unit.
5. Pack-out (repack) the TWPS. Refer to WP 0031, Preparation for Storage – Army Unit and WP 0032, Preparation for Storage – Marine Corps Unit.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0037 00
OPERATOR MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)
INTRODUCTION

INTRODUCTION

Preventive Maintenance Checks and Services (PMCS) provide scheduled procedures to maintain the TWPS at a specified level of performance by providing systematic inspection, detection, servicing, condition monitoring, and/or replacement to prevent impending failures. The following PMCS schedules are established for:

1. Maintenance to perform PMCS called out in Table 1, BEFORE start-up and operation of the TWPS. Service Upon Receipt from storage is covered separately in WP 0036.
2. Maintenance to perform PMCS called out in Table 1, DURING operation of the TWPS.
3. Maintenance to perform PMCS called out in Table 1, AFTER operation, shut down and cool-down of the TWPS. Preparation for Storage is covered separately in WP 0031 and WP 0032.
4. Maintenance to perform PMCS at the interval hours of operation called out in Table 2.

PMCS TABLE FORMAT

Preventive Maintenance Checks and Services (PMCS) tables list inspection and care requirements to keep the TWPS in good operating condition. The tables are set up to allow the operating crew to make checks during a walk-around of the unit. The following describes the purpose of each column in each PMCS Table.

1. ITEM NO: Each maintenance check is identified by a separate item number. The item column will be used as a source of item numbers for the “TM Number” on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.
2. INTERVAL: This column indicates when to perform the service check or maintenance.

   Before
   During
   After
   Periodic (see procedure for weekly, hours, quarterly, etc.)

3. ITEM TO BE CHECKED OR SERVICED: this column identifies the component, assembly, or system to be checked or serviced.
4. PROCEDURE: This column identifies what check or inspection task to perform and what action to take if corrections need to be made. Appropriate work packages are also referenced here.
5. EQUIPMENT NOT READY IF: This column indicates equipment conditions that make the equipment not capable of performing its assigned mission.

GENERAL INSPECTION AND MAINTENANCE

The following general inspection and maintenance procedures can be performed at any time. It is a good practice to perform these general procedures regularly to ensure that the TWPS remains in good operating condition.

1. Keep the TWPS clean. Dirt, grease, oil, and debris get in the way and may cover up serious problems.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0037 00**
OPERATOR MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)
INTRODUCTION

2. Rust and Corrosion. Check the TWPS body and frame for rust and corrosion. If any bare metal or corrosion exists, clean and apply a thin coat of oil, report to supervisor, or prepare an SF 368, Products Quality Deficiency Report. Using key words such as “corrosion”, “rust”, “deterioration”, or “cracking” will ensure that the information is identified as a Corrosion Prevention and Control (CPC) problem.
3. Bolts, Nuts, Screws. Check for obvious looseness, missing, bent or broken condition. Correct or report to supervisor.
4. Welds. Look for loose or chipped paint, rust, or gaps where parts are welded together. If a bad weld is located, report it to the supervisor.
5. Electrical Wires and Connections. Look for cracked, frayed, or broken insulation, bare wires and loose or broken connections. Correct or report to supervisor.
6. Hoses and Fluid Lines. Look for wear, damage, and leaks. Make sure clamps and fittings are tight. Wet spots or stains around fittings and connectors indicate leaks. Correct or report to supervisor.
7. Leakage definitions are as follows:
    a. **Class I:** For oil and fuel: Seepage of fluid (as indicated by wetness) but not enough to form drops. For water: Seepage of fluid (as indicated by wetness) or leakage great enough to form drops, but not enough to cause drops to fall.
    b. **Class II:** For oil and fuel: Leakage of fluid great enough to form drops, but not enough to cause drops to fall. For water: Leakage great enough to result in more than a slow dripping from the leaking item.
    c. **Class III:** For oil and fuel: Leakage great enough to cause drops to fall from leaking item. For water: Rapid dripping or spray deemed to be a safety hazard or has the potential to damage other equipment.

CAUTION

Operation is allowable with Class I and II leakage. Class II leaks should be corrected when operational demands allow. Check regularly for any increase in leakage.

Do not continue operation with Class III leakage.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

0038 00

THIS SECTION COVERS:

Before, During, After, and Periodic Preventive Maintenance Checks and Services (PMCS)

BEFORE Maintenance Interval: BEFORE start-up and operation of the TWPS.
DURING Maintenance Interval: DURING operation of the TWPS.
AFTER Maintenance Interval: AFTER operation, shut down and cool-down of the TWPS.
PERIODIC Maintenance Interval: at the number of hours or intervals specified.

INITIAL SETUP:

TWPS Set Up for Operation

Maintenance Level

Operator/Crew

Table 1. Preventive Maintenance Checks and Services (PMCS).

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
1	Before	Fire Extinguisher	Check charge. If not in the green, replace. Make sure the seal is in place.	Not in the green.
2	Before	Eyewash bottle	Check that at least one bottle is full and unopened and has not exceeded the expiration date.	Both bottles empty or past expiration date.
3	Before	Main power cable connections	Check that the main power cable ends are properly connected to Ground, Neutral L1, L2, L3 as labeled and that the connections are tight.	Not properly connected.
4	Before	Ground cable	Check to be sure that the ground cable is tightly connected to the generator and to the ground rod lug.	Not properly connected.
5	Before	Generator	Perform PMCS in accordance with TM 9-6115-645-10.	
6	Before	Diesel engine for pump P-1 or P-8	Check for loose nuts and bolts. Tighten if loose.	Loose or missing hardware.
			Check the lube oil level. Add oil if the lube oil level is low.	Lube oil low.
			Check the fuel level and add fuel as necessary. Pour the fuel through the filling port filter.	Insufficient fuel for expected period of operation.
			Check for fuel or lube oil leakage. For class I or II leakage, notify Unit Maintenance. For Class III leakage, discontinue operation of the pump.	Class III leakage.
			Check fuel lines, hoses, muffler, air cleaner assembly, recoil starter assembly and other parts for damage. Notify Unit Maintenance if any repairs are required.	Engine is unsafe to operate because of damaged parts.
			If changing fuel type from diesel to JP-8, notify Unit Maintenance to replace the filter with the spare provided as BII.	Fuel oil filter not replaced before changing fuel from diesel fuel to JP-8.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

0038 00

Table 1. Preventive Maintenance Checks and Services (PMCS).

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
7	Before	Raw water pumps P1 and P2, MF Feed Pump P3, and Product Water Distribution Pump P7	Inspect pump for loose mounting, damaged frame, cracked housing. Tighten mountings if loose. Notify Unit Maintenance if damage to frame or housing found.	Pump unsafe to operate due to loose or damaged parts.
			Check motor/junction box connecting cable and power cable for damage. Notify Unit Maintenance to replace if damage found. **NOTE** **Make sure dust caps are installed on all unused cables and electrical connectors.**	Motor is unsafe to operate because of damaged power cable.
8	Before	Cyclone separator	Check retainer chains for damage. Notify Unit Maintenance to replace if broken.	Both retainer chains broken.
9	Before	Raw water and distribution suction hoses	Check for flattened hoses. Check to be sure gaskets are in place. Use BII spare gaskets as needed.	Not enough hose assemblies available.
10	Before	Raw water and distribution discharge hoses	Check for obvious tears. Check to be sure gaskets are in place. Use BII spare gaskets as needed.	Not enough hose assemblies available.
11	Before	Raw water, distribution and waste adaptors	Check for broken or cracked fittings.	Damage will result in water streaming out under pressure.
12	Before	Anchor Rope	Check for severe fraying.	Severely frayed
13	Before	MF Feed Tank Strainer S-1	Check for holes and tears. Replace with spare from BII as needed.	
14	Before	MF Feed Strainer clamp and elbow clamps	Check to be sure that the clamps were tightened after cleaning the strainer at the last shutdown.	
15	Before	Air compressor assembly	Check the compressor oil level. Add oil if needed.	Insufficient oil.
			Check for oil leakage as evidenced by oil on adjacent components. Notify Unit Maintenance if leaks found. For Class III leakage, discontinue operation of the compressor.	Class III leakage.
			Check for water in oil as evidenced by milky color on dipstick. Notify Unit Maintenance if signs of water found.	Signs of water in oil.
16	Before	Air compressor belt.	Check compressor belt for ¼-in. deflection, wear, cracks, or if belt has rolled over (WP 0042). Notify Unit Maintenance to adjust belt tension or replace worn belt (WP 0056). May run with rolled belt, but have Unit Maintenance replace the belt when time permits if it has rolled over (WP 0056).	Belt has more than ¼ -in. deflection, is worn, or has cracks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

0038 00

Table 1. Preventive Maintenance Checks and Services (PMCS).

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
17	Before	HP Pumps	Make sure the HP pump mounting flange drain tube is directed off the TWPS deck and that the tube is free of obstructions to allow any water that may accumulate in the flange to freely drain.	Drain tube is blocked or is not laid out to allow it to drain freely.
18	Before	Diesel heater	Inspect for loose or missing nuts, bolts, screws. Inspect for damaged housings, control boxes, fuel tank, electrical cables, frame.	Missing or damaged parts that would prevent operation or make the heater unsafe to operate.
			Check the fuel level and add fuel as necessary. A minimum of about one gallon of fuel must be in the tank in order to operate the heater.	Insufficient fuel for expected period of operation.
			Check for fuel or lube oil leakage. For class I or II leakage, notify Unit Maintenance. For Class III leakage, discontinue operation of the pump.	Class III leakage.
			Inspect the air intake filter for dirt. Clean if necessary (refer to WP 0044).	Heater will not operate due to dirty air intake filter.
19	During	Portable heater ducts	Inspect for debris or tears. Clean out any debris. Replace the ducts if torn beyond usability.	
20	During	Hose heating blankets.	Inspect exposed cable and connectors for damage. Notify Direct Support for connector replacement. Replace blanket if cable damaged. Inspect for tears. Notify Direct Support if blankets need repair (WP 0072). Replace blanket if needed.	
21	During	Pump heating collars	Inspect for damage. Replace if needed.	
22	During	Fabric wall (A-TWPS) and Cold Weather Cover (MC-TWPS)	Inspect fabric, hook and loop material, buckles and straps for damage. Notify Direct Support if repair needed (WP0072).	
23	During	Flat Rack	Check the flat rack panel latch mounting bolts for tighteness. Tighten if necessary.	
24	During 1st 24 hrs of operation	RO Element	Perform RO Element Product Flow and Conductivity Test at the beginning of deployment. Record data for reference. Note any element with unusual performance (WP 0016).	

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0038 00
OPERATOR MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Table 1. Preventive Maintenance Checks and Services (PMCS).

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
25	During	Diesel engine	**WARNING** **If the engine has been running, the engine, its muffler and other components may be hot. Be careful not to touch hot surfaces. Failure to observe this warning can result in burns.**	
			Check for unusual noise or excessive vibration from the engine or if the engine is misfiring or running rough. If you notice any of these conditions, notify Unit Maintenance.	Engine has not been repaired.
			Check the color of the exhaust gas. If it is black or too white, notify Unit Maintenance.	Engine has not been repaired.
			Check for fuel or lube oil leakage. For class I or II leakage, notify Unit Maintenance. For Class III leakage, discontinue operation of the pump.	Class III leakage.
26	During	Raw water pump P2, MF Feed Pump P3, RO Feed Pump P4, and Product Water Distribution Pump P7.	Check for unusual or excessive noise at the electric motor. Bearings may be failing. Notify Unit Maintenance. Continue operation.	
27	During	Raw water pumps P1 / P2, MF Pump P3, RO Pump P4, and Distribution Pumps P7 / P8.	Check for leakage between the pump and motor or diesel engine. Leakage indicates a worn shaft seal. Notify Unit Maintenance. Continue operation.	Class III leakage.
28	During	Raw water, distribution, and waste hoses and adaptors.	Check hoses and connections for leaks. Check plastic couplings and adaptors for leaks.	Class III leakage.
29	During	Cyclone separator	Check for leaks. Check for cracks in fittings. Make sure there is a steady stream coming out of the cyclone drain.	Class III leakage.
30	During	MF Feed, cleaning waste, and distribution tanks	Check for leakage. If at tank fittings, tighten the fittings. If fabric leaks, notify Unit Maintenance to repair when operational requirements allow (WP 0066).	
31	During	RO Vessels	Check for leaking.	Class II or III leakage.
32	During	Air Compressor	Check for duration that compressor runs after backwash. If the compressor runs longer than 14 minutes, troubleshoot the air system (WP 0033).	Compressor runs continuously.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0038 00
OPERATOR MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Table 1. Preventive Maintenance Checks and Services (PMCS).

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
33	During	Air compressor intermediate separator automatic drain valve XV-910; coalescer CO-1 automatic drain valve XV- 911	Check that intermediate separator and coalescer CO-1 automatic drain valves can be heard cycling while the compressor is operating. Notify Unit Maintenance if a valve is not operating. Use the manual drain valve to drain the air at 15-minute intervals if automatic valve is stuck open. Check for leakage from the drain hole opening. Notify Unit Maintenance if leakage found.	Compressor runs continuously.
34	During	Air System	Check Gauges PI-901, PI-902 and PI-903 for proper reading when air compressor is off. Troubleshoot air system as indicated (WP 0033).	PI-901 not within 750-1000 psig PI-902 not at 90 to 110 psig. PI-903 not at 13 to 16 psig.
35	During	MF and RO system piping	Check for leaks. Note Class I and II leaks. Repair Class II leaks during the normal PMCS shutdown period (WP 0045). Do not operate with Class III leaks.	Class III leakage.
36	During	HP Pumps	Check for leakage at the pump/motor adaptor drain tube. Dripping is acceptable. A steady flow indicates that the shaft seal is worn. Notify Unit Maintenance. Continue operation.	Water spraying out of perforations on pump/motor adapter cover.
37	During	RO Elements	Perform RO Element Product Flow and Conductivity Test prior to shut down at the end of deployment. Record data for reference. Note any element with unusual performance (WP 0016).	
38	After	Diesel engine	**WARNING** **If the engine has been running, the engine, its muffler and other components may be hot. Allow the engine and its parts to cool before handling. Failure to observe this warning can result in burns.** Check for worn or damaged parts. Notify Unit Maintenance if any repairs are required.	Engine is unsafe to operate due to worn or damaged parts.
39	After	Connectors and Terminals with dust caps	Use the fine brush from the tool box to clean dust and sand out of connectors, terminals and dust caps before capping a connection. Spray connectors and terminals with corrosion preventive compound (WP 0079, Table 1, item 12. Install the dust cap provided with connectors and terminals whenever a connector is disconnected from its terminal.	Connector or terminal threads are clogged with dust or sand.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Table 1. Preventive Maintenance Checks and Services (PMCS).

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
40	After	MF Feed Tank Strainer S-1	Check fabric for holes and tears. Discard and order BII replacement if damaged (WP 0040).	
41	After	MF Feed Basket Strainer S-2	Remove, inspect, and clean (WP 0040).	
42	After	Air compressor belt guard	Inspect for loose or missing mounting hardware.	Guard is loose or damaged.
43	After	Air compressor oil level	Check oil level. Add oil if needed.	Insufficient oil.
44	After	Interior electrical cables	Check for cuts, loose connections/damaged connectors.	Damage that would prevent operation.
45	After	Eyewash bottle	Check that at least one bottle is full and unopened and has not exceeded the expiration date.	Both bottles empty or past expiration date.
46	After	Portable heater ducts	Inspect for debris or tears. Clean out any debris. Replace the ducts if torn beyond usability.	
47	After	Hose heating blankets.	Inspect exposed cable and connectors for damage. Notify Direct Support for connector replacement. Replace blanket if cable damaged. Inspect for tears. Notify Direct Support if blankets need repair (WP 0072). Replace blanket if needed.	
48	After	Pump heating collars	Inspect for damage. Replace if needed.	
49	After	Fabric wall (A-TWPS) and Cold Weather Cover (MC-TWPS)	Inspect fabric, hook and loop material, buckles and straps for damage. Notify Direct Support if repair needed (WP0072).	
50	After	Frame tie down and lift provisions	Inspect for damage. Notify Direct Support if any damage is found that may affect the integrity of the components. Do not use damaged components.	
51	After	(A-TWPS only) Flat rack latches and seals	Inspect for damage. Notify Unit Maintenance for repairs if needed (WP 0065).	

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Table 2. Periodic PMCS for TWPS.

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
1	Weekly (when in use)	Diesel heater air intake filter	Clean the air intake filter often. Clean more frequently if the heater is operated in dusty conditions (refer to WP 0044).	Filter missing or damaged.
2	Weekly	Diesel engine	Spray the throttle linkage (speed control) and plate with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
3	Weekly	P-1, P-2, P-7 and P-8 pumps	Spray motor/diesel engine shaft, drive sleeve and clamp with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
4	Weekly	Pipe couplings	Spray all around the top and bottom clamp fittings with the corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
5	Weekly	High Pressure Pumps	Remove the mounting flange cover plate and spray corrosion preventive compound (BII) (WP 0079, Table 1, item 12) on the motor and pump shafts, the shaft couplings, and the coupling set screws.	
6	Weekly	Pressure Regulating Valves PRV- 901 and PRV-902	Spray the screws that secure the pressure regulator to the tee pipe with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
7	Weekly	Air solenoid valves XV-901, XV-902, XV-903, XV-910	Spray the 4 cap screws on both ends with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
8	Weekly	MF Lower Feed Inlet Valve V-113	Spray the limit stop stop-screws and the nuts and washers that secure the valve body to the actuator with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
9	Weekly	Flexi Joint Expansion Joints	Spray the “coil springs” and the limit links (wires) on both flexi joint expansion joints (one at the MF inlet and one at the MF outlet) with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
10	Weekly	All straps	Spray all strap metal hardware, especially the ratchet strap metal hardware, with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
11	First 20 hr PMCS shutdown for the TQG	MF Filter Elements	Perform the MF Pressure Integrity Test procedures (WP0016). If the MF Pressure Integrity Test indicates failure, perform the MF Sonic Test (WP0016).	

Table 2. Periodic PMCS for TWPS - Continued.

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
12	First 50 hours of operation	Diesel engine	Notify Unit Maintenance to change the lube oil and clean the filter for a new engine after the first 50 hours of operation (WP 0050).	Maintenance log does not contain entries for these procedures after the first 50 hours of a new engine operation.
13	100 hours of operation	Air compressor belt.	Check compressor belt for ¼-in. deflection, wear, cracks, or if belt has rolled over (WP 0042). Notify Unit Maintenance to adjust belt tension or replace worn belt (WP 0056). May run with rolled belt, but have Unit Maintenance replace the belt when time permits if it has rolled over (WP 0056).	Belt has more than ¼ -in. deflection, is worn, or has cracks.
14	100 hours of operation	Diesel engine	Notify Unit Maintenance to change the diesel engine oil (WP 0050).	Maintenance log does not contain an entry for this procedure after each 100 hours of engine operation.
15	150 hours of operation (when in use)	Diesel heater fuel tank	Drain the fuel tank. Flush it out with clean fuel. Refill with new, clean fuel.	Heater will not operate due to clogged fuel lines or fuel filter.
16	200 hours of operation	Diesel engine	Notify Unit Maintenance to clean the fuel filter (WP 0050.)	
17	200 hours of operation	Diesel engine	Check the air filter (WP 0039).	
18	300 hours	Air compressor intake filter element AF-1	Inspect/clean (WP 0042).	
19	300 hours of operation	Air compressor, motor and sheaves.	Spray motor and compressor shafts and sheave bushings with corrosion preventive compound (BII) (WP 0079, Table 1, item 12)	
20	300 hours	Air system AF-2 Air Purifier Filter Cartridge	Replace (WP 0042).	
21	300 hours	MF filter elements	Perform the MF Pressure Integrity Test procedures (WP 0016). If the MF Pressure Integrity Test indicates failure, perform the MF Sonic Test (WP 0016).	
22	400 hours of operation	Diesel engine	Notify Unit Maintenance to replace the lube oil filter (WP 0050).	

Table 2. Periodic PMCS for TWPS – Continued.

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
23	400 hours of operation	Diesel engine	Notify Unit Maintenance to replace the fuel filter (WP 0050).	
24	400 hours of operation	Diesel engine	Replace the air filter after every 400 hours of operation (more frequently in dusty conditions). (WP 0039).	
25	500 hours of operation	RO elements	Perform RO Element Product Flow and Conductivity Test after every 500 hours of operation. Record data for reference. Note any element with unusual performance (WP 0016).	
26	500 hours of operation of the diesel engine	Diesel engine	Notify Unit Maintenance to: - Clean the fuel injection valve nozzle. - Adjust the intake and exhaust valve clearance. - (WP 0050.)	
27	500 hours of operation of the diesel heater	Diesel heater fan blades	Clean (WP 0044).	
28	600 hours	Air compressor intake filter element AF-1	Inspect/clean (WP 0042).	
29	900 hours	Air compressor intake filter element AF-1	Replace (WP 0042).	
30	1000 hours	Air compressor	Notify Unit Maintenance to replace the compressor oil (WP 0056).	
31	1000 hours	HP Pumps	Notify Unit Maintenance to replace the inlet and outlet valve cartridges and pistons (WP 0053).	
32	1000 hours	Diesel engines	Notify Direct Support to service cylinder head (WP 0068) Notify Direct Support to replace piston rings (WP 0068)	
33	1500 hours	Air System	Notify Unit Maintenance to inspect and clean the air compressor intermediate filter and the CO-1 coalescer filter elements (WP 0056).	
34	2000 hours	HP Pumps	Notify Unit Maintenance to replace the cluster plate and shaft seal. This will coincide with replacement of the pistons and the valves (WP 0053).	
35	3000 hours	Air compressor	Notify Unit Maintenance to replace valve head assemblies (WP 0056).	
36	Quarterly when in use.	Diesel heater fuel filter	Notify Unit Maintenance to clean. Replace if blocked (WP 0064).	

Table 2. Periodic PMCS for TWPS - Continued.

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
37	Quarterly	Miscellaneous components requiring corrosion prevention action	Spray the following components with the corrosion preventive compound (BII bucket 6) - P-1 and P-8 throttle linkage - P-1 and P-8 diesel engine electric starter mounting hardware - P-2 and P-7 exposed motor shaft and shaft sleeve clamp - Exposed threads of turbocharger assembly mounting studs - Exposed threads of RO feed pump assembly mounting studs - Exposed threads of HP pump mounting bolts - Exposed compressor and compressor motor shafts - Compressor motor mounting hardware - Clamps, bolts, nuts, and gasket retainer for all coupling clamps - Retainer wire ball slots on the three expansion joints at the microfilter inlet and outlet - Electrical connectors for pressure transmitters PT-101, PT-102, PT-201 and PT-302 - Ratchet strap hardware - (A-TWPS only) Hardware that secures the A-TWPS skid to the flat rack	
38	Semi-annual	Diesel heater output air filter	Notify Unit Maintenance to replace (WP 0064).	
39	Semi-annual	TWPS unit	Unpack, set up, and operate the TWPS. Perform all Before, During, After, and Weekly PMCS. Change oil in the air compressor and the P-1 and P-8 pump engines. Perform preparation for storage procedures (Army WP 0031; Marine Corps (WP 0032)	
40	Annually	High Pressure Pump Motor, MF and RO Feed Pump Motors, and Air Compressor Motors	Notify Unit Maintenance to apply grease through the zirk grease fittings (WP 0047, item 14).	
41	Annually	Air Receiver Tank	Check the hydro-test date (stamped on the valve end of the tank). If the date is close to or greater than 5 years old, notify Direct Support to have the air receiver tank hydro-tested.	The hydro-test date is 5 years old or older.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0039 00**
OPERATOR MAINTENANCE PROCEDURES
RAW WATER SYSTEM

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Operator / Crew
Tools
Operator's Tool Kit (BII) (33901161)
Parts
Air cleaner filter element (TM 10-4610-309-24P)
Personnel Required
One
Equipment Condition
Diesel engine-driven pump (raw water or extended distribution) removed from service

REPLACE:

Air Cleaner Filter Element:

Replace the air cleaner filter element for the diesel engine-driven pump from the raw water or the extended distribution system as follows:

WARNING

If the engine has been running, the muffler/exhaust system may be hot. Do not touch to prevent burns.

1. Remove the air cleaner assembly cover nut and pull off the cover.
2. Remove the filter element and replace with a new element.
3. Reinstall the cover and secure with the nut.

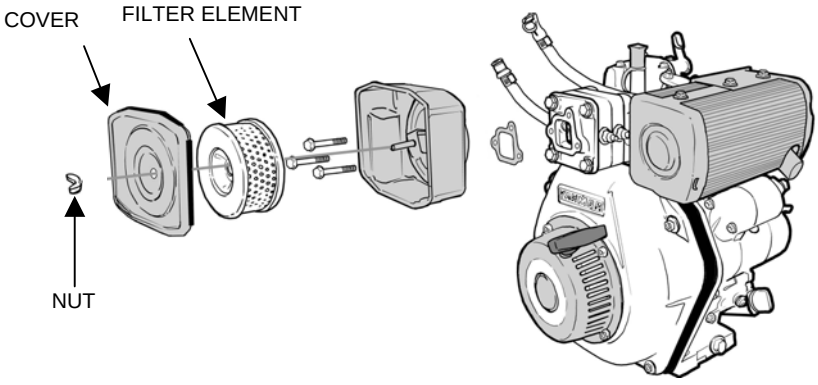

Figure 1. Air Cleaner Filter Element Replacement.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0040 00**
OPERATOR MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

THIS SECTION COVERS:
Replace, Service

INITIAL SETUP:

Maintenance Level
Operator/Crew
Tools
Operator's Tool Kit (BII) (33901161)
MF C-spanner (BII)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
Standby or short term shutdown with drain down as noted.

GENERAL:

The procedures covered in this work package include:

- Micro-Filter Element Replacement
- MF Feed Tank Bag Strainer S-1 Cleaning
- Basket Strainer S-2 Cleaning

REPLACE

Micro-Filter (MF) Element Replacement:

Parts (TM 10-4610-309-24P):
Module O-rings
MF Element (Submodule)
MF Element O-rings (supplied with MF Element)
Filtrate Cup
Clips
Materials:
Valve seal lubricant (supplied with O-ring kits) (WP 0079, Table 1, item 18)
Clean, dry, lint-free rags (WP 0079, Table 1, item 23)
Personnel:
Two
Equipment Condition:
TWPS In short-term shutdown, anticipated repair less than 4 hours

Replace MF elements (Submodules) MF-1 through MF-12, including the inspection and replacement of the Submodule O-rings, filtrate cups and clips, as follows:

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0040 00**
OPERATOR MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

1. MF element (Submodule) removal:

WARNING

Clearance between outer sleeves of MF modules is tight. Each filter module contains gear-like ribs around the sleeves. Care must be taken not to get fingers caught between the filter module outer sleeves. Failure to observe this warning can result in injury to fingers and hands.

a. Insert the hook end of the C-spanner into one of the grooves in the outer sleeve at the top of the module; rotate the sleeve clockwise to remove.
b. Remove the outer sleeve from the head and lower it.
c. Remove the clips from the submodule (see Figure 1).

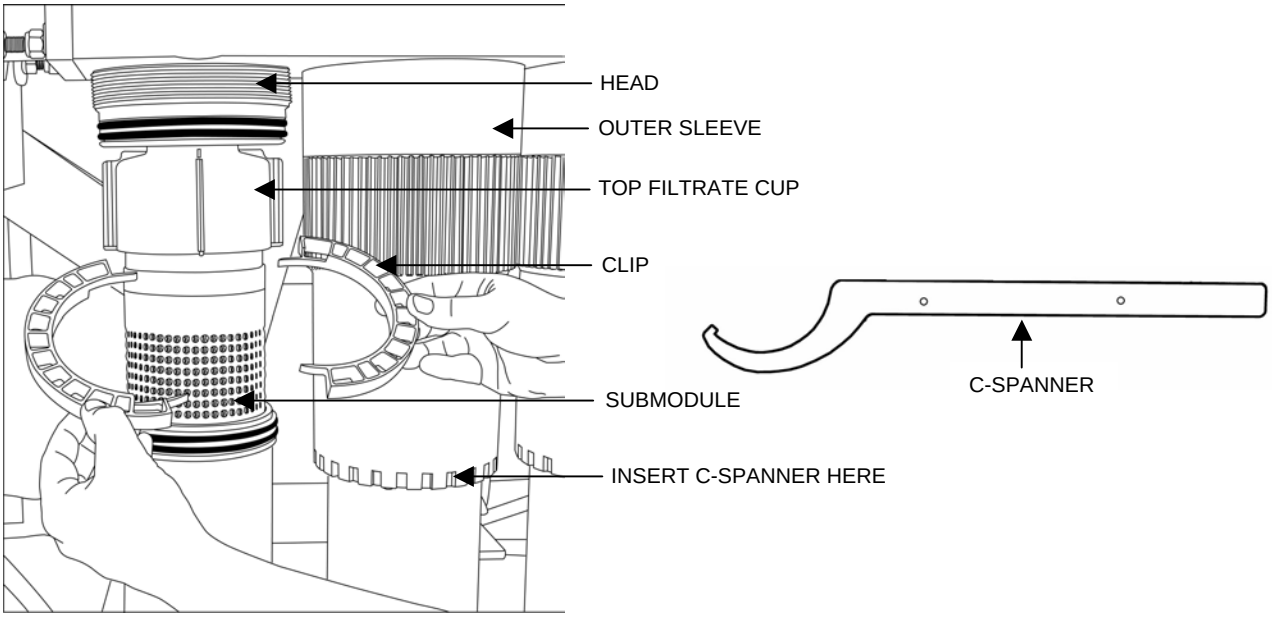

Figure 1. MF Module Sleeve and Upper Clip Removal.

d. Screw the top outer sleeve back onto the head for a few turns to support the center tube.
e. Remove the outer sleeve from the lower end of the module by turning it counter-clockwise (see Figure 2).
f. Remove the clips from the submodule.
g. If necessary, force the center tube downward to disengage its O-rings from the lower outer sleeve.
h. Lift and support the bottom outer sleeve and the center tube.
i. Firmly push the submodule down into the bottom filtrate cup. Avoid squeezing the submodule screen against the fibers.

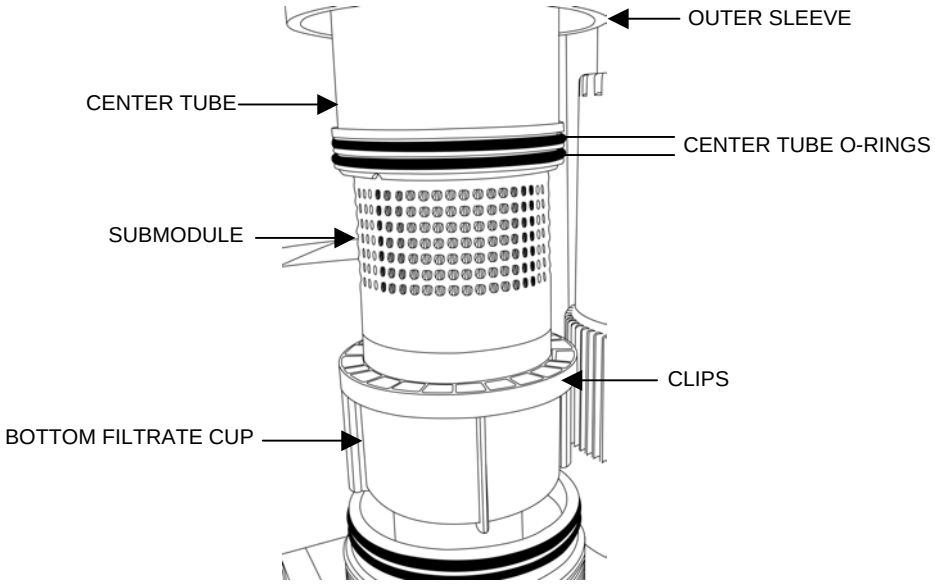

Figure 2. MF Module Sleeve and Lower Clip Removal.

NOTE

Avoid squeezing the submodule screen against the fibers. Do NOT use a metal lever between the filtrate cup and the headpiece.

j. Push the top filtrate cup downward until the top filtrate cup is disengaged from the head.

WARNING

Two-person lift. Two people are required to safely move the MF module. Lift with your legs, not your back. Failure to observe this warning can result in back injury.

NOTE

If the top filtrate cup re-engages in the top head while lifting, the filtrate cups have not been pushed far enough onto the submodule.

k. Remove the whole assembly (submodule, filtrate cups, and center tube assembly) by lifting the bottom filtrate cup until it clears the bottom head.

NOTE

Make sure that there is a clean area to place the submodule, If not, lay down a cloth and use this as your work area. Place one end of the assembly on the ground and stand it up.

2. Disassemble the submodule as follows (see Figure 3):
    a. Remove the filtrate cup from both ends.
    b. Remove the two O-rings from one end of the submodule and slide the submodule out of the center tube.
    c. Remove all O-rings from the filtrate cups, submodule, center tube and heads.

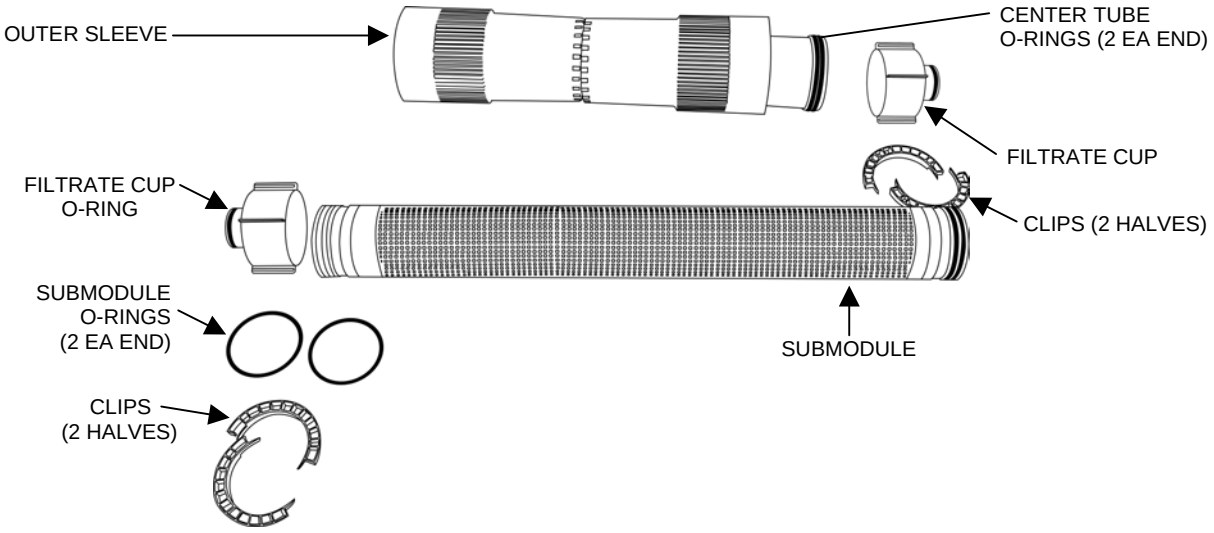

Figure 3. MF Submodule Components.

3. Inspect all components:
    a. O-rings and sealing surfaces must be free of defects.
    b. All components must be clean.
    c. Damaged O-rings, cups, and clips must be replaced.
4. Replace the submodule as follows (see Figure 3):
    a. Remove the new submodule from the box and open the end of the protective bag. Use the bag to protect the submodule until it is installed.
    b. Remove the new submodule O-rings from the box.
    c. Install an O-ring on each filtrate cup in the end groove and lubricate with valve seal lubricant. Make sure that the O-ring is not twisted. Apply lubricant about 2 inches inside of the cup.
    d. Install two new O-rings on the end of the submodule. Make sure that the O-rings are not twisted. Apply lubricant to the O-rings.
    e. Press a filtrate cup fully onto the submodule. The filtrate cup can be tapped lightly on the end to assist in assembly.

NOTE
This end will be the lower end when reinstalling the module in the MF assembly.

    f. Slide the submodule through the module center tube (cup end out). Record the submodule serial number etched into the O-ring groove end.

g. Roll two O-rings onto the upper end of the submodule, past the O-ring grooves, and up to the exposed screen of the submodule. The O-rings will be rolled down into their grooves at a later step.
h. Place the second filtrate cup fully over this end of the submodule. The filtrate cup will loosely slide onto the submodule, allowing for easier manipulation.
i. Install the two O-rings on the bottom head, two on the top head, and two at each end of the center tube. Make sure that the O-rings are not twisted. Lubricate these eight O-rings.

WARNING

Two-person lift. Two people are required to safely move the MF module. Lift with your legs, not your back. Failure to observe this warning can result in back injury.

5. Install the submodule into the MF assembly as follows:
   a. Install the center tube/submodule assembly into the unit, pushing the lower filtrate cup into the lower head.
   b. Push the top filtrate cup up into the upper head.
   c. Roll the two O-rings on the upper end of the submodule up into their grooves. Make sure that the O-rings are not twisted. Lubricate the O-rings.
   d. Install a pair of clips on the upper end of the submodule, and use them to lift the submodule into the upper filtrate cup until the clips contact the filtrate cup.

WARNING

Clearance between the outer sleeves of the MF modules is tight. Each filter module contains gear-like ribs around the sleeves. Care must be taken not to get fingers caught between filter module outer sleeves. Failure to observe this warning can result in injury to fingers and hands.

   e. Lift the top outer sleeve and push it firmly into the upper head until the O-rings engage. Screw the outer sleeve all the way onto the upper head.
   f. Lift and support the lower outer sleeve to gain access to the lower filtrate cup and submodule.
   g. Slide the lower filtrate cup downward.

NOTE

The filtrate cup must be low enough and the submodule must be high enough to allow correct fitting of both clips. If the submodule stretches slightly while sliding the filtrate cup, it must be lifted in order to fit the clips in place. Avoid squeezing the exposed screen against the fibers.

   h. Install the clips on the lower end of the submodule.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0040 00**
OPERATOR MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

WARNING

Clearance between the outer sleeves of the MF modules is tight. Each filter module contains gear-like ribs around the sleeves. Care must be taken not to get fingers caught between filter module outer sleeves. Failure to observe this warning can result in injury to fingers and hands.

i. Push the lower outer sleeve firmly down to fully engage the O-rings with the top outer sleeve. Screw the outer sleeve all the way onto the lower head, then back the sleeve down a little leaving a very small gap.

NOTE

Ensure that the top outer sleeve does not unscrew from the upper head while screwing the lower sleeve onto the lower head.

j. Unscrew the upper sleeve from the upper head just a little leaving a very small gap.

6. Use the log sheets to record the submodule serial numbers and to note replacement of the filtrate cups and clips.
7. Operational check
   a. Return to normal operation.
   b. Check for leaks.

NOTE

Until the new elements have been operated for at 50 - 200 hours, they will not pass the MF pressure integrity test. (See WP 0016).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0040 00**
OPERATOR MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

SERVICE

MF Feed Tank Bag Strainer S-1 Cleaning:

Personnel:
One
Equipment Condition:
TWPS at standby or short-term shutdown

Clean MF Feed Tank Bag Strainer S-1 as follows (see Figure 4):

1. Unstrap the raw water hose from the tripod and lift the hose out of the top of the MF feed tank.
2. Loosen the bag strainer drawstring and gather the top of the strainer and pull it out of the tank.
3. Inspect the bag strainer for large holes or tears that would prevent it from serving its function. Replace if necessary. Two spare strainer bags are supplied as BII.
4. Clean the bag strainer by hosing it off with fresh, clean water.
5. Insert the bag strainer into the MF feed tank and drape the top of the strainer over the lip of the tank. Tighten the drawstring enough to take up the slack and place it under just a little tension.
6. Place the raw water hose back into the top of the MF feed tank.
7. Secure the hose on the tripod using the hook and loop strap.

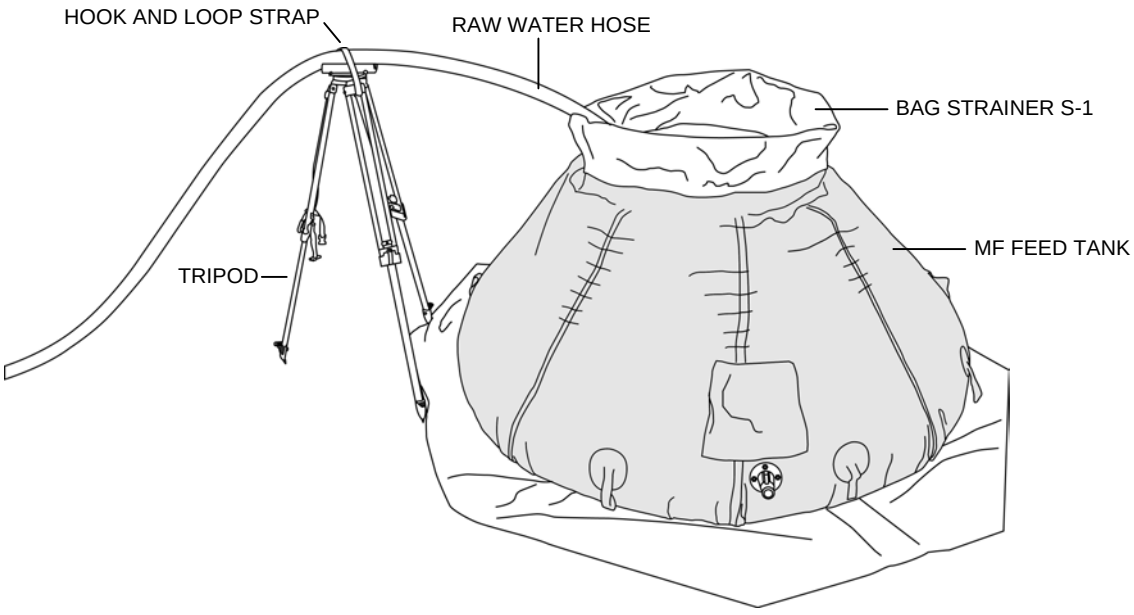

Figure 4. MF Feed Tank Bag Strainer.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0040 00**
OPERATOR MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

Basket Strainer S-2 Cleaning:

Personnel:
One
Equipment Condition:
TWPS at standby or short-term shutdown

Clean MF Basket Strainer S-2 as follows (see Figure 5):

1. Remove the basket strainer S-2 as follows:
   a. Open Basket Strainer S-2 Drain Valve V-109 to begin draining the strainer and the elbow pipe above the strainer.
   b. Open Basket Strainer S-2 Vent/Sample Valve V-110 to allow air into the elbow pipe so that the pipe and the top of the strainer can completely drain.
   c. Remove the smaller sanitary clamp that secures the strainer outlet to the elbow pipe.
   d. Remove the grooved coupling at the other end of the elbow pipe and remove the pipe.
   e. Remove the larger sanitary clamp that secures the top of the strainer to the strainer body.
   f. Lift the top of the strainer and the attached strainer basket out of the strainer body.

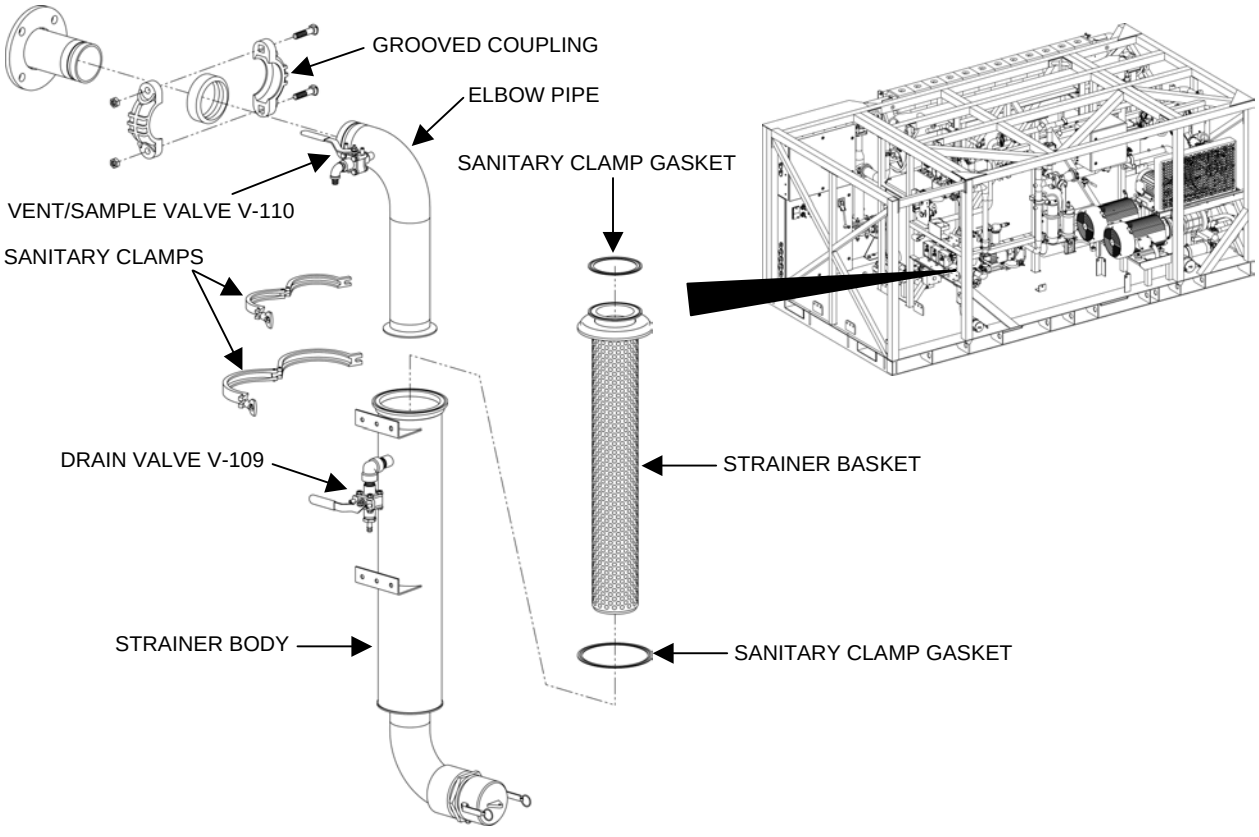

Figure 5. MF Basket Strainer S-2 Removal.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0040 00**
OPERATOR MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

2. Clean the strainer basket as follows:
    a. Hose the basket off with fresh, clean water.
    b. Brush off any debris stuck on the basket using a fiber bristle brush.
    c. Hose the basket off again with fresh, clean water.
3. Re-install the basket strainer as follows:
    a. Lower the strainer basket back into the strainer body.
    b. Inspect the gaskets for the grooved coupling and sanitary clamps. Replace if needed.
    c. Secure the top of the strainer to the body of the strainer using the larger sanitary clamp. Tap the clamp lightly around the circumference with a hammer and repeat tightening.
    d. Secure the lower end of the elbow pipe to the top of the strainer using the smaller sanitary clamp. Leave the clamp loose.
    e. Secure the upper end of the elbow pipe using the grooved coupling. Tighten the coupling.
    f. Tighten the smaller sanitary clamp. Tap the clamp lightly around the circumference with a hammer and repeat tightening.
    g. Close Strainer Drain Valve V-109.
    h. Close Strainer Vent/Sample Valve V-110.
    i. Start up the system and check for leaks at the valves and clamps.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0041 00**
OPERATOR MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

THIS SECTION COVERS:
Clean, Inspect, Replace, Repair, Calibrate

INITIAL SETUP:

Maintenance Level
Operator/Crew
Tools
Operator's Tool Kit (BII) (33901161)
Element pusher (BII)
References
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS in Standby Shutdown with Drain-Down or Short-Term Shut-Down

GENERAL:

The procedures covered in this work package include:

- RO Feed Tank Strainer S-3 Cleaning
- Inline RO Strainer S-4 Cleaning
- RO Feed Pressure Transmitter PT-201 Replacement
- RO Vessel Inspection
- RO Element Replacement
- RO Element Simulator Installation
- RO Vessel Repair (Seal Replacement)
- Main Pressure Control Valve HCV-401 Calibration

RO FEED TANK PUMP INLET STRAINER S-3 CLEANING:

Equipment Condition:
TWPS in Standby Shutdown Without Draining Down

Clean RO Feed Tank Pump Inlet Strainer S-3 as follows (see Figure 1):

CAUTION

Do not allow the screws or washers to fall into the RO feed tank. Pump inlet strainer S-3 will not prevent this mounting hardware from entering the pump. Failure to observe this caution can result in severe damage to and the failure of the RO feed pump if the hardware is sucked into the pump.

1. Remove the six screws and flat washers from the middle feed tank hatch cover.
2. Lift off the hatch cover.
3. Inspect the hatch cover gasket for damage or deterioration and replace if needed.
4. Lift the strainer out of the RO feed tank.

5. Clean off any debris adhering to the strainer.
6. Inspect the strainer for damage. Notify Unit Maintenance to replace the strainer if damage prevents it from keeping coarse material from entering the tank outlet to the RO feed pump.
7. Lower and position the strainer over the strainer guide at the bottom of the tank.
8. Place the hatch cover gasket and hatch cover on the RO feed tank.
9. Secure the hatch cover to the tank using the six screws and flat washers.

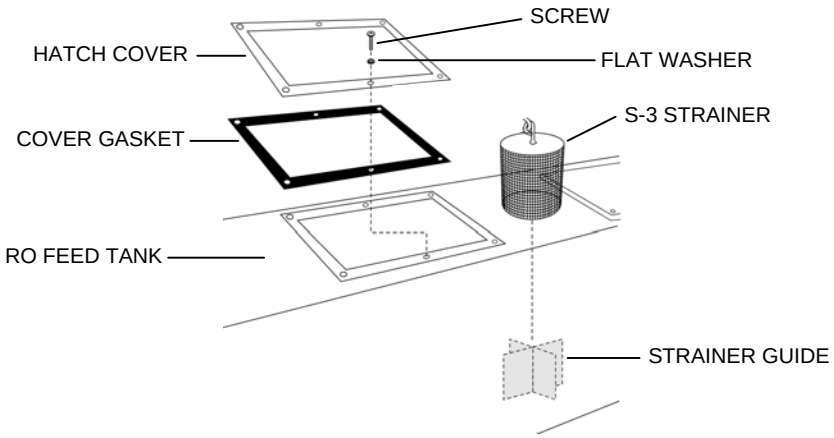

Figure 1. RO Feed Tank Pump Inlet Strainer S-3 Cleaning.

INLINE RO STRAINER S-4 CLEANING:

Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source

1. Make sure TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Close HP Pump Inlet Valve V-212.
3. Open Strainer S-4 Drain Valve V-213. Close the valve when the strainer has drained.
4. Remove the strainer as follows (see Figure 2):
    a. Remove the grooved coupling. Push the gasket back onto the pipe end.
    b. Remove the sanitary clamp and the strainer body. If the strainer does not come out easily, it may be necessary to loosen the pipe clamp downstream (to the right) of the strainer's grooved coupling.
    c. Remove the sanitary clamp gasket and set aside for reuse or replace if damaged.
    d. Remove the strainer from the body.
    e. Clean and reinstall the strainer into the strainer body. Set the sanitary gasket in place on the strainer body flange.
    f. Inspect the grooved coupling gasket. Replace if damaged.
    g. Install the strainer assembly:
        1) Set the strainer body in place and install the sanitary clamp. Partially tighten the clamp. Be careful to keep the gasket centered within the strainer flange.

2) Push the grooved coupling gasket back into place. Install the grooved coupling and partially tighten.
3) Tighten the sanitary clamp and then the grooved coupling.

h. If the pipe clamp downstream of the coupling was loosened earlier, tighten it now.
i. Open HP Pump Inlet Valve V-212 and return to normal operation.

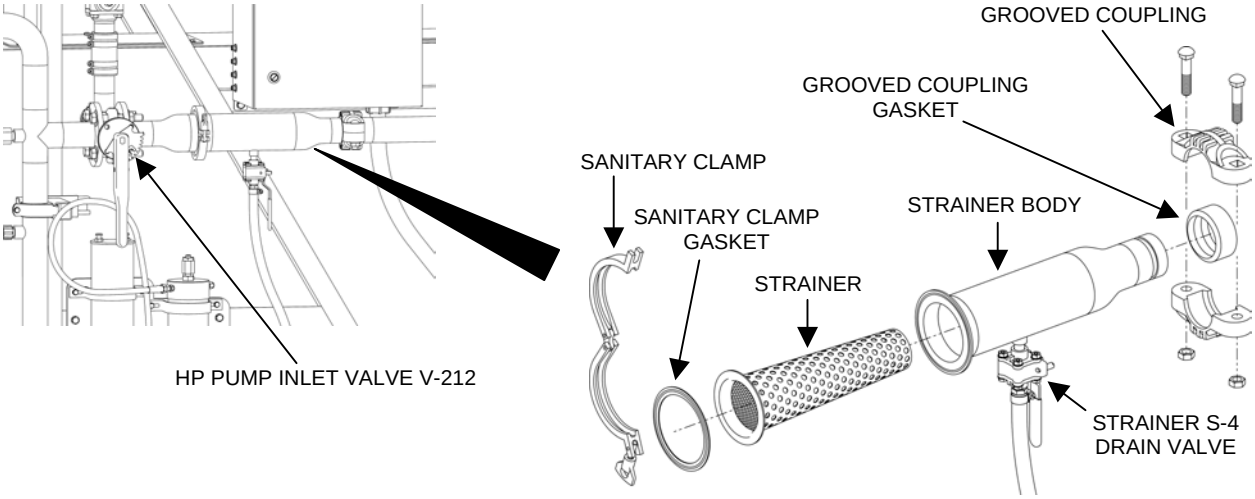

Figure 2. Inline RO Strainer S-4 Removal.

RO FEED PRESSURE TRANSMITTER PT-201 REPLACEMENT:

Parts:
RO Feed Pressure Transmitter PT-201 (BII)
Material:
Five Gallon Bucket
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace RO Feed Pressure Transmitter PT-201 as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on a transmitter. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on a transmitter. Failure to observe this warning could result in serious injury or death from electrical shock.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0041 00**
OPERATOR MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

1. Make sure that the TWPS is in Standby Shutdown With Drain-Down
2. Remove the transmitter from the RO system as follows (see Figure 3):
    a. Disconnect the electrical cable attached to the transmitter.

NOTE

If possible, place a bucket under the transmitter to catch any excess fluid in the line that may run out when the transmitter is removed.

    b. Remove the transmitter from the threaded pipe connection.

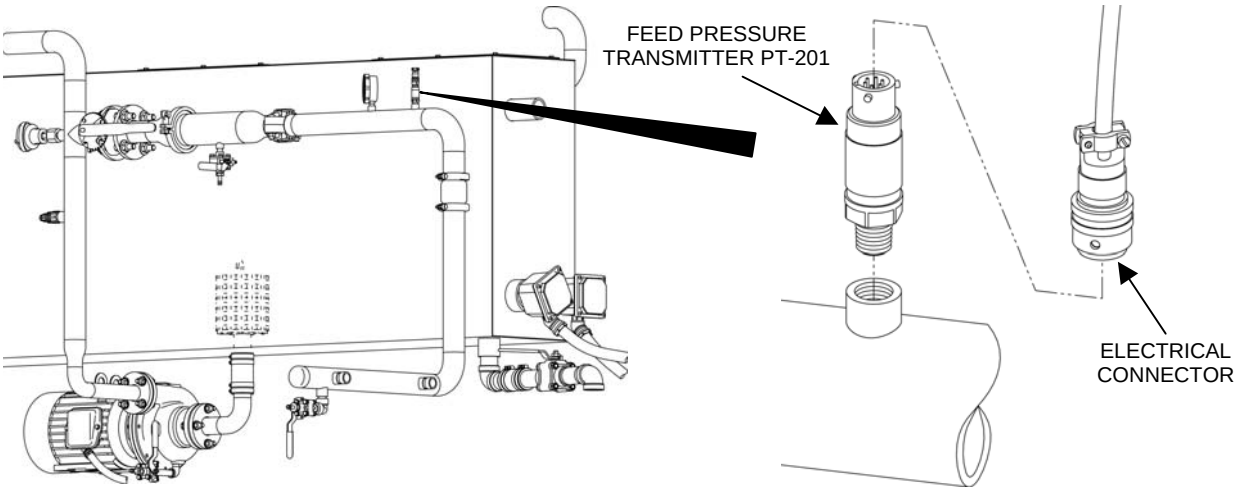

Figure 3. RO Feed Pressure Transmitter PT-201 Replacement.

3. Clean the area around the removed transmitter and inspect the area for corrosion, cracks or other conditions that could cause the transmitter or pipe connection to leak or malfunction.
4. Install the new transmitter as follows:

NOTE

Apply pipe tape to the external pipe thread of the transmitter following the procedures in ASSEMBLY and Pipe Tape in the General Maintenance WP 0045.

Be careful not to over-tighten the transmitter or back off the transmitter after tightening as this could weaken the teflon tape and cause leakage.

    a. Install the transmitter and tighten into position.
    b. Reconnect the electrical cable to the transmitter.
5. Operate the TWPS and check for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0041 00**
OPERATOR MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

RO VESSELS INSPECTION:

RO Vessels ROV-1 through ROV-5:

Inspect the ends of the RO Vessels for corrosion and damaged or deteriorated parts. Replace parts as necessary.

1. Check that the port nut for each vessel is snug and tighten if necessary.
2. Check that the port retainer and retaining ring for each vessel are correctly installed and in their proper position.
3. Correct any improperly installed/positioned parts.

WARNING

Potential for catastrophic failure. Any leakage indicates a potentially dangerous condition. Failure to eliminate leakage could result in vessel failure. Failure to observe this warning can result in severe equipment damage and serious injury or death.

4. Check for leakage. Determine and correct the cause of any leaks found.

RO ELEMENT REPLACEMENT:

Parts (TM 10-4610-309-24P):
Two RO Element Assemblies for each vessel
Materials:
Pad, Scouring (WP 0079, Table 1, item 31)
Mild soap solution
Glycerin (BII) (WP 0079, Table 1, item 21)
Clean water
Corrosion Preventive Compound (BII) (WP 0079, Table 1, item 17)
Tape, Antiseizing (BII) (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down or Short-Term Shut-Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0041 00**
OPERATOR MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

Replace an RO Element as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing an RO element. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

High pressure. The RO Vessels and RO system may be pressurized up to 1200 psig. The TWPS must be drained down to relieve RO system pressure prior to working on any part of the system. Failure to observe this warning can result in an explosive release of parts that can cause injury or death to personnel and damage to equipment.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the following piping (see Figure 4):
    a. For RO element 10:
        1) Remove the grooved coupling at the RO reject port.
        2) Remove the grooved coupling in the U-shaped RO reject pipe run.
        3) Disconnect the hose from Main Pressure Control Valve HCV-401.
        4) Disconnect the hose from Auxiliary Pressure Control Valve HCV-401A.
        5) Remove the flex strut pipe support that secures the RO reject pipe to the floor.
        6) Remove the RO reject pipe run that includes Main Pressure Control Valve HCV-401, Auxiliary Pressure Control Valve HCV-401A, Pressure Indicator PI-401, and RO Vessel Drain Valve V-408.
    b. For RO Element 5:
        1) Disconnect the sample/drain hose from MF Filtrate Sample Valve V-204.
        2) Remove MF Filtrate Sample Valve V-204 to provide room to install the RO elements after the RO simulator has been removed.
    c. For RO Element 8:
        1) Remove the two sanitary clamps from the MF lower shell backwash pipe run.
        2) Remove the pipe section that was secured by the two sanitary clamps and remove the two sanitary clamp gaskets.
    d. For all RO Elements:
        1) Tag and remove the black product water hoses from the 3-way valves.
        2) Tag and remove the clear sample/drain hoses from the 3-way valves.
        3) Tag and remove the grooved couplings and feed/reject pipes from the RO vessel feed/reject ports.

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REVERSE OSMOSIS SYSTEM

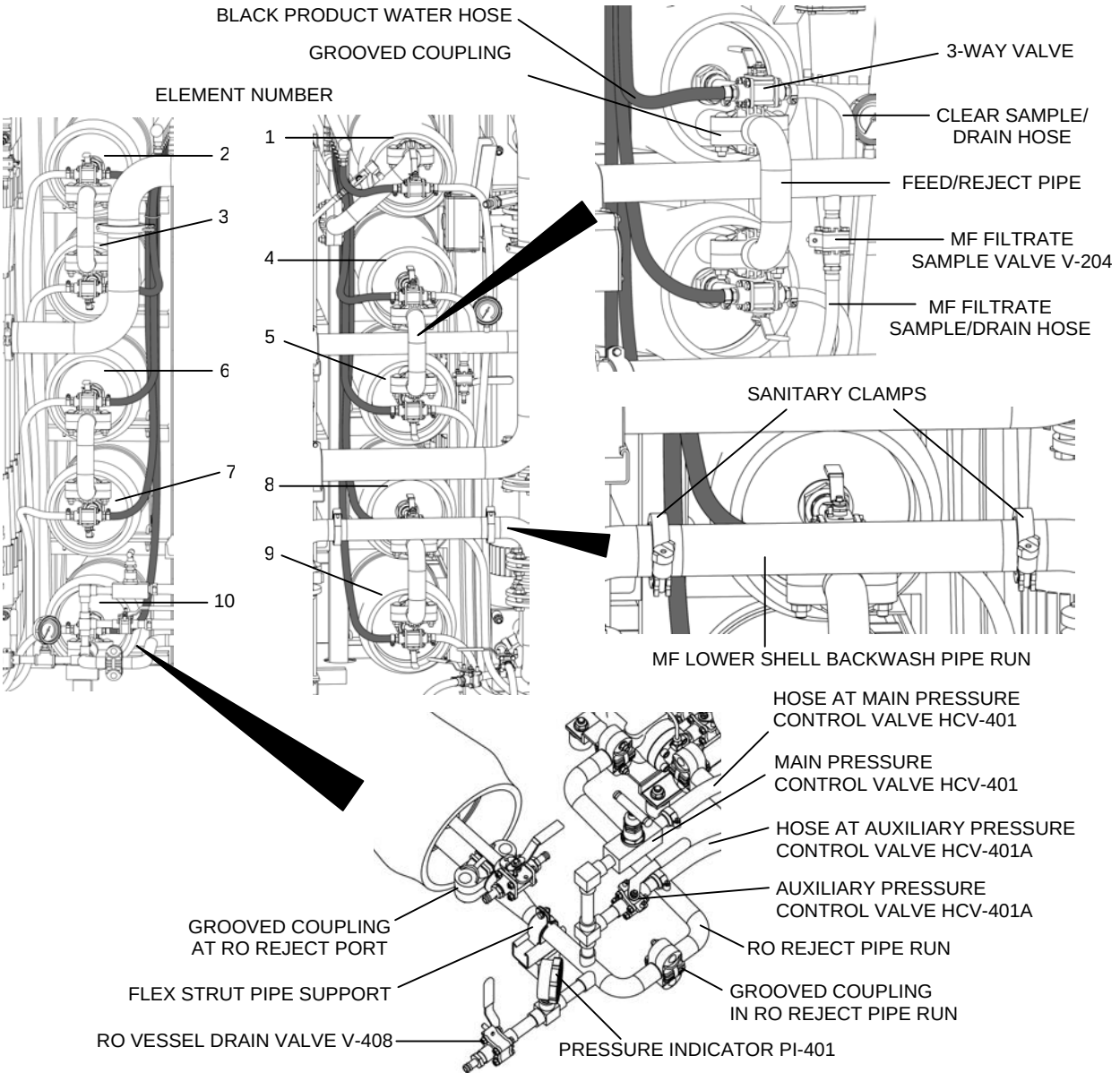

Figure 4. Parts to Remove in Order to Remove RO Simulators.

3. Remove the end cap from the vessel (see Figure 5).

CAUTION

Avoid hitting or levering against the vessel or applying undue force when removing the retaining ring and the end cap. Failure to observe this caution may damage the vessel that could lead to a catastrophic failure.

NOTE

Before removing the end cap a line must be marked from the end cap to the RO vessel. The line will be used to align the end cap with the vessel when the end cap is reinserted in the vessel. The end cap must be inserted so that the raw water pipes can be connected to it without having to rotate the end cap.

a. Using a grease pencil or other marker, draw a single orientation line from the end cap to the vessel.
b. Lift the end of the retaining ring up and out of the stainless steel groove.
c. After starting the ring out of the groove, ease it out.
d. Grasp the 3-way valve and pull the end cap straight out.

NOTE

A sharp forceful tug may be needed to start the end cap assembly moving. It may be helpful to rock the end cap slightly to break the end cap seal bond.

e. If the end cap seal remains in the vessel bore after the end cap is removed, remove the end cap seal.
f. Repeat the end cap removal steps for the end cap at the other end of the vessel.

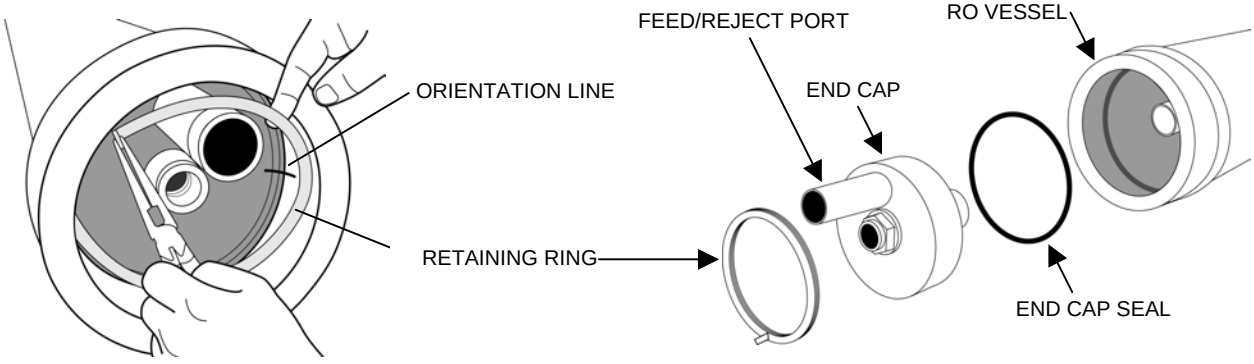

Figure 5. RO Vessel End Cap Removal.

NOTE

If RO simulators are still inside the RO vessels rather than RO elements, clean off any excess lubricant inside the vessels, then pull the simulators out of the vessel from the end closest to the operator station (see WP 0036).

4. Remove the RO elements from the vessel (see Figure 6).

WARNING

Damage or scratches deeper than the paint can result in failure of the vessel wall during operation. Do not scratch or damage the vessel bore when removing or installing elements. Failure to observe this warning can result in injury or death or damage to equipment from catastrophic failure of the vessel under high pressure during operation.

a. Remove the thrust ring from the downstream end of the vessel.

NOTE

There is no thrust ring at the upstream end of the RO vessels.

b. Remove the adapters from the elements at both ends of the vessel.
c. Clean off any excess lubricant from the inside of the vessel before removing the elements.
d. Insert the element pusher into the upstream end of the vessel and push the elements out of the vessel in the direction of feed flow and out the downstream end of the vessel.

CAUTION

Support the element as it is pushed out of the vessel. Do not allow the element weight to be supported by the inter-connector. Failure to observe this caution can result in damage to the inter-connector or the outer surface of the elements.

e. Support the first element as it comes out of the vessel.
f. Disconnect the first element from the element inter-connector.
g. Remove the inter-connector from the second element.
h. Push the second element out of the downstream end of the vessel using the element pusher.

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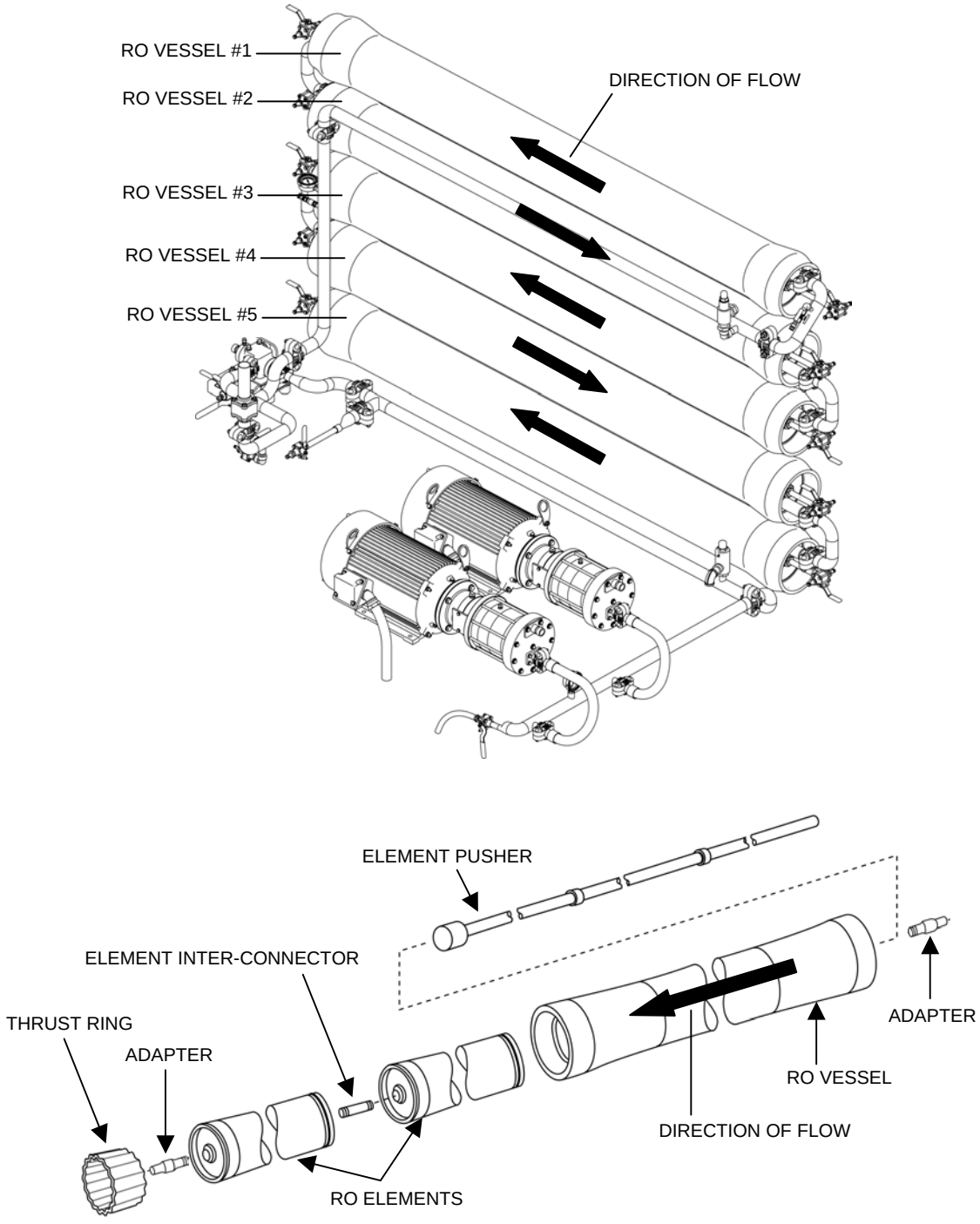

Figure 6. RO Element Removal.

5. Clean and inspect the inside of the vessel as follows:
    a. Flush out the vessel with clean water to remove any debris.
    b. Inspect the inside surface of the vessel for corrosion, deposits or other foreign matter. If any are found, clean the surface as follows:
        1) Using a scouring pad and a mild soap solution, clean each end of the vessel liner surface up to eight in. from each end of the vessel.
        2) Rinse away all loosened deposits from the inside of the vessel.

WARNING

Do not attempt to repair a fiberglass vessel. If a vessel has damage or scratches deeper than the paint, the vessel should be replaced. Failure to observe this warning can result in injury or death or damage to equipment from catastrophic failure of the vessel under high pressure during operation.

    c. Examine the inside of the vessel for scratches or imperfections that may affect the sealing ability of the end cap or element seals. If severe scratches or damage are found, Notify Direct Support to replace the vessel as described in WP 0070, RO System Direct Support Maintenance Procedures under the heading **RO Vessel Replacement**.

CAUTION

Do not attempt to repair a damaged vessel.

6. Install the new elements as follows (see Figure 7):
    a. Lubricate the inside of the vessel at the ends with a 50/50 glycerin/water mixture to ease the insertion of the elements and to reduce the chance of scratching the vessel bore. The mixture can be applied using a swab soaked in the mixture.

CAUTION

Be sure to install the thrust ring in the downstream end of the vessel. Failure to observe this caution can result in serious damage.

    b. Insert a clean thrust ring into the downstream end of the vessel. The thrust ring requires no orientation; simply push it into the downstream end of the vessel.
    c. Insert the end cap assembly, with the first element adapter, into the downstream end of the vessel as follows:
        1) Align the orientation mark that you put on the end cap assembly during removal with the orientation mark that you put on the vessel.

CAUTION

Do not rotate the end cap assembly after inserting it into the vessel. Failure to observe this caution may cause the end cap seal to bind or become detached.

2) Hold the end cap assembly square to the axis of the vessel and slide it straight into the vessel until a slight resistance is felt.
3) Install the retaining ring into the groove in the vessel.

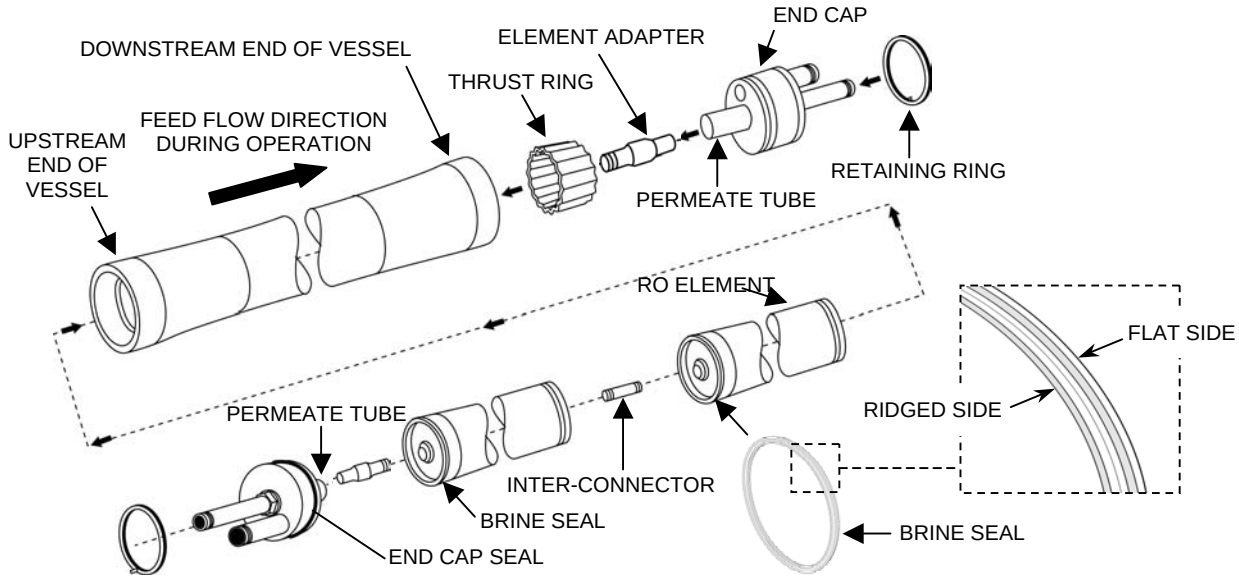

Figure 7. RO Element Installation.

NOTE
Take care not to scratch or damage the RO element during installation.

d. Load the first element into the upstream end of the vessel inserting the brine seal end of the element last. Leave a few inches of the element sticking out of the vessel to allow you to connect the next element to it.

NOTE
Apply only enough glycerin to the inter-connector O-ring to give the O-ring a luster. Excessive lubricant could contaminate the elements.

e. Apply a small amount of glycerin to the inter-connector O-ring.
f. Assemble the inter-connector to the element that was just loaded into the vessel.

CAUTION

Support the second element as it is assembled to the inter-connector and the first element. Do not allow the element weight to be supported by the inter-connector. Failure to observe this caution can result in damage to the inter-connector or the outer surface of the elements.

g. Line up the second element to be loaded and assemble the end without the brine seal to the inter-connector that is already assembled on the first element.

h. Push both elements into the vessel until only a few in. of the second element are left sticking out of the vessel.
i. Install an adapter to the element permeate (product water) tube at the upstream end of the vessel.
j. Push the elements into the vessel as far as they will go.

7. Install the upstream end cap assembly as follows (see Figure 8):
   a. Apply glycerin inside the vessel from behind the retaining ring groove to about one-half in. into the vessel.
   b. Cover the entire end cap seal with a thin layer of glycerin. Make sure no dirt contaminates the glycerin.
   c. Align the orientation mark that you put on the end cap assembly during removal with the orientation mark that you put on the vessel.

CAUTION

Do not rotate the end cap assembly after inserting it into the vessel. Failure to observe this caution may cause the end cap seal to bind or become detached.

   d. Hold the end cap assembly square to the axis of the vessel and slide it straight into the vessel until a slight resistance is felt.
   e. Using both hands, push the end cap in as far as it will go (a forceful thrust may be needed to push the end cap seal into the vessel bore.) When the end cap is in the correct position, the entire retaining ring groove will be exposed.

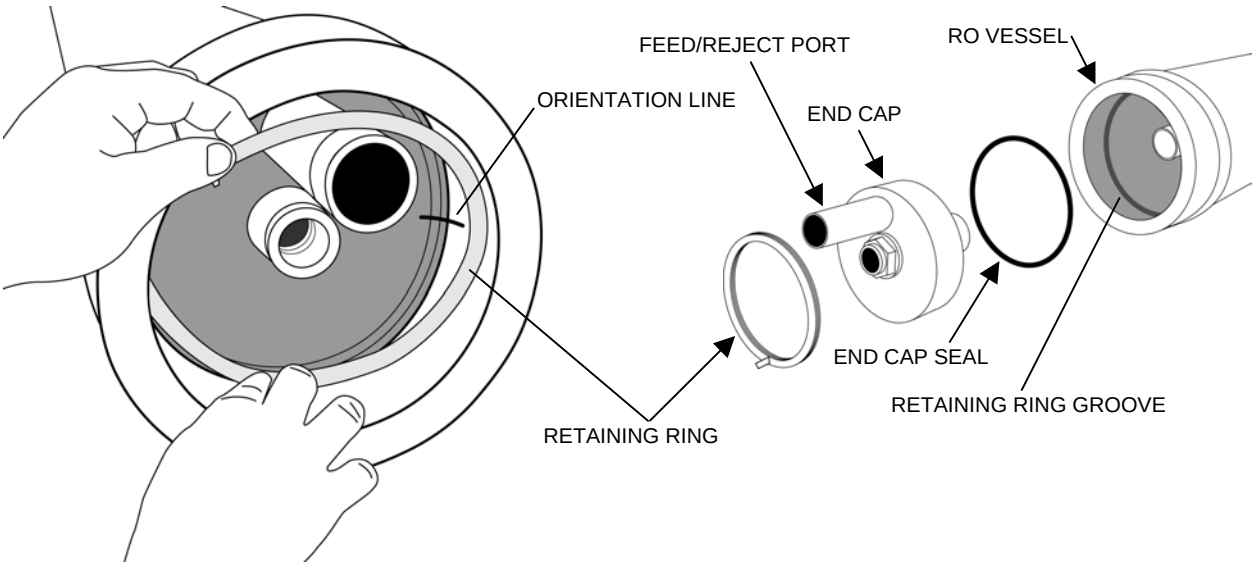

Figure 8. RO Vessel End Cap and Retaining Ring Installation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0041 00**
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REVERSE OSMOSIS SYSTEM

WARNING

Potential catastrophic failure point. The retaining ring must be correctly installed. Failure to observe this warning can result in explosive end cap failure when the vessel is pressurized which, in turn, can cause death, serious injury, and/or severe equipment damage.

f. Place the tip of the retaining ring into the groove, then slide your fingers around the ring pushing it into the groove as you go until the entire ring is in the groove (see Figure 8).
g. Verify that the retaining ring is fully seated in the groove before proceeding.

8. Reinstall the following piping:
   a. Reinstall the feed/reject piping to the vessel feed/reject ports.
   b. Reinstall the black product water hoses and the clear sample/drain hoses to the vessel 3-way valves.
   c. Reinstall any TWPS piping that was removed in order to remove the RO elements.

WARNING

Potential for catastrophic failure. Improper assembly or corrosion damage can result in mechanical failure, property damage and serious injury or death. Perform the recommended pre-pressurization checks before pressurizing the RO vessels. Failure to observe this warning can result in severe equipment damage and serious injury or death.

9. Perform the following pre-pressurization checks:
   a. Make sure that all the elements were installed in each vessel.
   b. Make sure that the element inter-connector was installed in each vessel.
   c. Make sure that the thrust ring was installed in the downstream end of the vessels.
   d. Make sure that the element adapters were installed at each end of the vessels.
   e. Make sure that the port nut at each end of the vessels is snug.
   f. Make sure that the port retainers were correctly installed.
   g. Make sure that the retaining ring is properly seated in the groove at each end of the vessels.
   h. Make sure that all end cap assemblies are in good condition, with no evidence of damage or corrosion.
   i. Make sure that all piping connections will provide a leak-free seal.
   j. If you are unable to ensure all of the above checks, or if you do not understand what is required by any of the checks, do not pressurize the vessels until proper assembly can be assured. If this means disassembling and reassembling any or all of the vessels to ensure that maintenance and proper assembly is performed, then disassemble and reassemble as necessary.
10. Flush the new RO elements at initial use as follows:
    a. **Slowly** fill the vessels with feed water to allow trapped air to escape.
    b. **Slowly** pressurize the vessels to avoid damage to the elements and vessel components.
    c. Discharge the product water to the ground for 2 hours to flush the new elements before connecting to the distribution system.

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RO ELEMENT SIMULATOR INSTALLATION:

Parts (TM 10-4610-309-24P):
Five RO Element Simulators
Materials:
Pad, Scouring (WP 0079, Table 1, item 31)
Mild soap solution
Glycerin (BII) (WP 0079, Table 1, item 21)
Clean water
Corrosion Preventive Compound (BII) (WP 0079, Table 1, item 17)
Tape, Antiseizing (BII) (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down or Short-Term Shut-Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

If a TWPS unit is to be taken out of service to use for training, the RO Elements should be removed and replaced with RO Element Simulators. Install RO Element Simulators as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing an RO element. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

High pressure. The RO Vessels and RO system may be pressurized up to 1200 psig. The TWPS must be drained down to relieve RO system pressure prior to working on any part of the system. Failure to observe this warning can result in an explosive release of parts that can cause injury or death to personnel and damage to equipment.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Refer to **RO ELEMENT REPLACEMENT** in this work package and perform the following steps:
   a. Remove the piping from in front of the RO vessels.
   b. Remove the end caps from the RO vessels.
   c. Remove the RO elements from the RO vessels.
   d. Clean and inspect the inside of the RO vessels.
3. Install an RO element simulator in each RO vessel as follows (see Figure 9):

NOTE

Each RO element simulator comes as an assembly. Steps 3a-3d are provided in the event that components have been separated from an RO simulator assembly.

   a. Make sure a permeate port adapter is inserted over the narrower end of both of the pressure vessel adapters.
   b. Lightly lubricate the o-rings on both of the pressure vessel adapters with glycerin or comparable lubricant.

c. Insert the pressure vessel adapter with the threaded pipe nipple into the end of the simulator pipe that has a small hole in it.
d. Insert the other pressure vessel adapter into the other end of the simulator pipe.
e. Slide a simulator assembly into the end of each RO vessel that is closest to the operator station. It does not matter which end of the simulator is inserted first.

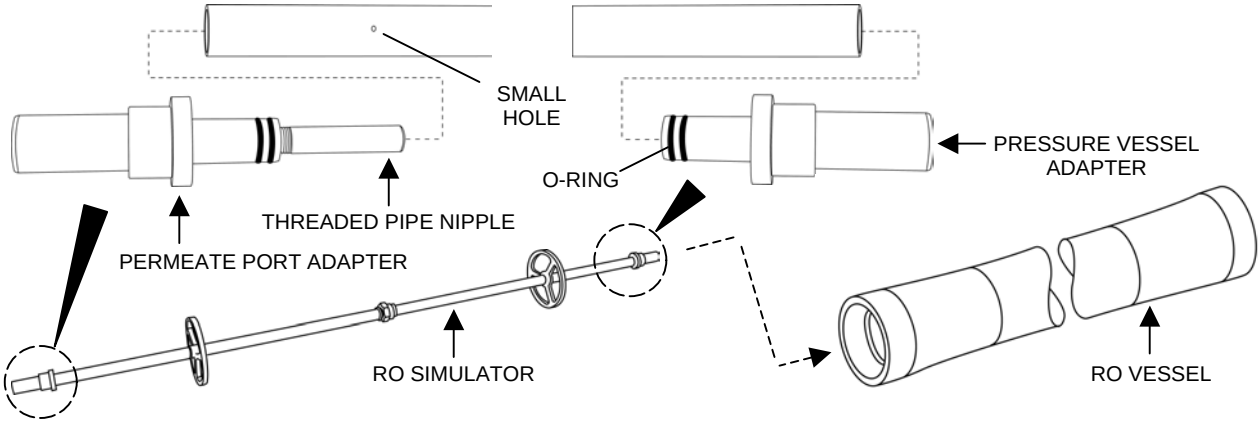

Figure 9. RO Element Simulator Installation.

4. Refer to **RO ELEMENT REPLACEMENT** in this work package and perform the following steps:
   a. Install the upstream end cap assembly.
   b. Install the downstream end cap assembly following the same procedures used for installing the upstream end cap assembly.
   c. Reinstall the piping that was removed earlier from in front of the RO vessels.

WARNING

Potential for catastrophic failure. Improper assembly or corrosion damage can result in mechanical failure, property damage and serious injury or death. Perform the recommended pre-pressurization checks before pressurizing the RO vessels. Failure to observe this warning can result in severe equipment damage and serious injury or death.

5. Perform the following pressurization checks:
   a. Make sure that a simulator was installed in each vessel.
   b. Make sure that the port nut at each end of the vessels is snug.
   c. Make sure that the port retainers were correctly installed.
   d. Make sure the retaining ring is properly seated in the groove at each end of the vessels.
   e. Make sure that all end cap assemblies are in good condition, with no evidence of damage or corrosion.
   f. Make sure that all piping connections will provide a leak-free seal.
   g. If you are unable to ensure all of the above checks, or if you do not understand what is required by any of the checks, do not pressurize the vessels until proper assembly can be assured. If this means disassembling and reassembling any or all of the vessels to ensure that maintenance and proper assembly is performed, then disassemble and reassemble as necessary.

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RO VESSEL REPAIR:

Parts (TM 10-4610-309-24P):
- Feed Port Seal O-rings
- Permeate Port Seal O-rings
- End Cap Seal
- Adapter Seal O-rings
- PWT Seal O-rings
- RO Element Inter-connector O-rings

Materials:
- Pad, scouring (WP 0079, Table 1, item 31)
- Mild soap solution
- Glycerin (BII) (WP 0079, Table 1, item 21)
- Clean water
- Corrosion preventive compound (BII) (WP 0079, Table 1, item 17)
- Tape, antiseizing (BII) (WP 0079, Table 1, item 43, 44)
- Clean, dry, lint-free rags (WP 0079, Table 1, item 33)

Equipment Condition:
- TWPS in Standby Shutdown with Drain-Down or Short-Term Shut-Down
- Army TWPS: Generator off and TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

If the TWPS is showing high product water TDS (conductivity), the most likely cause is RO vessel O-ring leakage, especially with newly installed elements. Replace feed and permeate port seal O-rings, the end cap seal, adapter seal O-rings, PWT seal O-rings, and element inter-connector O-rings as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to repairing an RO vessel. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

High pressure. The RO Vessels and RO system may be pressurized up to 1200 psig. The TWPS must be drained down to relieve RO system pressure prior to working on any part of the system. Failure to observe this warning can result in an explosive release of parts that can cause injury or death to personnel and damage to equipment.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.

2. Remove the following piping (see Figure 10):
    a. For RO element 10:
        1) Remove the grooved coupling at the RO reject port.
        2) Remove the grooved coupling in the U-shaped RO reject pipe run.
        3) Disconnect the hose from Main Pressure Control Valve HCV-401.
        4) Disconnect the hose from Auxiliary Pressure Control Valve HCV-401A.
        5) Remove the flex strut pipe support that secures the RO reject pipe to the floor.
        6) Remove the RO reject pipe run that includes Main Pressure Control Valve HCV-401, Auxiliary Pressure Control Valve HCV-401A, Pressure Indicator PI-401, and RO Vessel Drain Valve V-408.
    b. For RO Element 5:
        1) Disconnect the sample/drain hose from MF Filtrate Sample Valve V-204.
        2) Remove MF Filtrate Sample Valve V-204 to provide room to install the RO elements after the RO simulator has been removed.
    c. For RO Element 8:
        1) Remove the two sanitary clamps from the MF lower shell backwash pipe run.
        2) Remove the pipe section that was secured by the two sanitary clamps and remove the two sanitary clamp gaskets.
    d. For all RO Elements:
        1) Tag and remove the black product water hoses from the 3-way valves.
        2) Tag and remove the clear sample/drain hoses from the 3-way valves.
        3) Tag and remove the grooved couplings and feed/reject pipes from the RO vessel feed/reject ports.

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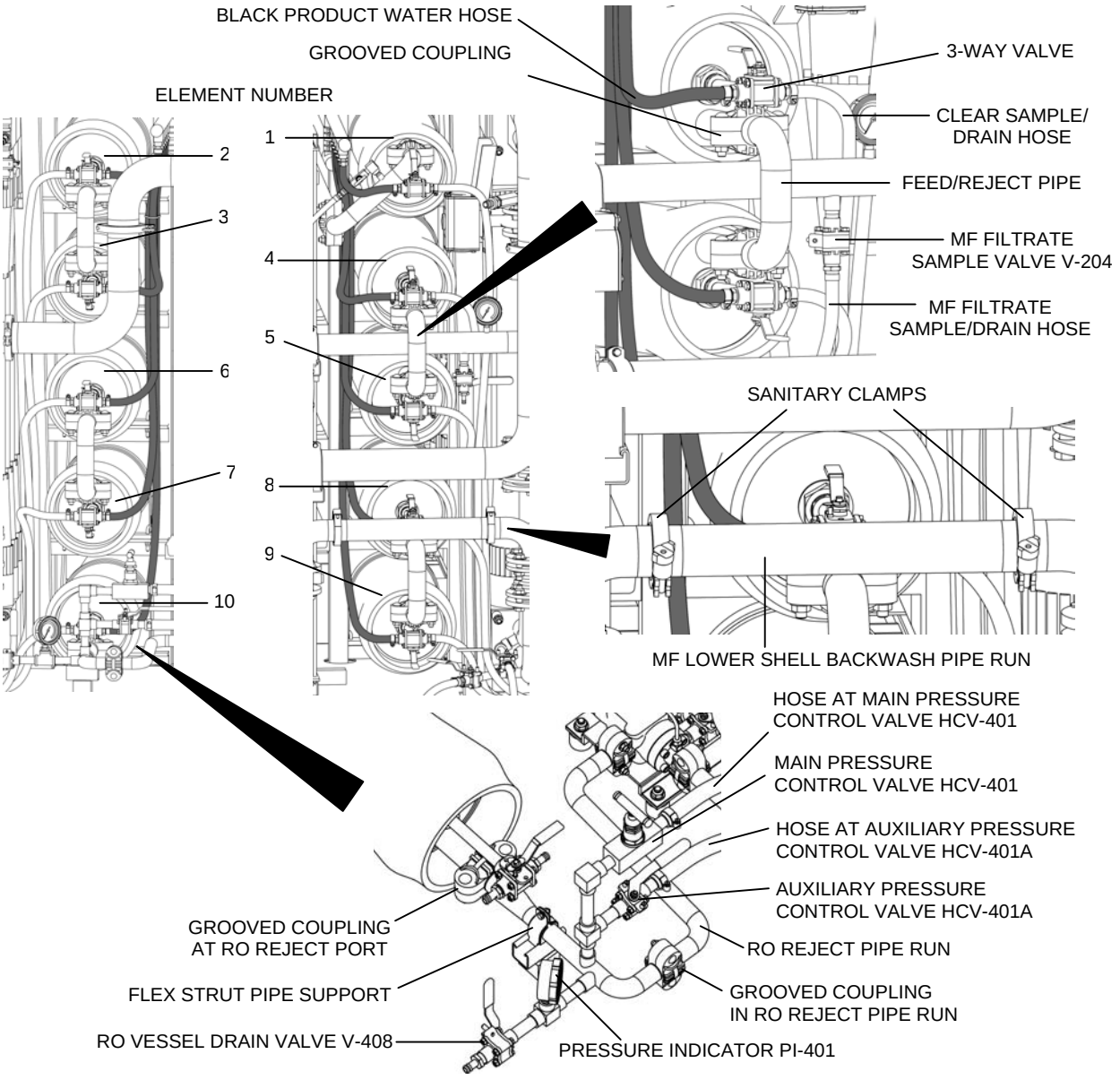

Figure 10. Parts to Remove in Order to Remove RO Elements.

3. Remove the end cap from the vessel (see Figure 11).

CAUTION

Avoid hitting or levering against the vessel or applying undue force when removing the retaining ring and the end cap. Failure to observe this caution may damage the vessel that could lead to a catastrophic failure.

NOTE

Before removing the end cap, a line must be marked from the end cap to the RO vessel. The line will be used to align the end cap with the vessel when the end cap is reinserted in the vessel. The end cap must be inserted so that the raw water pipes can be connected to it without having to rotate the end cap.

a. Using a grease pencil or marker, draw a single orientation line from the end cap to the vessel.
b. Lift the end of the retaining ring up and out of the stainless steel groove.
c. After starting the ring out of the groove, ease it out.
d. Grasp the 3-way valve and pull the end cap straight out.

NOTE

A sharp forceful tug may be needed to start the end cap assembly moving. It may be helpful to rock the end cap slightly to break the end cap seal bond.

e. If the end cap seal remains in the vessel bore after the end cap is removed, remove the end cap seal.
f. Repeat the end cap removal steps for the end cap at the other end of the vessel.

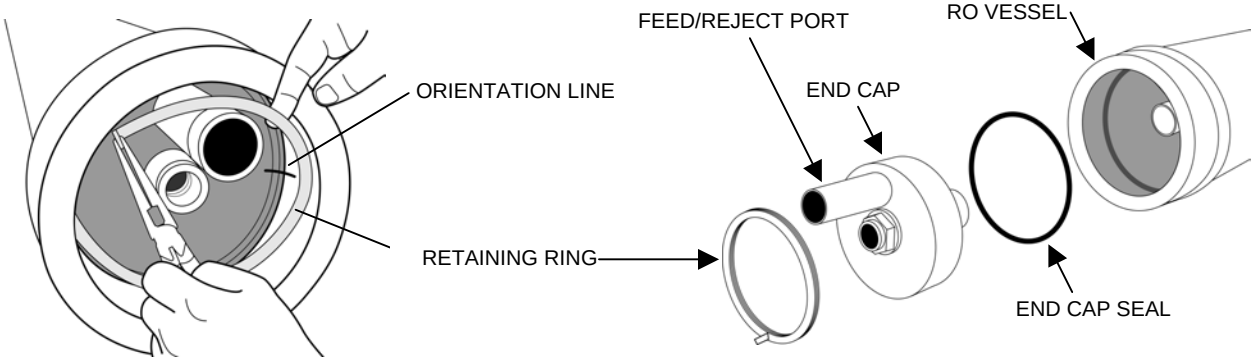

Figure 11. RO Vessel End Cap Removal.

4. Remove the RO elements from the vessel (see Figure 12).

WARNING

Damage or scratches deeper than the paint can result in failure of the vessel wall during operation. Do not scratch or damage the vessel bore when removing or installing elements. Failure to observe this warning can result in injury or death or damage to equipment from catastrophic failure of the vessel under high pressure during operation.

a. Remove the thrust ring from the downstream end of the vessel.

NOTE
There is no thrust ring at the upstream end of the RO vessels.

b. Remove the adapters from the elements at both ends of the vessel.
c. Clean off any excess lubricant from the inside of the vessel before removing the elements.
d. Insert the element pusher into the upstream end of the vessel and push the elements out of the vessel in the direction of feed flow and out the downstream end of the vessel.

CAUTION

Support the element as it is pushed out of the vessel. Do not allow the element weight to be supported by the inter-connector. Failure to observe this caution can result in damage to the inter-connector or the outer surface of the elements.

e. Support the first element as it comes out of the vessel.
f. Disconnect the first element from the element inter-connector.
g. Remove the inter-connector from the second element.
h. Push the second element out of the downstream end of the vessel using the element pusher.

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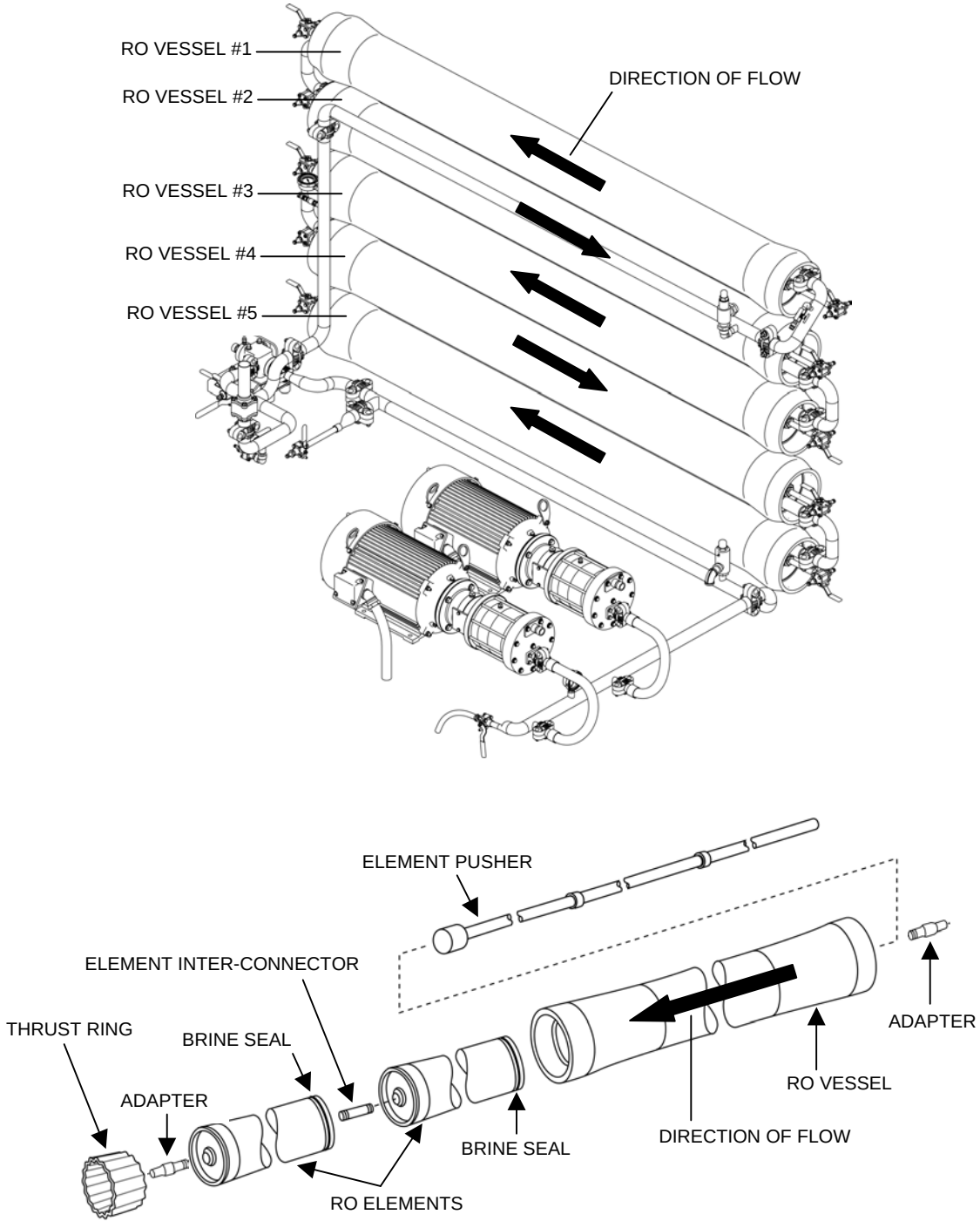

Figure 12. RO Element Removal.

5. Clean and inspect the inside of the vessel as follows:
    a. Remove the 3-way ball valve and piping by unscrewing the permeate port nut. Not the position of the 3-way valve.
    b. Flush out the vessel with clean water to remove any debris.
    c. Inspect the inside surface of the vessel for corrosion, deposits or other foreign matter. If any are found, clean the surface as follows:
        1) Using a scouring pad and a mild soap solution, clean each end of the vessel liner surface up to eight in. from each end of the vessel.
        2) Rinse away all loosened deposits from the inside of the vessel.

WARNING

Do not attempt to repair a fiberglass vessel. If a vessel has damage or scratches deeper than the paint, the vessel should be replaced. Failure to observe this warning can result in injury or death or damage to equipment from catastrophic failure of the vessel under high pressure during operation.

    d. Examine the inside of the vessel for scratches or imperfections that may affect the sealing ability of the end cap or element seals. If severe scratches or damage are found, Notify Direct Support to replace the vessel as described in WP 0070, RO System Direct Support Maintenance Procedures under the headings **REPLACE** and **RO Vessel**.

CAUTION

Do not attempt to repair a damaged vessel.

6. Disassemble the end cap(s) as follows (see Figure 13):
    a. Remove the permeate port nut by unscrewing (left-handed thread).
    b. Remove the permeate port by pressing the port out of the end cap from the threaded end.
    c. Hold the feed/reject port and the bearing plate still and rotate the seal plate slightly to break the seal. Remove the seal plate.
    d. Press the long, exposed end of the feed/reject port further into the bearing plate to free the port retainer set.
    e. Remove the two-piece feed/reject port retainer set.
    f. Remove the feed/reject port from the bearing plate.

CAUTION

Be careful not to damage end cap, port, adapter, or inter-connector surfaces when removing O-rings and seals. Failure to observe this caution may result in leakage.

7. Remove and discard the following O-rings and seals (see Figure 13):
    a. Feed port O-ring
    b. Permeate port O-ring
    c. End cap seal
    d. Adapter O-ring
    e. PWT O-rings (two at each of the two adapters)
    f. Inter-connector O-rings (two at each end of the inter-connector)

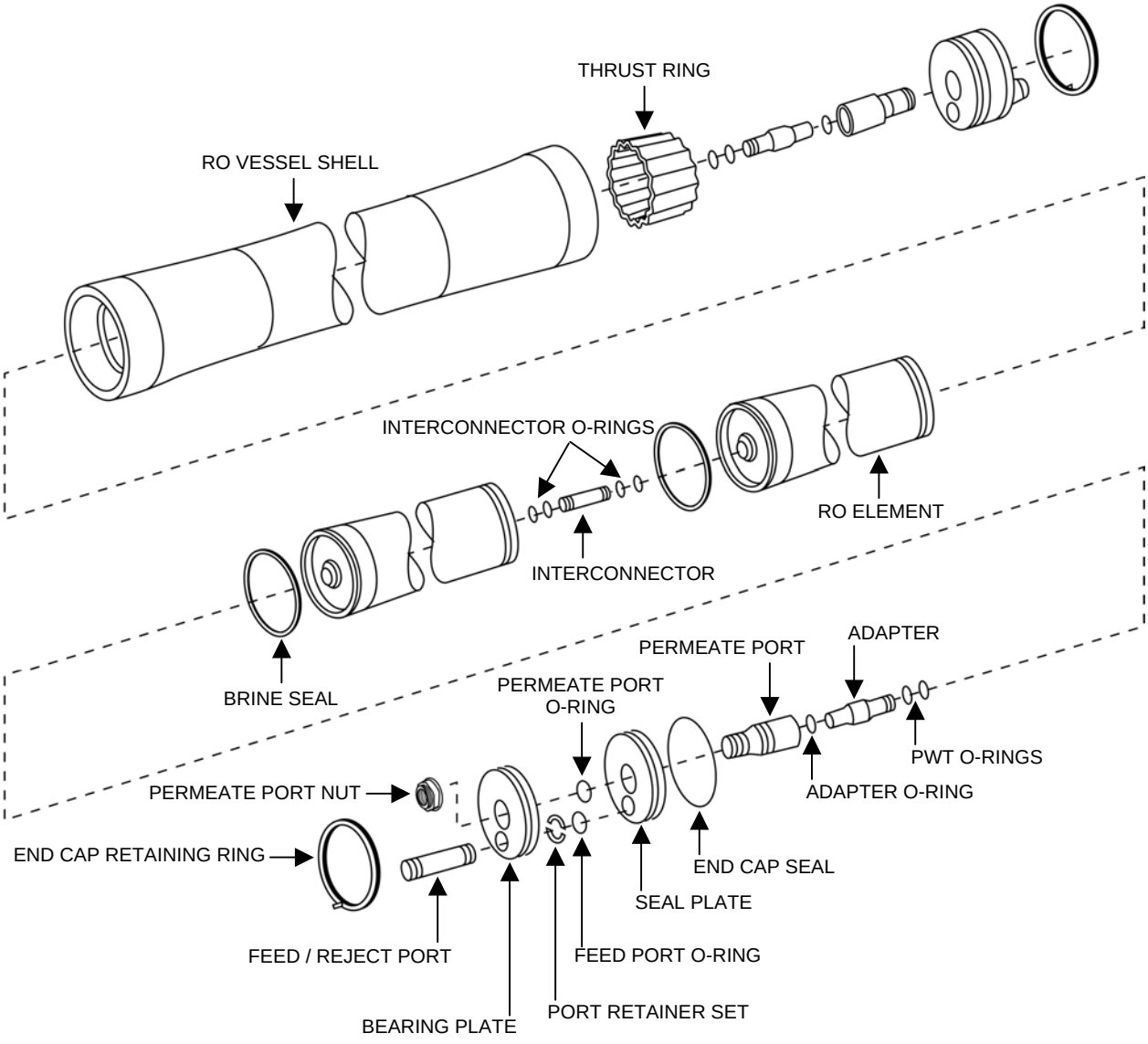

Figure 13. Element O-Ring Replacement.

8. Wash all components in fresh water.
9. Inspect all components for damage that could affect structural strength or sealing properties. Replace any parts that are unacceptable. Examples of when component replacement is required are as follows:
    a. Feed/reject port is bent or distorted.
    b. Permeate port internal or external thread is stripped
    c. Permeate port nut is stripped.
    d. Bearing plate is bent or distorted or anodized coating is removed.
    e. Seal plate is cracked or distorted or sealing area is damaged.
    f. Retaining ring is bent or damaged.

WARNING

Potential cause of RO vessel failure. The RO end caps must be correctly assembled. Incorrect assembly can result in catastrophic failure. Failure to observe this warning can result in severe equipment damage and serious injury or death.

10. Assemble the end cap as follows:
    a. Cover each of the following new O-rings or seals with a thin, even layer of glycerin and install:
        (1) Feed port O-ring
        (2) Permeate port O-ring
        (3) End cap seal
        (4) Adapter O-ring
        (5) PWT O-rings (two at each of the two adapters)
        (6) Inter-connector O-rings (two at each end of the inter-connector)
    b. Hold the bearing plate so that the counter bore of the off-center hole is facing you.
    c. From the other side, insert the smaller, machined end of the feed/reject port through the off-center hole.
    d. Install the port retainer set into the groove in the machined end of the feed/reject port.
    e. Pull the feed/reject port back until the retainer set settles into the bottom of the bearing plate recess.
    f. While holding the feed/reject port, retainer set and bearing plate together, position the larger diameter side of the seal plate so that it faces the bearing plate and press the seal plate onto the machined end of the feed/reject port.
    g. Rotate the seal plate until the holes in the seal plate align with the holes in the bearing plate.
    h. Insert the threaded end of the permeate port through the seal plate and the bearing plate. Press firmly until the permeate port bottoms onto the seal plate.

WARNING

Potential cause of RO vessel failure. When the port nut is tightened, the sealing plate must sit flush against the bearing plate. If there is any gap between the sealing plate and bearing plate, the components are not assembled correctly. Failure to observe this warning can result in severe equipment damage and serious injury or death.

i. Thread the port nut (left-hand thread) onto the permeate port. Tighten snug tight.
j. Reinstall the 3-way valve and piping by screwing the piping into the permeate port nut. The valve must be installed in the position noted at removal.

11. Reinstall the elements as follows (see Figure 14):
    a. Lubricate the inside of the vessel at the ends with a 50/50 glycerin/water mixture to ease the insertion of the elements and to reduce the chance of scratching the vessel bore. The mixture can be applied using a swab soaked in the mixture.

CAUTION

Be sure to install the thrust ring in the downstream end of the vessel. Failure to observe this caution can result in serious damage.

    b. Insert a clean thrust ring into the downstream end of the vessel. The thrust ring requires no orientation; simply push it into the downstream end of the vessel.
    c. Insert the end cap assembly, with the first element adapter, into the downstream end of the vessel as follows:
        1) Align the orientation mark that you put on the end cap assembly during removal with the orientation mark that you put on the vessel.

CAUTION

Do not rotate the end cap assembly after inserting it into the vessel. Failure to observe this caution may cause the end cap seal to bind or become detached.

        2) Hold the end cap assembly square to the axis of the vessel and slide it straight into the vessel until a slight resistance is felt.
        3) Install the retaining ring into the groove in the vessel.

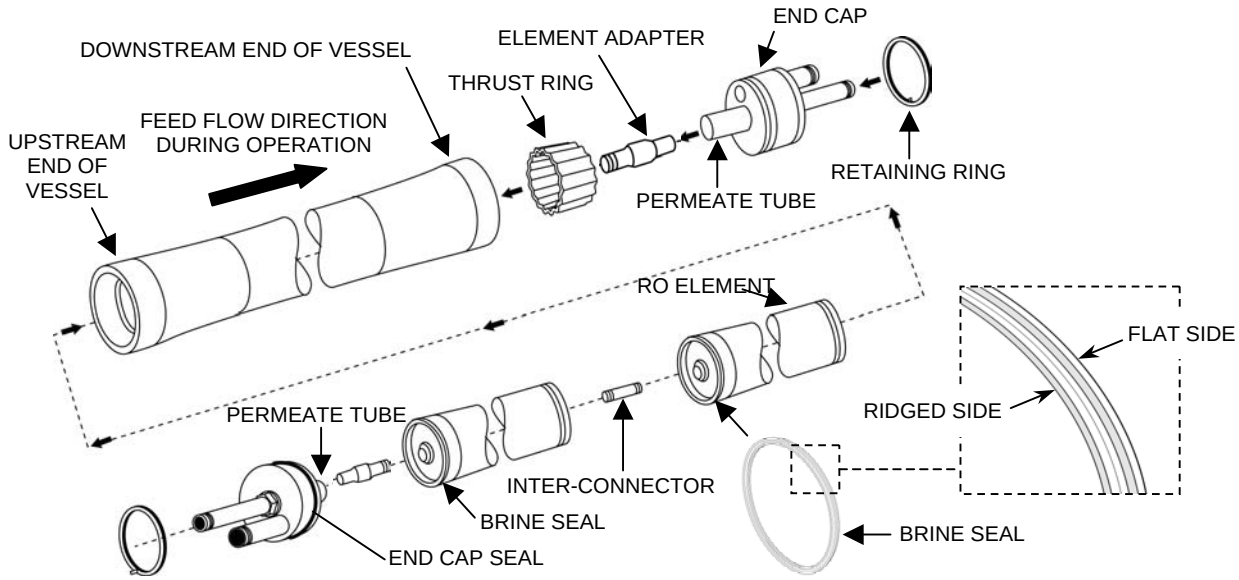

Figure 14. RO Element Installation.

NOTE
Take care not to scratch or damage the RO element during installation.

d. Load the first element into the upstream end of the vessel inserting the brine seal end last. Leave a few inches of the element sticking out of the vessel to allow you to connect the next element to it.

NOTE
Apply only enough glycerin to the inter-connector O-ring to give the O-ring a luster. Excessive lubricant could contaminate the elements.

e. Apply a small amount of glycerin to the inter-connector O-ring.
f. Assemble the inter-connector to the element that was just loaded into the vessel.

CAUTION

Support the second element as it is assembled to the inter-connector and the first element. Do not allow the element weight to be supported by the inter-connector. Failure to observe this caution can result in damage to the inter-connector or the outer surface of the elements.

g. Line up the second element to be loaded and assemble the end without the brine seal to the inter-connector that is already assembled on the first element.
h. Push both elements into the vessel until only a few in. of the second element are left sticking out of the vessel.

i. Install an adapter to the element permeate tube at the upstream end of the vessel.
j. Push the elements into the vessel as far as they will go.

12. Install the upstream end cap assembly as follows (see Figure 15):
    a. Apply glycerin inside the vessel from behind the retaining ring groove to about one-half in. into the vessel.
    b. Cover the entire end cap seal with a thin layer of glycerin. Make sure no dirt contaminates the glycerin.
    c. Align the orientation mark that you put on the end cap assembly during removal with the orientation mark that you put on the vessel.

CAUTION

Do not rotate the end cap assembly after inserting it into the vessel. Failure to observe this caution may cause the end cap seal to bind or become detached.

    d. Hold the end cap assembly square to the axis of the vessel and slide it straight into the vessel until a slight resistance is felt.
    e. Using both hands, push the end cap in as far as it will go (a forceful thrust may be needed to push the end cap seal into the vessel bore.) When the end cap is in the correct position, the entire retaining ring groove will be exposed.

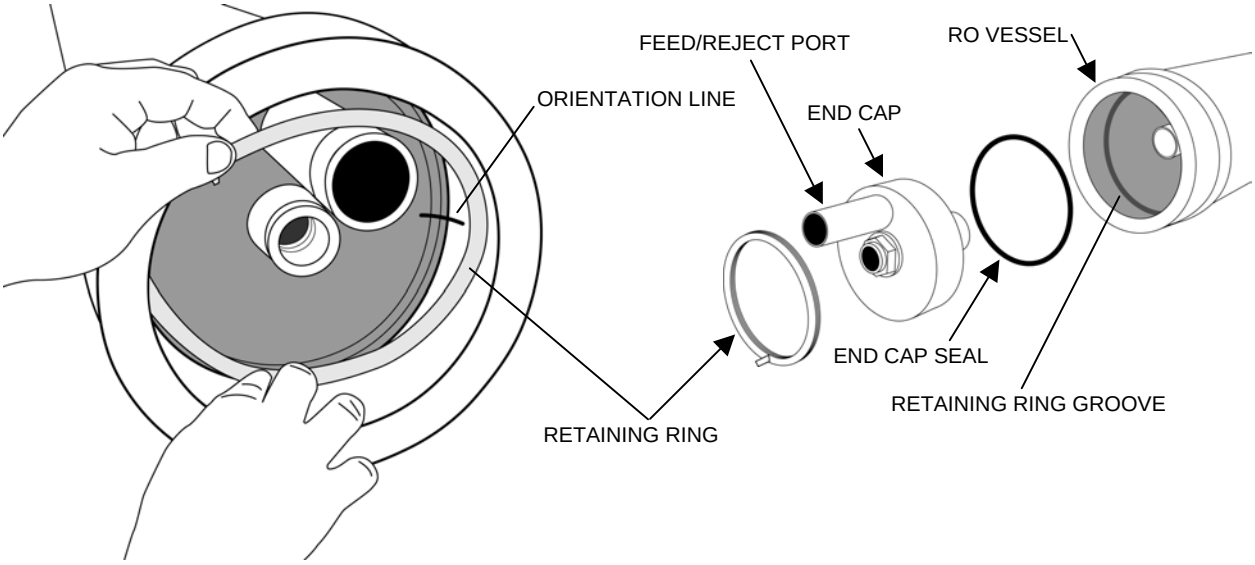

Figure 15. RO Vessel End Cap and Retaining Ring Installation.

WARNING

Potential catastrophic failure point. The retaining ring must be correctly installed. Failure to observe this warning can result in explosive end cap failure when the vessel is pressurized which, in turn, can cause death, serious injury, and/or severe equipment damage.

f. Place the tip of the retaining ring into the groove, then slide your fingers around the ring pushing it into the groove as you go until the entire ring is in the groove (see Figure 15).
g. Verify that the retaining ring is fully seated in the groove before proceeding.

13. Reinstall the following piping:
    a. Reinstall the feed/reject piping to the vessel feed/reject ports.
    b. Reinstall the black product water hoses and the clear sample/drain hoses to the vessel 3-way valves.
    c. Reinstall any TWPS piping that was removed in order to remove the RO elements.

WARNING

Potential for catastrophic failure. Improper assembly or corrosion damage can result in mechanical failure, property damage and serious injury or death. Perform the recommended pre-pressurization checks before pressurizing the RO vessels. Failure to observe this warning can result in severe equipment damage and serious injury or death.

14. Perform the following pre-pressurization checks:
    a. Make sure that all the elements were installed in each vessel.
    b. Make sure that the element inter-connector was installed in each vessel.
    c. Make sure that the thrust ring was installed in the downstream end of the vessels.
    d. Make sure that the element adapters were installed at each end of the vessels.
    e. Make sure that the port nut at each end of the vessels is snug.
    f. Make sure that the port retainers were correctly installed.
    g. Make sure that the retaining ring is properly seated in the groove at each end of the vessels.
    h. Make sure that all end cap assemblies are in good condition, with no evidence of damage or corrosion.
    i. Make sure that all piping connections will provide a leak-free seal.
    j. If you are unable to ensure all of the above checks, or if you do not understand what is required by any of the checks, do not pressurize the vessels until proper assembly can be assured. If this means disassembling and reassembling any or all of the vessels to ensure that maintenance and proper assembly is performed, then disassemble and reassemble as necessary.
15. Pressurize the vessels.
    a. Vessels should be filled with feed water slowly to allow trapped air to escape.
    b. Vessels should be pressurized slowly to avoid damage to the elements and vessel components.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0041 00**
OPERATOR MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

MAIN PRESSURE CONTROL VALVE HCV-401 CALIBRATION:

Equipment Condition:
TWPS in Standby Shutdown with Drain-Down or Short-Term Shut-Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to calibrating Main Pressure Control Valve HCV-401. Failure to observe this warning can result in injury or death or damage to equipment.

High pressure. The RO Vessels and RO system may be pressurized up to 1200 psig. The TWPS must be drained down to relieve RO system pressure prior to working on any part of the system. Failure to observe this warning can result in an explosive release of parts that can cause injury or death to personnel and damage to equipment.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.

NOTE
Calibrating Main Pressure Control Valve HCV-401 consists of tightening the packing gland to eliminate leaks in the packing gland area of the valve.

2. Calibrate Main Pressure Control Valve HCV-401 as follows:
   a. Loosen the locking nut.
   b. Tighten the packing gland ¼ turn.
   c. Retighten the locking nut.
   d. If the valve still leaks, repeat the previous three steps.

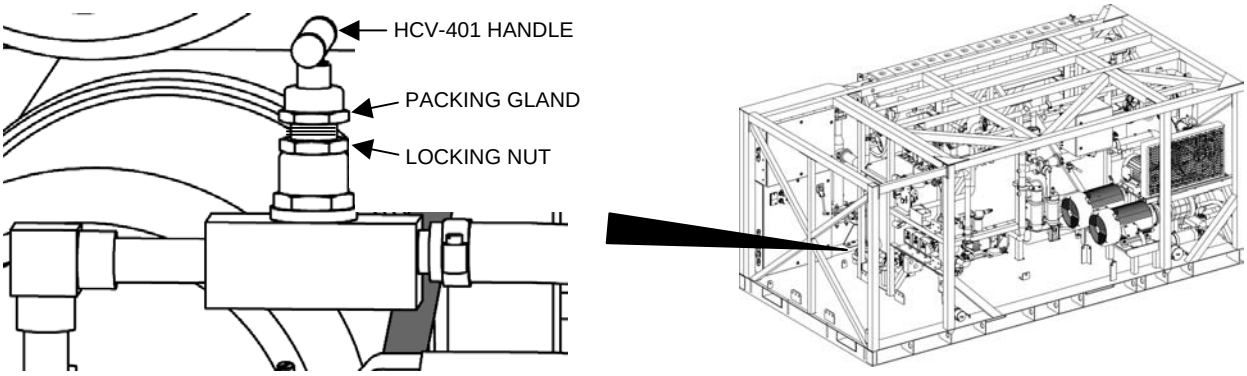

Figure 16. Main Pressure Control Valve HCV-401 Calibration.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES AIR SYSTEM

0042 00

THIS SECTION COVERS:
Replace, Service

INITIAL SETUP:

Maintenance Level
Operator/Crew
Tools
Operator Tool Kit (BII) (33901161)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS removed from service or during operation as required

GENERAL:

This work package contains information and instructions for replacing and servicing components in the air system. The procedures covered in this work package include:

- Entire Air System Bleed Down Procedure
- Compressor Intake Filter Element AF-1 Replacement
- AF-2 Purifier Filter Cartridge Replacement
- Pressure Switch Assembly PSL/PSH-901 Adjustment
- Pressure Regulating Valve PRV-901 and PRV-902 Adjustment
- Bleed the Lubrication System (Vent the Oil Pump)
- Check Compressor Belt Tension

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0042 00**
OPERATOR MAINTENANCE PROCEDURES
AIR SYSTEM

ENTIRE AIR SYSTEM BLEED DOWN PROCEDURES

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Bleed the entire air system as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the entire air system as follows (see Figure 1 for valve location):
    a. Stop the air compressor by switching the Air Compressor control at the OCP to OFF.
    b. Close Air Receiver Tank Shut-Off Valve V-907.
    c. Make sure that Low Pressure Air Shut Off Valve V-909 is open.
    d. **Slowly** open Low Pressure Air Vent Valve V-910 to bleed the air from the air system.
    e. **Slowly** open High Pressure Air Vent Valve V-904.

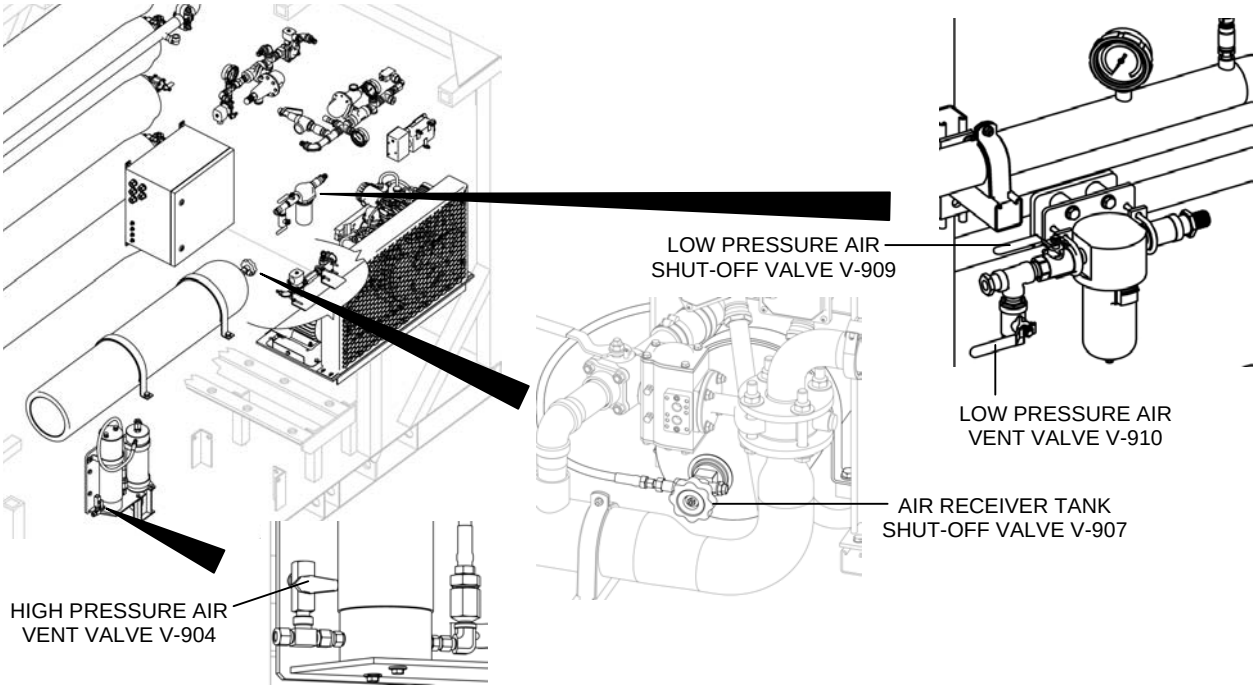

Figure 1. Valves for Bleeding the Entire Air System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0042 00**
OPERATOR MAINTENANCE PROCEDURES
AIR SYSTEM

REPLACE

Compressor Intake Filter Element AF-1 Replacement:

Parts (TM 10-4610-309-24P):
Filter element
O-ring, filter
O-ring, cover
Equipment Condition:
TWPS in Standby Shutdown without Drain-Down

Clean or replace the intake filter element as follows (see Figure 2):

NOTE
The filter cap has spring pressure behind it. Be careful when removing the cap so the spring does not pop out and get lost.

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Stop the air compressor by switching the Air Compressor control at the OCP to OFF.
3. Remove the filter cover and compression spring.
4. Remove the filter element and filter O-ring. inspect them for damage or deterioration and replace as necessary.
5. To clean the filter element, blow compressed air through it from the inside.
6. Install the filter element and O-ring. If reinstalling the same element, turn it 90 degrees from its previous position so a different area of the filter is next to the air inlet.
7. Inspect the filter cover O-ring for damage or deterioration and replace it if necessary.
8. Install the spring and filter cover.

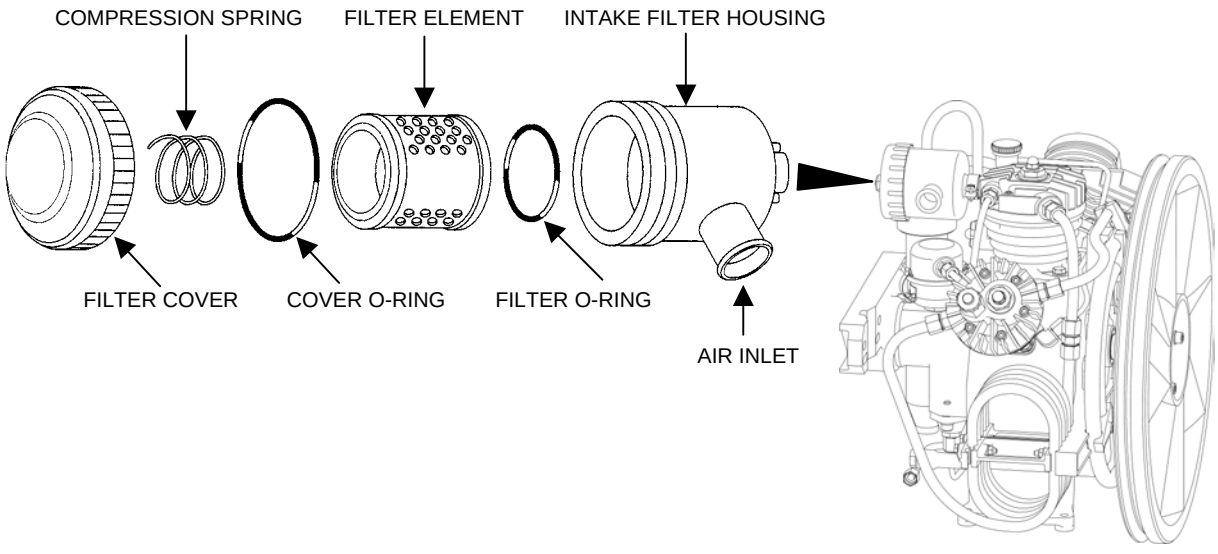

Figure 2. Intake Filter Element AF-1 Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0042 00**
OPERATOR MAINTENANCE PROCEDURES
AIR SYSTEM

AF-2 Purifier Filter Cartridge Replacement:

Tools:
Air Compressor Purification Chamber Wrench (BII)
Parts (TM 10-4610-309-24P):
Purifier Cartridge
Material:
Glycerin (BII) (WP 0079, Table 1, item 14)
Equipment Condition:
TWPS in Standby Shutdown without Drain-Down

WARNING

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to replacing the AF-2 Purifier Filter Cartridge. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the AF-2 purifier cartridge as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the air system as follows (see Figure 3 for valve location):
   a. Stop the air compressor by switching the Air Compressor control at the OCP to OFF.
   b. **Slowly** open High Pressure Air Vent Valve V-904 to bleed high-pressure air from the air system.

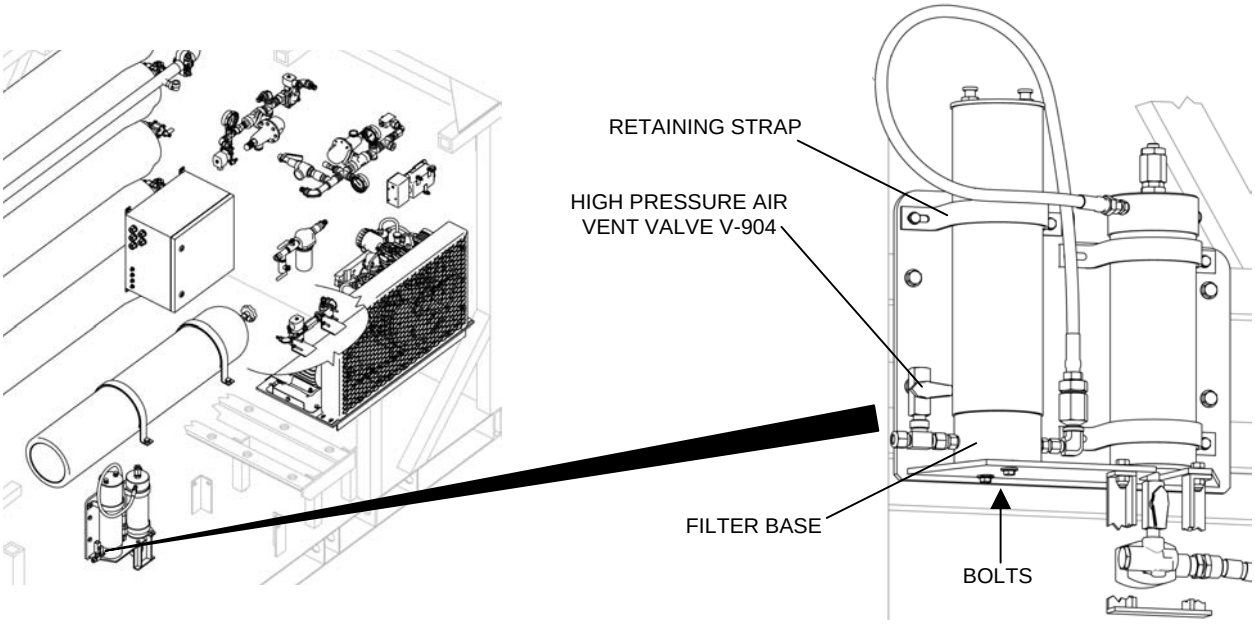

Figure 3. Valve for Bleeding the Air System.

3. Remove the purifier cartridge as follows (see Figure 4):
    a. Unscrew the filter head using the purifier chamber wrench.
    b. Remove the two bolts on the bottom of the filter base (see Figure 3).
    c. Unbolt and remove the retaining strap and tilt the filter assembly outward (see Figure 3).
    d. Pull out the cartridge using the lifting ring on top of the cartridge

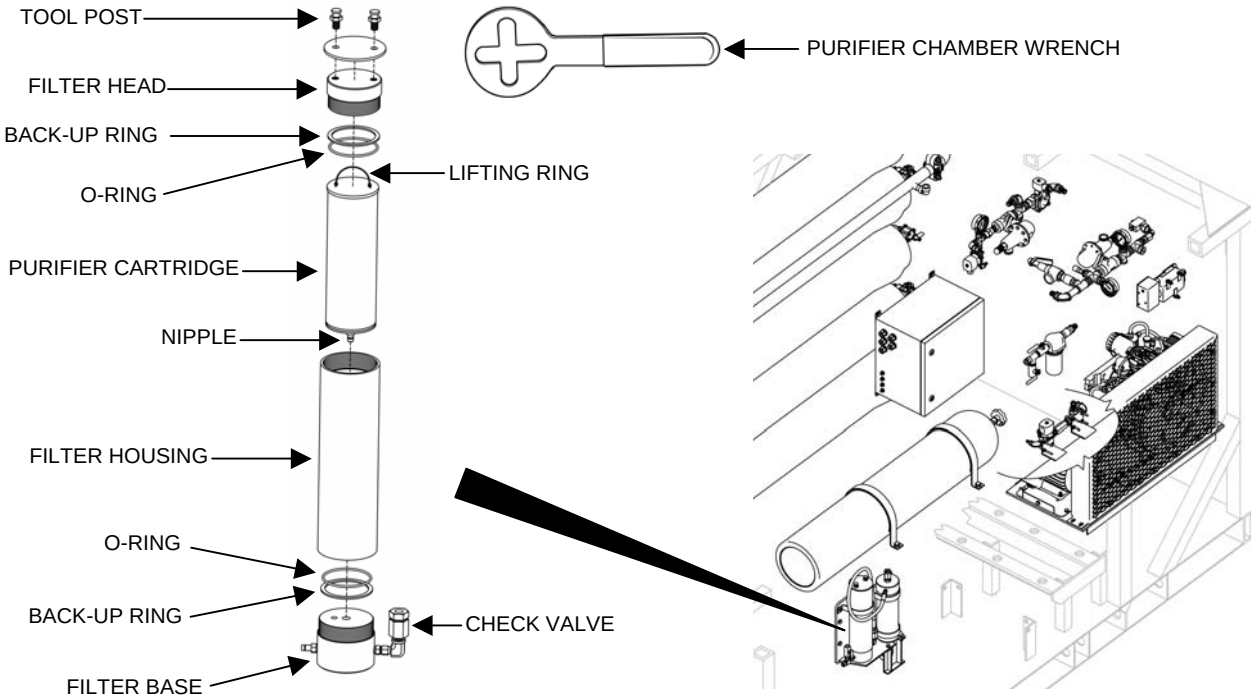

Figure 4. AF2 Purifier Cartridge Replacement.

4. Prior to installing the new cartridge, perform the following steps:
    a. Dry the inside of the filter housing with a clean, lint free cloth and check for corrosion.
    b. Remove the protective sleeve from the new cartridge.
    c. Remove the protective cap from both ends of the new cartridge.
5. Install the new cartridge. Be sure the nipple of the cartridge snaps into place (see Figure 4).
6. Reinstall the two bolts into the bottom of the filter base.
7. Reinstall the filter head.
8. Reinstall the retaining strap.
9. Close High Pressure Vent Valve V-904.
10. Start up the Air Compressor.
11. Check the filter assembly for leaks.

NOTE

If air is detected bleeding out of the bottom of the purification chamber, the cartridge has not been installed properly or is missing.

12. If the filter assembly leaks after a new cartridge has been installed, perform the following:
    a. Remove the purifier cartridge following step 3.
    b. Inspect the O-rings, replace if necessary.
    c. Ensure protective caps and devices have been removed from the nipple of the cartridge.
    d. Inspect the inside of the filter housing and make sure that no foreign objects are inside the chamber, especially in the filter base where the nipple fits.
13. Replace the cartridge following steps 4 - 7.

SERVICE

Pressure Switch Assembly PSL/PSH-901 Adjustment:

Equipment Condition:
TWPS in Standby Shutdown without Drain-Down

Adjust the Pressure Switch PSL/PSH-901 high-pressure shut-off setting as follows (see Figure 5):

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).

WARNING

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to adjusting the pressure switch. Failure to observe this warning can result in injury to personnel and damage to equipment.

2. Close Air Receiver Tank Shut-Off Valve V-907.
3. Switch the Air Compressor control at the OCP to OFF.
4. **Slowly** open High Pressure Air Vent Valve V-904 to bleed the air from the high-pressure system. Then close the valve.
5. Remove the screws and cover plate from the back of Pressure Switch Assembly PSL/PSH-901.
6. Keep the pressure-adjusting nut in place and loosen the lock nut.

NOTE

A small turn of the pressure-adjusting nut will result in a large change in the high-pressure shut-off setting. Make adjustments in increments of about 1/8 to 1/4 turn.

Turning the adjusting nut into the spring (clockwise) increases the high-pressure shut-off setting. Turning the nut away from the spring (counter-clockwise) reduces the high-pressure shut-off setting.

The low-pressure compressor turn-on setting is a fixed span from the high-pressure setting and cannot be adjusted independently. Adjusting the high-pressure setting changes the low-pressure setting by the same amount.

7. Turn the pressure adjusting nut 1/8 to 1/4 turn in the desired direction.
8. Open Air Receiver Tank Shut-Off Valve V-907.
9. Switch the Air Compressor control to AUTO.

10. Observe the effect of your adjustment as follows:
    a. If increasing the high-pressure shut-off setting, observe Pressure Gauge PI-901 while the compressor operates. Note the pressure at which the compressor shuts off.
    b. If reducing the high-pressure shut-off setting, **slowly** open Low Pressure Air Vent Valve V-910 to bleed the air from the air system until the compressor comes on. Observe Pressure Gauge PI-901 while the compressor operates. Note the pressure at which the compressor shuts off.
11. Repeat steps 2 through 10 until the compressor shuts off within a range of 925 to 975 psig.
12. Hold the pressure-adjusting nut in place and tighten the lock nut.
13. Reinstall the cover plate on the back of Pressure Switch Assembly PSL/PSH-901 using the screws removed earlier.

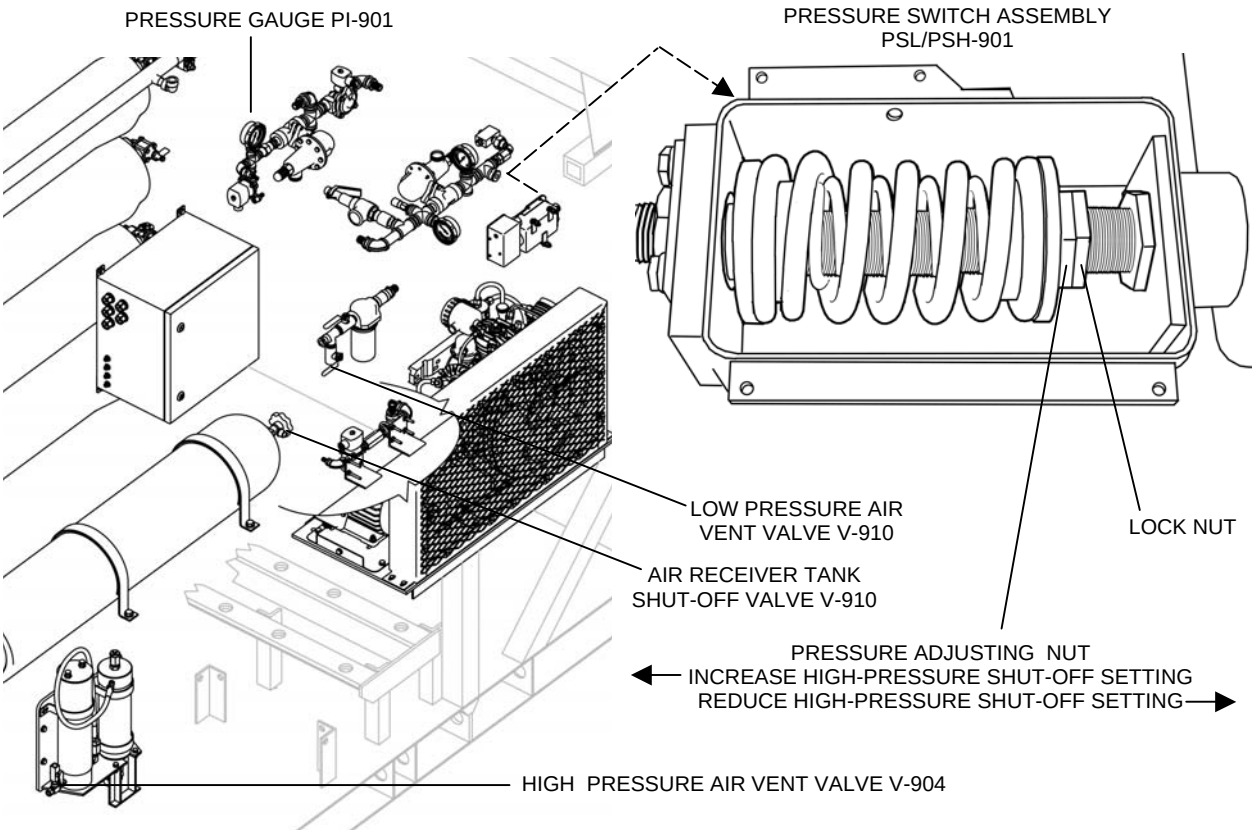

Figure 5. Pressure Switch PSL/PSH-901 Adjustment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0042 00**
OPERATOR MAINTENANCE PROCEDURES
AIR SYSTEM

Pressure Regulating Valve PRV-901 and PRV-902 Adjustment:

Equipment Condition:
TWPS operating

Adjust Pressure Regulating Valve PRV-901 or PRV-902 as follows (see Figure 6):

WARNING

Moving parts. The compressor may operate during this procedure. Keep hands, loose clothing and other loose personal effects away from the compressor fan and fan belt. Failure to observe this warning may result in serious injury.

1. Unscrew and remove the plastic adjusting screw cap from the valve body.
2. Loosen the lock nut.

NOTE

Turning the adjusting screw clockwise increases the regulated pressure. Turning the screw counter-clockwise reduces the regulated pressure.

3. To adjust the regulated pressure at PRV-901, crack low pressure vent valve V-910 open just enough to provide a minimal air flow, observe Pressure Gauge PI-902 and turn the pressure adjusting screw in the desired direction to obtain a reading of 100 psig. Then close valve V-910.
4. To adjust the regulated pressure at PRV-902, crack low pressure vent valve V-915 open just enough to provide a minimal air flow, observe Pressure Gauge PI-903, and turn the pressure adjusting screw in the desired direction to obtain a reading of 15 psig. Then close valve V-915.
5. Hold the pressure adjusting screw in place and tighten the lock nut.
6. Reinstall the cap on the body of the pressure regulating valve.

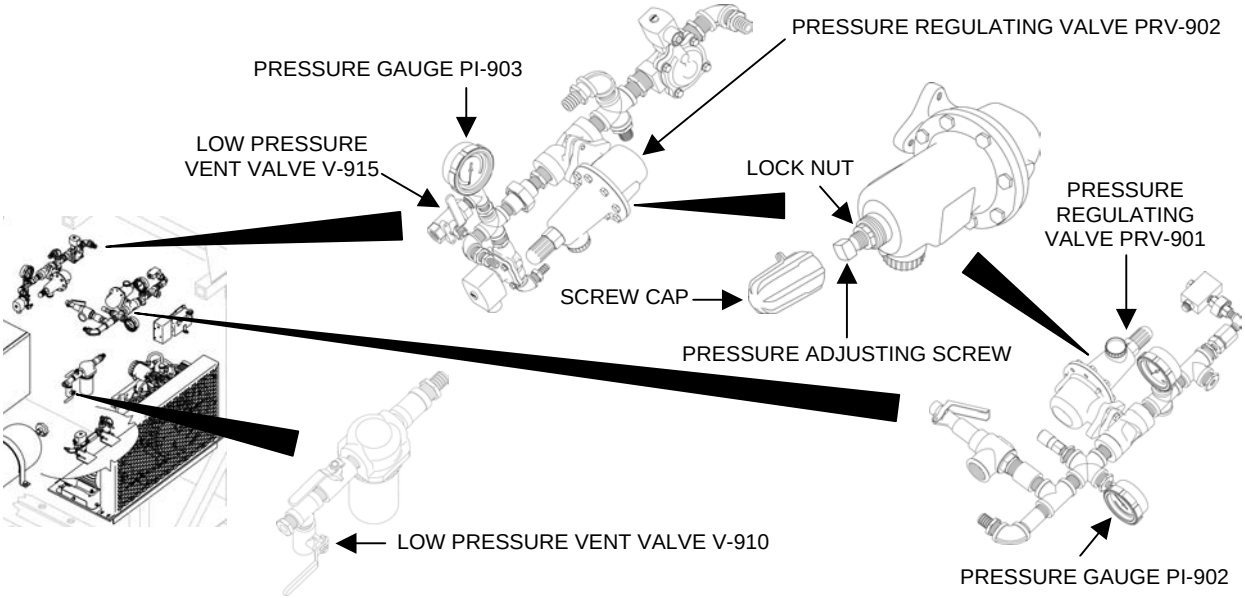

Figure 6. Pressure Regulating Valve PRV-901 or PRV-902 Adjustment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0042 00**
OPERATOR MAINTENANCE PROCEDURES
AIR SYSTEM

Bleed the Lubrication System (Vent the Oil Pump):

Equipment Condition:
TWPS in Standby Shutdown without Drain-Down

Bleed the air compressor lubrication system (vent the oil pump) as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the air from the high pressure air system as follows:
   a. Switch the Air Compressor control at the OCP to OFF.
   b. **Slowly** open High Pressure Air Vent Valve V-904 to bleed the air from the high-pressure system. Then close the valve (see Figure 7 for valve location).

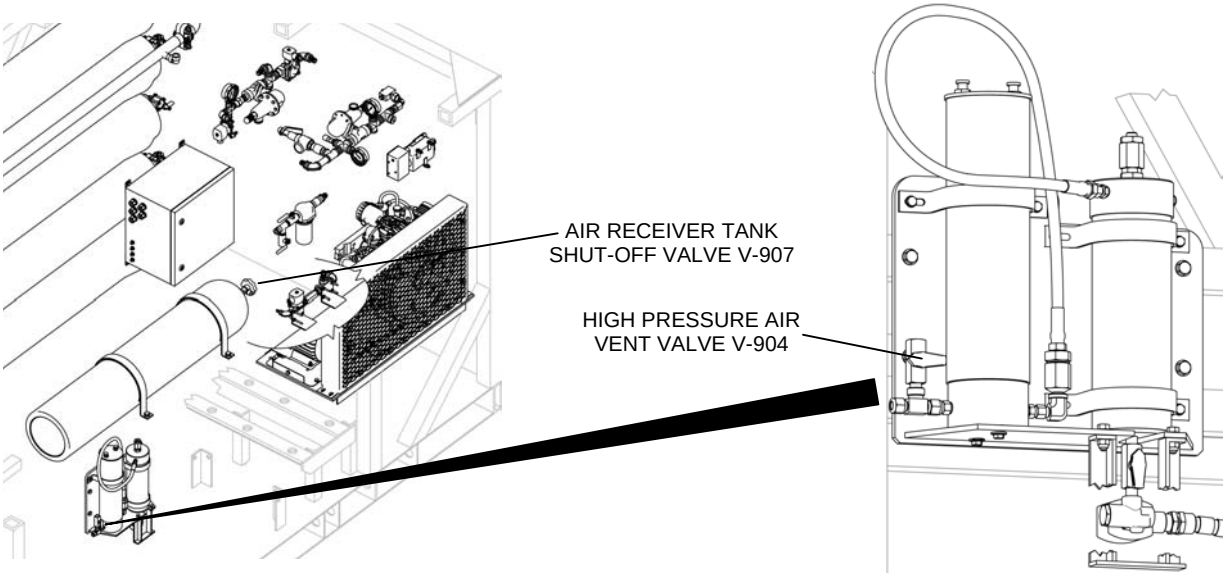

Figure 7. Valve for Bleeding the High Pressure Air System.

WARNING

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to bleeding the air compressor lubrication system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Moving parts. The compressor must not be allowed to operate during this procedure. Make sure the Air Compressor control at the OCP is switched to OFF before disconnecting tubing from the compressor oil pump and turning the compressor flywheel. Failure to observe this warning may result in serious injury.

3. Bleed the air compressor lubrication system (vent the oil pump) as follows (see Figure 8):
    a. Remove the 15 cap screws, 15 lock washers, and 15 flat washers from the front of the belt guard assembly and lift the front screen off the belt guard assembly to provide access to the flywheel.
    b. Place a rag under the compressor oil pump.
    c. Unscrew the tube nut and disconnect the oil pump supply tubing from the bottom of the oil pump.
    d. Turn the compressor flywheel counterclockwise by hand until bubble-free oil comes from the fitting. This should only take a few turns of the flywheel.
    e. Reconnect the supply tubing to the oil pump.
    f. Reinstall the belt guard screen.

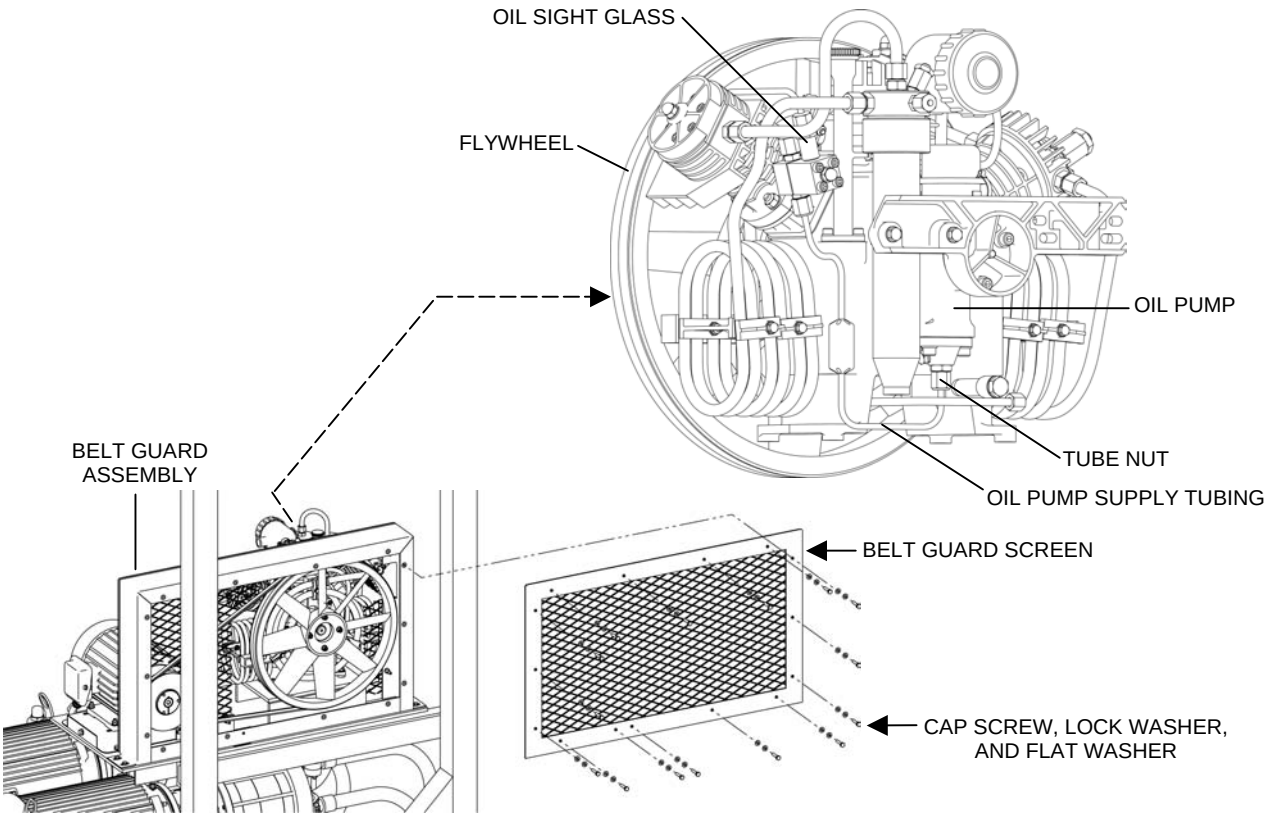

Figure 8. Air Compressor Oil Pump Supply Tubing and Flywheel.

4. Open Air Receiver Tank Shut-Off Valve V-907.
5. Switch the Air Compressor control at the OCP to OFF.
6. While the compressor is operating, check the oil sight glass for oil flow and that there are no air bubbles visible.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0042 00**
OPERATOR MAINTENANCE PROCEDURES
AIR SYSTEM

Compressor Belt Tension Check:

Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

Check the air compressor drive belt tension as follows (see Figure 9):
1. Make sure that electrical power to the TWPS has been shut off.
2. Reach in behind the belt guard assembly and push down hard in the center of the belt with your thumb.
3. The belt should deflect about ¼ -in.
4. If the belt deflects more than or less than ¼ -in, notify Unit Maintenance to adjust the belt tension.

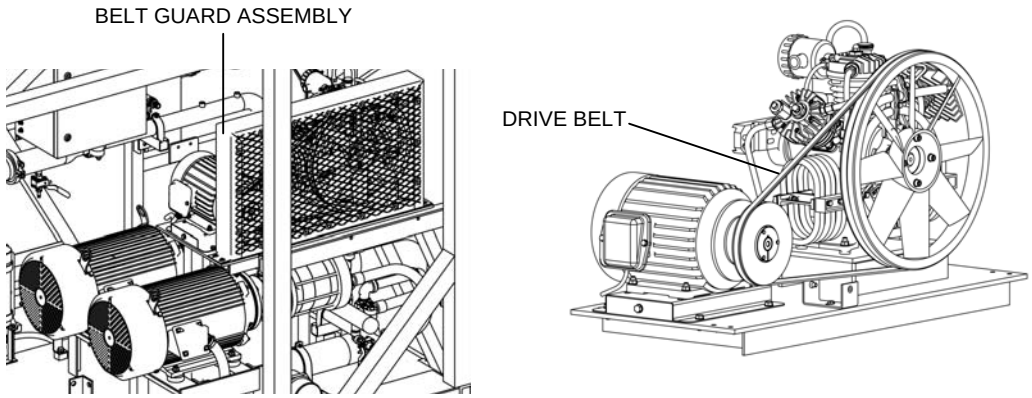

Figure 9. Compressor Belt Tension Check.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) OPERATOR MAINTENANCE PROCEDURES CONTROL INSTRUMENTS

0043 00

THIS SECTION COVERS:
Configuration, Calibration

INITIAL SETUP:

Maintenance Level
Operator/Crew
Tools
Operator's Tool Kit (BII) (33901161)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS removed from service

GENERAL:

The procedures covered in this work package include:

- Panel Mounted Flow Transmitter FT-101, FT-401, FT-501 Configuration
- Panel Mounted Product Conductivity Transmitter CIT-501 Configuration
- Panel Mounted Product Conductivity Transmitter CIT-501 Calibration

PANEL MOUNTED FLOW TRANSMITTER FT-101, FT-401, FT-501 CONFIGURATION:

Equipment Condition:
Operating

Configure the flow transmitters listed below as follows:

- MF Feed Flow Transmitter FT-101
- RO Reject Flow Transmitter FT-401
- Product Flow Transmitter FT-501

NOTE

The transmitter and the sensor that feeds information to the transmitter are configured using the following keys on the face of the transmitter (see Figure 1):

- **Enter key: Pressing this key does two things: It displays submenu and edit/selection screens, and it enters (saves) configuration values/selections.**
- **ESC key: Pressing this key always takes the display up on level in the menu tree. The ESC key can also "abort" the procedure to change a value or selection.**
- **Left and right arrow keys: Depending on the type of displayed screen, these keys do the following:**
    - **Measure Screen: At the Measure screen the left and right arrow keys change the readout (in a continuous loop sequence) to show different measurements.**
    - **Menu Screen: At the Menu screen the left and right arrow key are non-functional.**

- **Edit/Selection Screens: At the Edit/Selection screens the left and right arrow keys move the cursor left or right in order to select digit for adjustment with up and down arrow keys.**

- **Up and down arrow keys: Depending on the type of displayed screen, these keys do the following:**
  - **Measure Screen: At the Measure screen the up and down arrow keys are non-functional.**
  - **Menu Screen: At the Menu screen the up and down arrow keys move the display up or down between other same-level menu screens.**
  - **Edit/Selection Screens: At the Edit/Selection screens the up and down arrow keys adjust the selected digit value up or down, or move up or down between choices.**

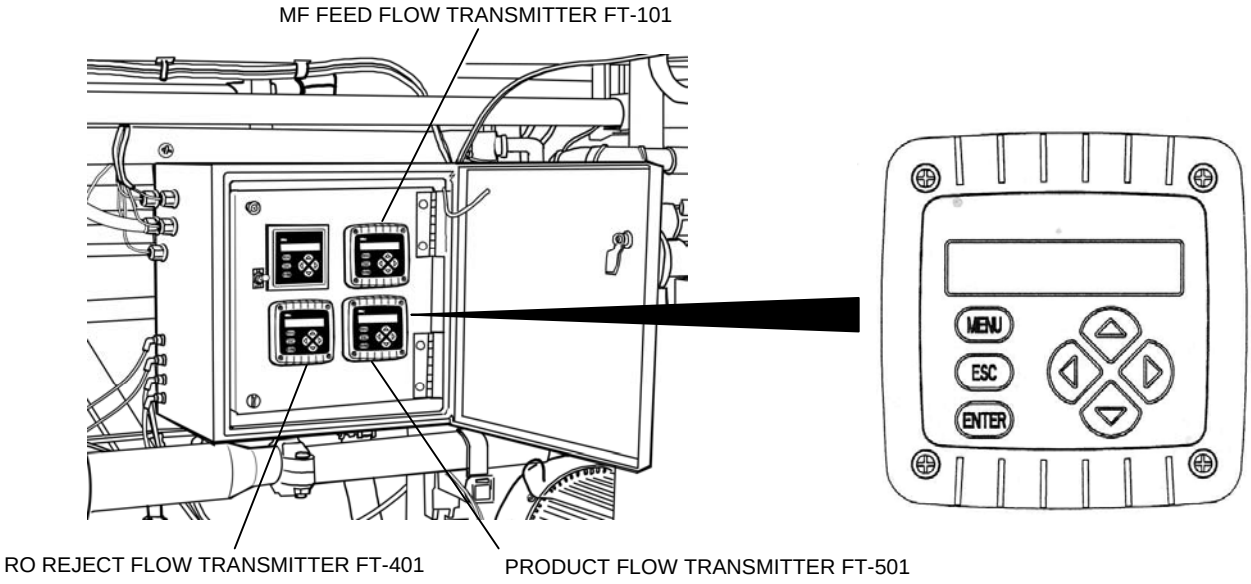

Figure 1. Transmitter Keypad.

Configure any of the three panel mounted flow transmitters as follows:

1. Select the language to operate the transmitter:
   a. Press the **MENU** key to display a **"MAIN MENU"** screen.
   b. If the "**MAIN MENU/CONFIGURE"** screen is not showing, use the **up** and **down** arrow keys to display it.
   c. Press the **ENTER** key to display **Configure/Set Output**.
   d. Press the **down** arrow key until **Configure/Language** screen appears.
   e. Press **ENTER** to verify that the language setting is at **English**. Select English if it is not, then press **ESC** to exit.
2. Configure the sensor:
   a. Set the Multiplier (for displayed flow rate).
      1) With the **Configure/Language** screen displayed, press **down** arrow key once to display **Configure/Sensor**.
      2) Press the **ENTER** key to display **Sensor/Set Multiplier**.

3) Press **ENTER** key again to display a screen like **Set Multiplier/(x100).**
4) Use the **up** and **down** arrow keys **to select "x1"**.
5) With **"x1"** selected press **ENTER** key to enter selection.

b. Set the Decimal (for displayed flow rate).
1) With the **Sensor/Set Multiplier** screen displayed, press the **down** arrow key once to display **Sensor/Set Decimal**.
2) Press the **ENTER** key to display a screen like **Set Decimal/xxx.x**. Use the **up** and **down** arrow keys to select **"xxx.x".**
3) With **"xxx.x"** selected press the **ENTER** key to enter this selection.

c. Set the Filter Time.
1) With the **Sensor/Set Decimal screen** displayed, press the **down** arrow key once to display **Sensor/Set Filter**.
2) Press the **ENTER** key to display a screen like **Set Filter/0 Seconds**.
3) Use the **up** and **down** arrow keys to adjust the displayed value to the desired filter time of **two (2) seconds** and press the **ENTER** key to enter the value.

d. Select the Flow Units (for displayed flow rates).
1) With the **Sensor/Set Filter** screen displayed, press the **down** arrow key once to display **Sensor/Flow Units**.
2) Press the **ENTER** key to display a screen like **Flow Units/US GAL/MIN**.
3) This setting is factory default to **US GAL/MIN.**
4) Press the **ENTER** key to accept this selection.

e. Select the Volume Units (for displayed volume).
1) With the **Sensor/Flow** Units screen displayed, press the **down** arrow key once to display **Sensor/Volume Units**.
2) Press the **ENTER** key to display a screen like **Volume Units/US GALLONS**.
3) This setting is factory default to **US GALLONS.**
4) Press the **ENTER** key to accept this selection

f. Select the Enter Note (top line of Measurement screen).
1) With the **Sensor/Volume Units** Screen displayed, press the **down** arrow key **three times** to display **Sensor/Enter Note.**
2) Press the **ENTER** key to display **Enter Note/Flow**.
3) This setting is factory default to **Flow.**
4) Press the **ENTER** key to accept this selection

g. Select the Sensor Type.
1) With the **Sensor/Enter Note** screen displayed. Press the **down** key once to display **Sensor/Select Sensor**.
2) Press the **ENTER** key to display a screen like **Select Sensor/GLI PIPE MOUNT**.
3) Use the **up** and **down** arrow keys to select the type of sensor and mounting arrangement for the transmitter according to the service as follows:
a) FT-101: **GLI PIPE MOUNT**
b) FT-401: **GLI PVDF T**
c) FT-501: **GLI PVDF T**
4) With the appropriate choice displayed, press the **ENTER** key to enter this selection.

h. Set the Sensor Data.
1) Press the **down** arrow key once to display **Sensor/Set Sensor**. Pressing the **ENTER** key displays **Set Sensor/Set Pipe ID** (for FT-101) or **Tee Size** (for FT-401 and FT-501).

2) **For FT-101 only.** With the **Set Sensor/Set Pipe ID** screen displayed, press the **ENTER** key to display a screen like **Set Pipe ID/(3.000 in.).** Use the arrow keys to adjust the display value to **3.314 in.** and press **ENTER** key to enter the value. (Right/left keys move the curser. Up/down keys change the value of the number at the curser.)
3) **For FT-401 and FT-501.** With the **Tee Size** screen displayed, press the **ENTER** key to display a screen like **Set Pipe ID/(3.000 in.).** Use the up/down arrow keys to adjust the display value to **2.0 in.** and press **ENTER** key to enter the value.

3. Configuring the Analog Output:
   a. Set the Parameter (representation)
      1) Press the **MENU** key to display a **"MAIN MENU"** screen.
      2) If the **MAIN MENU/Configure** screen is not showing use the **up** and **down** arrow keys to display it.
      3) Press the **ENTER** key to display **Configure/Set Output.**
      4) Press the **ENTER** key again to display **Set Output/Set Parameter.**
      5) Press the **ENTER** key again to display a screen like **Set Parameter/(Flow).**
      6) Use the **up** and **down** arrow keys to select desired choice **"FLOW"** press the **ENTER** key to enter this selection.
   b. Set the 4mA and 20mA Values (range expand)
      1) With the **Set Output/Set Parameter** screen displayed, press the **down** arrow key once to display **Set Output/Set 4mA Value**.
      2) Press the **ENTER** key to display a screen like **Set 4mA Value/(0.0 x 1GPM)**. Use the **arrow** keys to set a displayed value of **"0.0"** at which 4mA is desired, and press the **ENTER** key to enter this value.
      3) After the **Set Output/Set 4mA Value** screen re-appears, press the **down** arrow key once to display **Set Output/Set 20ma Value**.
      4) Press **ENTER** key to display a screen like **Set 20mA Value**. Use the **arrow** keys to set the display value as listed below. Press the **ENTER** key to enter the value.
         a) FT-101: **225**
         b) FT-401: **55**
         c) FT-501: **30**
   c. Set the Fail Level Mode (off, 4 mA or 20 mA).
      1) Press the **down** arrow key twice to display **Set Output/Set Fail Level**.
      2) Press the **ENTER** key to display **Set Fail Level/(OFF).** Use the **up** and **down** arrow keys to select **"OFF"** as the desired choice, then press the **ENTER** key to enter this selection.
4. Set the Passcode (feature enabled or disabled).
   a. Press the **MENU** key to display the **MAIN MENU** screen.
   b. If the **MAIN MENU/Configure** screen is not showing, use the **up** and **down** arrow keys to display it.
   c. Press the **ENTER** key to display **Configure/Set Output**.
   d. Press the **down** arrow key once to display **Configure/Set Passcode**.
   e. Press the **ENTER** key to display **Set Passcode/Disabled**.
   f. The desired choice is **"Disabled",** Press the **ENTER** key to enter this selection.
   g. Press **Menu** and then **Esc** to return to the normal display screen.
5. Panel Mounted Flow Transmitter configuration is now complete.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0043 00**
OPERATOR MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

PANEL MOUNTED PRODUCT CONDUCTIVITY TRANSMITTER CIT-501 CONFIGURATION

Equipment Condition:
Operating

Configure Conductivity Indicating Transmitter CIT-501 as follows:

NOTE

The user interface consists of a two-line LCD display and keypad with MENU, ENTER, ESC, Left and Right and Up and Down Keys (see Figure 2).

The MEASURE Screen is normally displayed. Pressing the MENU Key temporarily replaces the MEASURE screen with the top-level MAIN Menu-CALIBRATE branch selection screen. Using the keypad, you can then display other screens to calibrate, configure or test the Transmitter.

If the keypad is not used within 30 minutes, except during calibration or while using specific Transmitter test/maintenance functions, the display will automatically return to the MEASURE screen.

To display the MEASURE screen at any time, press the MENU key once and then the ESC key once.

The Conductivity Transmitter KEY Pad:

- **MENU Key:**
  - **Pressing this key when the MEASURE screen is displayed shows the MAIN MENU-CALIBRATE screen. Then, to display the CONFIGURE or top-level main branch screen press the Down- key.**
  - **Pressing the MENU-key when a menu screen is displayed always shows the top-level screen in that branch.**
  - **(Pressing the MENU-key also "aborts" the procedure to change values or selections).**
- **ENTER key: Pressing this key does two things:**
  - **It displays submenu and edit/selection screens.**
  - **It enters (saves) configuration values/selections.**
- **ESC key:**
  - **Pressing this key always takes the display up one level in the menu tree.**
  - **The ESC key can also "abort" the procedure to change a value or selection.**
- **Left and Right arrow keys: Depending on the type of displayed screen, these keys do the following:**
  - **Measure Screen: At the Measure screen the left and right arrow keys change the readout (in a continuous loop sequence) to show different measurements.**
  - **Menu Screen: At the Menu screen the left and right arrow key are non-functional.**
  - **Edit/Selection Screens: Coarse adjusts the displayed numerical value.**
- **Up and down arrow keys: Depending on the type of displayed screen, these keys do the following:**
  - **Measure Screen: At the Measure screen the up and down arrow keys are non-functional.**

- **Menu Screen: At the Menu screen the up and down arrow keys move up or down between other same-level menu screens.**
- **Edit/Selection Screens: At the Edit/Selection screens the up and down arrow keys "Fine" adjust the displayed numerical value (holding key down changes value faster), or moves up or down between choices.**

- **Measure Screen:**
  - **The measure screen can show seven different readout versions.**
  - **The standard readout used for our configuration is shown in Figure 2.**
  - **When the measure value is beyond the Transmitter's measuring range, series of "+" or "-" screen symbols appear respectively indicating that the value is above or below range.**

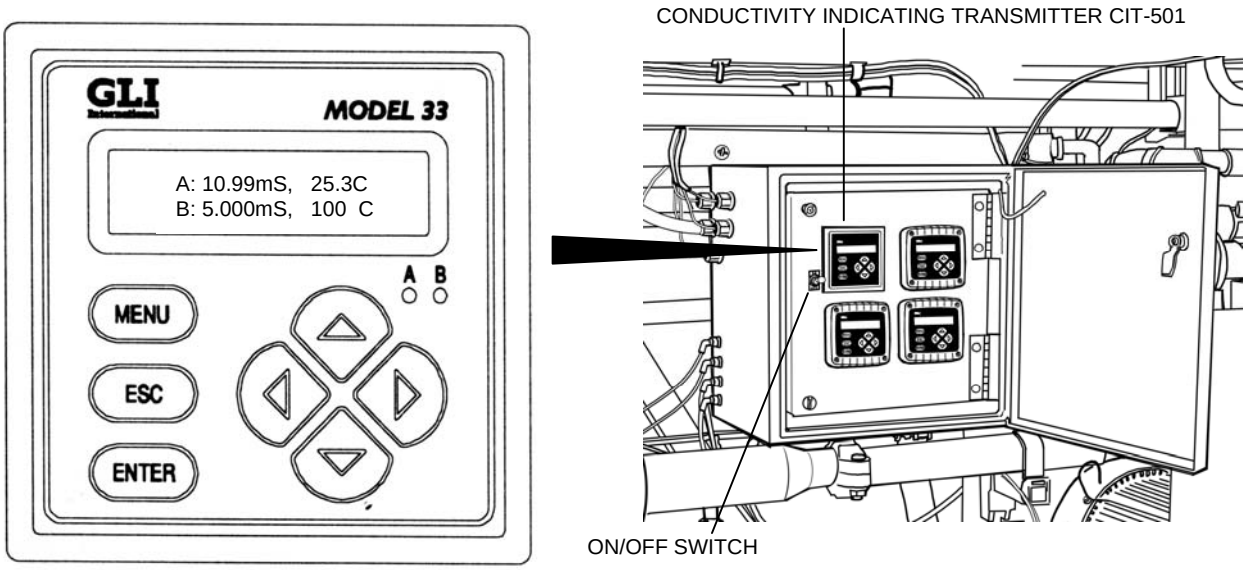

Figure 2. CIT-501 Conductivity RO Product Measure Screen Standard Configuration.

Configure the transmitter as follows:

1. Make sure the ON/OFF switch to the left of the transmitter is ON.
2. Select the language to operate the transmitter:
   a. Press the MENU key to display a "MAIN MENU" screen.
   b. If the "MAIN MENU/CONFIGURE" screen is not showing, use the Up and Down arrow keys to display it.
   c. Press the ENTER key to display Configure/Set Output 1.
   d. Press the Down arrow key until Configure/Language screen appears.
   e. Press ENTER key to display a language like English.
   f. Use the Up or Down key to select "English" as the language.
   g. Press the ENTER key to enter the language selected.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0043 00**
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NOTE

All listed sensor configuration instructions are for Sensor A. Configure Sensor B in the same way and with same values as Sensor A, except as listed in configuration step.

3. Select Measurement
    a. With the **Configure/Language** screen displayed, press the **Down key** once to display **Configure/Sensor A** (Press **Down Key** twice to display **Configure/Sensor B**).
    b. Press **ENTER key** to display **Sensor A/Select Measure.**
    c. Press **ENTER key** again to display a screen **Select Measure/(Conductivity)**.
    d. Use the **Up** or **Down key** to select desired measurement **"Conductivity".**
    e. Press the **ENTER key** to enter the selected measurement.
4. Select Display Format
    a. With the **Sensor A/Select Measure** screen displayed, press the **Down key** once to display **Sensor A/Display Format**.
    b. Press the **ENTER key** to display a screen like **Display Format/(200.0 us/cm).**
    c. Use the **Down** or **Up keys** to select a Display format .
        1) Conductivity For Sensor A ENTER: 200.0 us/cm
        2) Conductivity For Sensor B ENTER 2000 us/cm
    d. Press **ENTER key** to enter the selected display format.
5. Select Temperature Compensation
    a. With the **Sensor A/Display Format** screen displayed, press the **Down key** once to display **Sensor A/T-Compensation**.
    b. Press **ENTER key** to display a screen like **T-Compensation/Linear**.
    c. Use the **Down** and **Up keys** to select "**LINEAR**".
    d. Then press the **ENTER key** to enter the selection.
6. Select Config Linear
    a. With the **Sensor A/T-Compensation** screen displayed press the **Down key** until **Sensor A/Config Linear** screen appears.
    b. Press **ENTER key** to display **Config Linear/Set Slope**.
    c. Press **ENTER key** again to display a screen like **Set Slope/(2.00 %/°C)**.
    d. Use **Arrow keys** to adjust to a desired slope of **"2.00 %/ °C".**
    e. Press **ENTER key** to enter the slope.
    f. After the **Config Linear/Set Slope** screen re-appears, press the **Down key** once to display **Config Linear/Set Ref Temp**.
    g. Press **ENTER key** to display a screen like **Set Ref Temp/(25.0 °C)**.
    h. Use the **Arrow keys** to adjust to the desired reference temperature of **"25.0 °C".**
    i. Press the **ENTER key** to enter the reference temperature.
    j. After the **Config Linear/Set Ref Temp** screen re-appears, press **ESC key** once to return to the **Sensor A/Config Linear** Screen.
7. Select Cell K
    a. With the **Sensor A/Config Linear** screen displayed, press the **Down key** until **Sensor A/Cell Constant** screen appears.
    b. Press **ENTER key** to display **Cell Constant/Select Cell K**.
    c. Press **ENTER key** again to display a screen like **Select Cell K/(0.0500)**.
    d. Use the **Down** and **Up keys** to select the nominal cell category that corresponds to the sensor's **GLI Certified "K" Value**.
        1) For **Sensor A** Enter **"0.0500"**

2) For **Sensor B** Enter **"10"**

e. Press **ENTER key** to enter the selected nominal cell category.
f. After the **Cell Constant/Select Cell K** screen re-appears, press the **Down key** once to display **Cell Constant/Set Cell K**.
g. Press **ENTER key** to display a screen like **Set Cell K/ (0.0500)**.
h. Use the **Up** or **Down Arrow keys** to adjust the display value to **EXACTLY MATCH** the sensor's GLI certified "K" value listed on the Sensor cable.
i. Press **ENTER key** to enter the certified "K" value.
j. After the **Cell Constant/Set Cell K** screen re-appears, press **ESC key** once to return to the **Sensor A/Cell Constant** screen.

8. Set Filter Time
   a. With the **Sensor A/Cell Constant** screen displayed, press the **Down key** once to display **Sensor A/Set Filter**.
   b. Press the **ENTER key** to display a screen like **Set Filter/(0S)**.
   c. Use the **Arrow keys** to adjust to the desired filter time of **"2S".**
   d. Press **ENTER key** to enter the filter time.
9. Select Pulse Suppress (ON/OFF)
   a. With the **Sensor A/Set Filter** screen displayed, press the **Down key** once to display **Sensor A/Pulse Suppress**.
   b. Press the **ENTER key** to display a screen like **Pulse Suppress/ (ON)**.
   c. Use the **Down** and **Up keys** to select the pulse suppress mode of **"ON".**
   d. Press the **ENTER key** to enter pulse suppress mode.
10. Select Temp Element Type
   a. With the **Sensor A/Pulse Suppress** Screen displayed press the **Down key** twice to display **Sensor A/Temp Element**.
   b. Press **ENTER key** to display **Temp Element/Select Type**.
   c. Press **ENTER key** again to display a screen like **Select Type/(PT1000)**.
   d. Use the **Down** and **Up keys** to select **PT1000** as the type of temperature element used with the sensor to compensate the measurement.
   e. Press **ENTER key** to enter the selected temperature element.
11. Set T Factor (Sensor's GLI-certified "T" factor)
   a. With the **Temp Element/Select Type** screen displayed, press the **Down key** once to display **Temp Element/Set T Factor**.
   b. Press **ENTER key** to display a screen like **Set T Factor/(1000.0 OHMS)**.
   c. Use the **Arrow keys** to adjust the displayed value to **EXACTLY MATCH** the sensor's GLI certified T Factor listed on the cable
   d. Press **ENTER key** to enter certified T Factor.
   e. After the **Temp Element/Set T Factor** screen re-appears, press **ESC key** twice to return to the **Configure/Sensor A** screen.
12. Set °C or °F (temperature display format)
   a. With the **Configure/ Sensor A** screen displayed, press **UP key ONLY** twice until the **Configure/Set °C or °F** screen appears.
   b. Press **ENTER key** to display a screen like **Set °C or °F/(°C)**.
   c. Use the **Down and Up keys** to select the display temperature units **(°F)**.
   d. Press **ENTER key** to enter the selected display temperature units.
13. Set Parameter (These instructions configure Output 1. Configure Output 2 in the same way.)
   a. With the **Configure/Set °C or °F** screen displayed, press the **UP key ONLY** until **Configure/Set Output 1** appears.
   b. Press **ENTER key** to display **Set Output 1/Set Parameter**.

c. Press **ENTER key** again to display a display screen like **Set Parameter/(Sensor A)**.
d. Use the **Up** and **Down keys** to select the parameter the output will represent.
    1) **Output 1** Parameter **Sensor A**
    2) **Output 2** Parameter **Sensor B**
e. Press **ENTER key** to enter the selected parameter.

14. Set 0/4mA and 20mA Values (range expand)
    a. With the **Set Output 1/Set Parameter** screen displayed, press **Down key** once to display **Set Output 1/Set 4mA Value**.
    b. Press **ENTER key** to display a screen like **Set 4mA Value/ (0.0 uS/cm)**.
    c. Use the **Arrow keys** to set the value for which **0/4mA** is desired.
        1) For **Output 1 Sensor A** enter **0.0 uS/cm**
        2) For **Output 2 Sensor B** enter **0.0 uS/cm**
    d. Press **ENTER key** to enter the desired value selected.
    e. After the **Set Output 1 Set 4mA Value** screen re-appears, press **Down key** once to display **Set Output 1/Set 20mA Value**.
    f. Press **ENTER key** to display a screen like **+++.+ uS/cm**.
    g. Use **Arrow keys** (**Left** key **decreases** value and **Right** key **increases** value) to set value at which **20mA** is desired.
        1) For **Output 1 Sensor A** enter **100 uS/cm**
        2) For **Output 2 Sensor B** enter **2000 uS/cm**
    h. Press **ENTER key** to enter the desired value selected.
15. Set Filter Time
    a. With the **Set Output 1/Set 20mA Value** Screen displayed Press **Down key** Twice to display **Set Output 1/Set Filter**.
    b. Press **ENTER key** to display a screen like **Set Filter/(0S)**.
    c. Use **Arrow keys** to adjust to a filter time of **"2S".**
    d. Press **ENTER key** to enter the selected filter time.
16. Set Scale 0mA/4mA(low end point
    a. With the **Set Output 1/Set Filter** screen displayed, press **Down key** once to display **Set Output 1/Scale 0mA/4mA**.
    b. Press **ENTER** key to display a screen like **Scale 0mA/4mA/(4mA)**.
    c. Use the **Down** and **Up keys** to select the minimum value of **"4mA"** for the analog output
    d. Press **ENTER key** to enter the selected minimum value.
17. Return to Measure Screen - Press the **MENU key** once and then the **ESC key** once.
18. Panel Mounted Conductivity Transmitter configuration is now complete.
19. If the mission requires low EMI emissions, pull the conductivity transmitter ON/OFF switch out and move it to the OFF position.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0043 00**
OPERATOR MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

PANEL MOUNTED PRODUCT CONDUCTIVITY TRANSMITTER CIT-501 CALIBRATION:

Tools:
Portable TDS (conductivity) Meter
Equipment Condition:
Operating

Calibrate Product Conductivity Transmitter CIT-501 as follows:

1. Make sure the ON/OFF switch to the left of the transmitter is ON.
2. Measure the product conductivity with the portable TDS meter
   a. Calibrate the portable TDS meter before using (WP0016).
   b. Open the Product Utility Valve V-511 (see Figure 3). Allow the hose to flush.
   c. Fill the portable TDS meter cup three times to flush. Push the COND button and note the reading with the fourth fill.
3. Open the instrument panel and locate the conductivity transmitter (see Figure 2).
4. Press the **MENU key** to display a **MAIN MENU** screen. Press the **Down key** once to display **Main Menu (Calibrate)**.
5. Press **ENTER key** to display **Calibrate (Sensor A)**. If the conductivity measured with the portable TDS meter exceeds 200 us/cm, push the **Down key** once to display **Calibrate (Sensor B).**
6. Press **ENTER key** to display **Sensor A (1 Point Sample)** or **Sensor B (1 Point Sample)** as selected.
7. Press **ENTER key** again to display **1 Point Sample? (Hold Outputs).**
8. Press **ENTER key** again. The display reads **1 Point Sample: Sample Ready?**
9. Press **ENTER key** again. The display reads **xxxx us/cm Reading Stable?**
10. When the reading is stable, press **ENTER key**. The **1 Point Sample? xxxx us/cm** screen appears with the last reading value.
11. Use the **Arrow Keys** to adjust the display to **EXACTLY** match the value noted from the portable TDS meter reading.
12. Press **ENTER key** to confirm the value entered. **(Confirm Cal Ok?)** screen appears.
13. Press **ENTER key** twice to return to the normal display screen.
14. Panel Mounted Conductivity Transmitter calibration is now complete.
15. If the mission requires low EMI emissions, pull the conductivity transmitter ON/OFF switch out and move it to the OFF position.

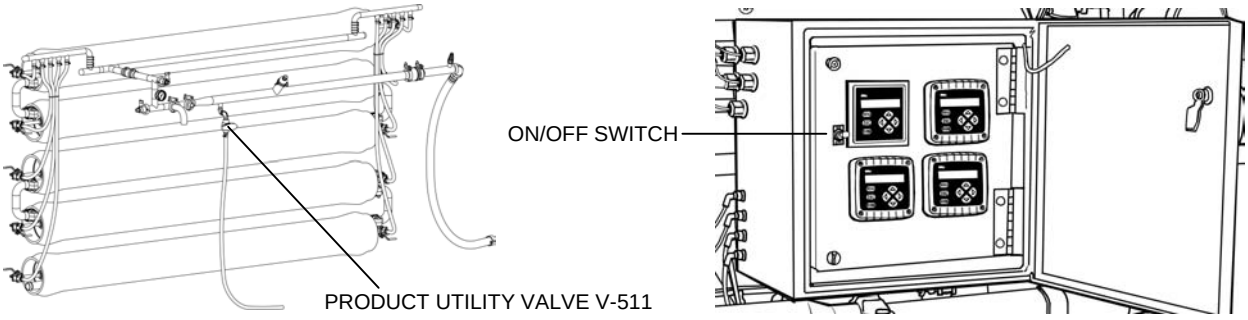

Figure 3. Product Utility Valve V-511.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0044 00**
OPERATOR MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

THIS SECTION COVERS:
Replace, Service

INITIAL SETUP:

Maintenance Level:
Operator/Crew
Tools:
Operator's Tool Kit (BII) (33901161)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required:
One
Equipment Condition:
TWPS set up for operation

GENERAL:

This work package contains information and instructions for replacing and servicing components in the Cold Weather System of the TWPS. The procedures covered in this work package include:

- Ice Hole Intake Strainer Replacement
- Hose Heating Blankets Replacement
- Pump Heating Collars Replacement
- Pump Skid Insulating Cover Replacement
- Diesel Heater Air Intake Filter Service
- Diesel Heater Fan Blade Service
- Diesel Heater Spark Plug Service
- Diesel Heater Photocell Service

REPLACE

Ice Hole Intake Strainer Replacment:

Part:
Ice hole intake strainer (TM 10-610-309-24P)
Equipment condition:
Ice hole intake strainer taken out of service

Inspect the ice hole intake strainer for damage that can prevent it from functioning properly and replace if necessary.

Hose Heating Blankets Replacement:

Part:
Hose heating blankets (TM 10-610-309-24P)
Equipment condition:
Hose heating blanket taken out of service

Replace ripped, torn, or otherwise unserviceable hose covers. Notify Unit Maintenance for repairs to damaged connectors. Forward hose covers to Direct Support Maintenance for surface repairs.

Pump Heating Collar Replacement:

Part:
Pump heating collars (BII)
Equipment condition:
Pump heating collar taken out of service

Replace damaged pump heating collars.

Pump Skid Insulating Cover Replacement:

Part:
Pump skid insulating covers (BII)
Equipment condition:
Pump skid insulating covers taken out of service

Replace ripped torn or otherwise unserviceable pump covers. Forward pump covers to Direct Support Maintenance for surface repairs.

SERVICE

Diesel Heater Air Intake Filter Service:

Part:
Diesel heater air intake filter (TM 10-610-309-24P)
Material:
Mild detergent and water
Equipment condition:
Diesel heater turned OFF

Clean or change the diesel heater air intake filter as follows (see Figure 1):

1. Pull the air intake filter out of the filter housing at the air intake end of the heater (it is not necessary to remove the housing).
2. If the filter is torn or deteriorated so that it cannot properly function, replace the filter. Otherwise, continue with cleaning the filter.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0044 00**
OPERATOR MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

CAUTION

Do not oil the air intake filter. Oil will block air flow and affect the heater operation.

3. Wash the filter with mild detergent and hot or cold water.
4. Dry the filter thoroughly or allow it to dry.
5. Insert the filter back into the filter housing.

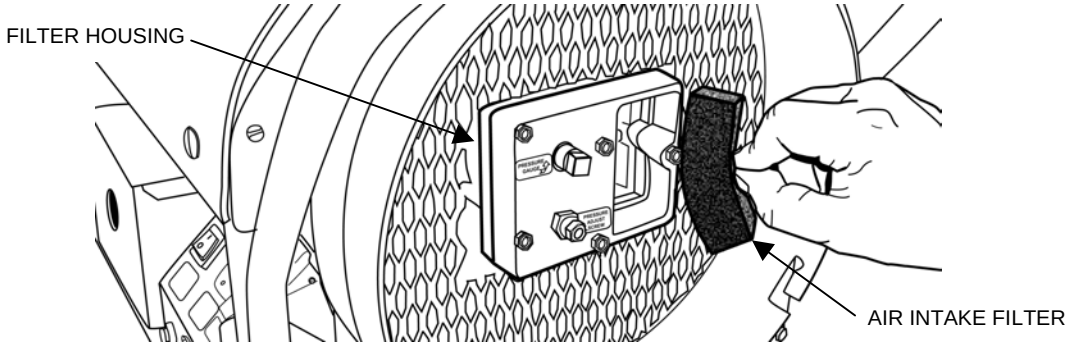

Figure 1. Diesel Heater Air Intake Filter Removal.

Diesel Heater Fan Blade Service:

Material:
Kerosene or solvent
Clean cloth (WP 0079, Table 1, item 23)
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

A build-up of dirt on the fan blades will reduce the air supply and cause faulty heater operation. Clean the diesel heater fan blades as follows:

WARNING

Mechanical and electrical hazard. Before opening up the top cover of the heater to access the fan blades, be sure the heater switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury if the fan operates or injury or death from electrical shock.

1. Make sure the heater switch is OFF.
2. Make sure the heater power cord is unplugged from the power source and from the heater.
3. Open the top cover of the heater by unsnapping the three “screws” at the front of the cover and lifting the cover (see Figure 2). (The three “screws” do not screw out. They are actually snaps that snap in and out of clips behind the cover. Pull the cover out at the screws to unsnap the screws from the clips.)

4. Open the access panel at the top of the heater.

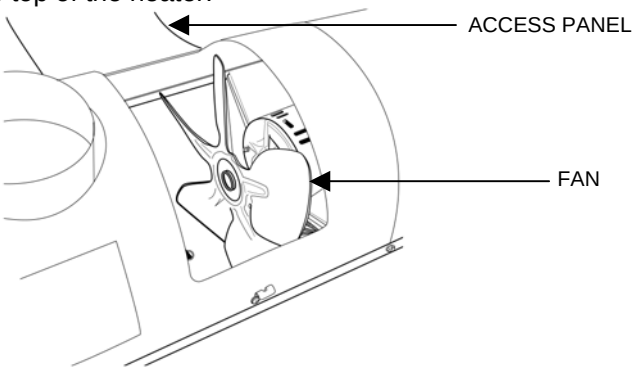

Figure 2. Diesel Heater Fan Blades.

CAUTION

Be careful not to bend the fan blades. A bent fan blade may reduce the air supply and result in faulty heater operation.

5. Wipe the fan blades clean using a cloth moistened with kerosene or solvent.
6. Dry the fan blades thoroughly.
7. Close the access panel.
8. Close and snap the top cover.

Diesel Heater Spark Plug Service:

Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Adjust the diesel heater spark plug gap as follows:

WARNING

Electrical hazard. The spark plug wire carries high voltage during heater operation. Before opening up the top cover of the heater to access the spark plug, be sure the heater switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury or death from electrical shock.

1. Remove the diesel heater spark plug as follows (see Figure 3):
   a. Make sure the heater switch is OFF.
   b. Make sure the heater power cord is unplugged from the power source and from the heater.

c. Open the top cover of the heater by unsnapping the three “screws” at the front of the cover and lifting the cover.
d. Open the access panel at the top of the heater.
e. Disconnect the spark plug wire from the spark plug.

CAUTION

Be careful not to bend the fan blades. A bent fan blade may reduce the air supply and result in faulty heater operation.

f. Remove the spark plug from the burner head using a socket wrench.

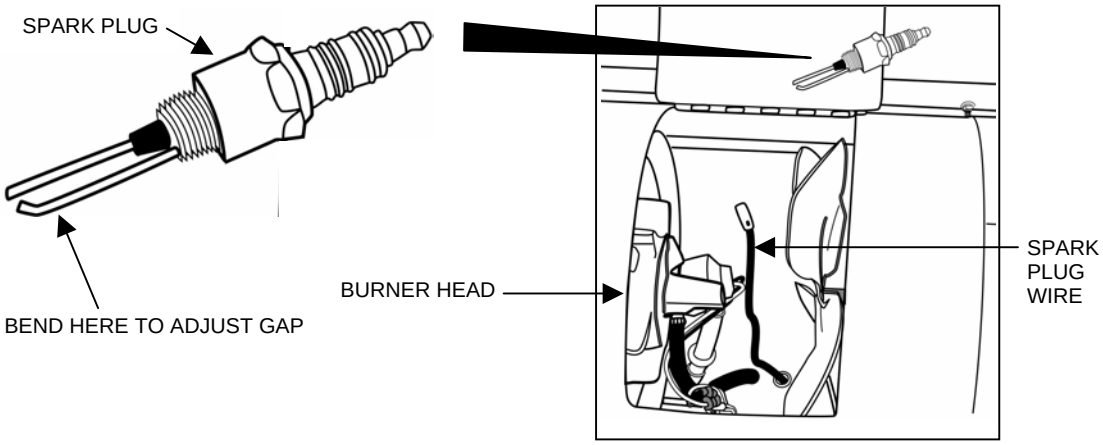

Figure 3. Diesel Heater Spark Plug Removal and Adjustment.

2. Check the gap between the spark plug electrodes. The gap should be between 0.045 and 0.055.
3. Adjust the gap between the electrodes if necessary by bending the outside electrode.
4. Reinstall the spark plug as follows:
    a. Screw the spark plug into the burner head.
    b. Tighten snug tight using the socket wrench. (Do not over-tighten.)
    c. Reconnect the spark plug wire to the spark plug.
5. Close the access panel.
6. Close and snap the top cover.

Diesel Heater Photocell Service:

Material:
Clean, dry, soft cloth (WP 0079, Table 1, item 23)
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Cleaning the diesel heater photocell as follows (see Figure 4):

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0044 00**
OPERATOR MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

WARNING

Electrical hazard. Before opening up the top cover of the heater to access the photocell, be sure the heater switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury or death from electrical shock.

1. Make sure the heater switch is OFF.
2. Make sure the heater power cord is unplugged from the power source and from the heater.
3. Open the top cover of the heater by unsnapping the three “screws” at the front of the cover and lifting the cover.
4. Open the access panel at the top of the heater.
5. Gently pull the photocell out of the bracket that is attached to burner head.
6. Inspect the glass face of the photocell. If dirty, wipe carefully with a clean soft cloth.
7. Gently reinsert the photocell all the way in to its holding bracket.
8. Close the access panel.
9. Close and snap the top cover.
10. Connect the power cord first to the heater and then to the power source.
11. Start the heater.
12. If the heater ignites, but the safety control trips, notify unit maintenance to test/replace the photocell.

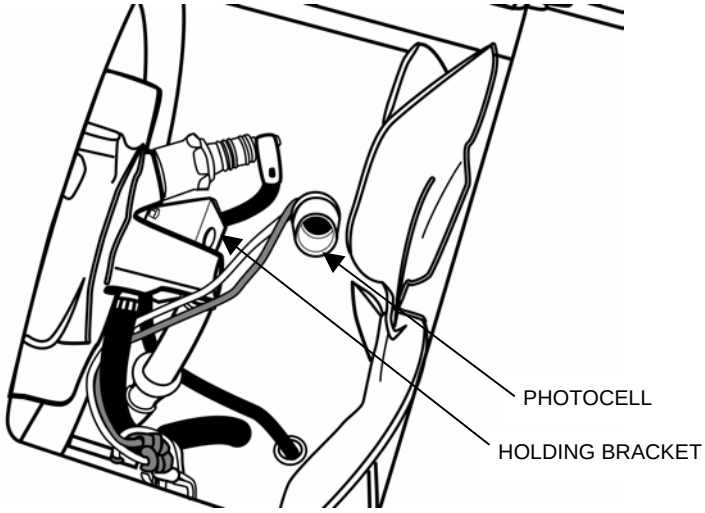

Figure 4. Diesel Heater Photocell Removal for Cleaning.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0045 00**
OPERATOR MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

THIS SECTION COVERS:
Replace, Assembly

INITIAL SETUP:

Maintenance Level
Operator/Crew
Tools
Operator's Tool Kit (BII) (33901161)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS in Standby Shutdown

GENERAL:

This work package contains information and instructions for replacing, repairing, and assembling components common to a number of TWPS systems. The procedures covered in this work package include:

- Clamped-On Hose Replacement
- Push-On Hose Replacement
- Tube Fitting-Connected Tube Replacement
- Grooved Couplings Replacement
- Pipe Coupling Replacement
- Sanitary Clamp and Gasket Replacement
- Solenoid Coil Replacement
- Antiseize Pipe Tape Installation

REPLACE

Clamped-On Hose Replacement:

Parts:
Replacement hose
Replacement clamp
Equipment Condition:
TWPS in Standby Shutdown with or without draining down as required

Replace a hose that is clamped onto a fitting as follows (see Figure 1):

1. When replacing a clamped-on drain hose, make sure the TWPS is in Standby Shutdown without Draining Down. Refer to WP 0017.
2. For all clamped-on hoses other than a drain hose, make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
3. Loosen the hose clamp and pull the clamp back down the hose from the fitting.
4. Pull or cut the hose off the fitting.
5. Remove the hose from the fitting at the other end in the same manner.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0045 00**
OPERATOR MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

NOTE

When measuring the length of a hose to be replaced, remember to include any portions of the old hose that you cut off in the total length for the replacement hose.

The black product tubing must be cut to a length so that, when installed, it does not drop below the end connection on the 3-way valve.

6. Measure the hose length.
7. Cut new hose to length from bulk.
8. Obtain replacement clamps if the existing clamps are rusted, corroded, or need replacement for any other reason.
9. Slide a clamp over one end of the replacement hose.
10. Push the hose all the way onto its fitting.
11. Slide the clamp up the hose over the fitting and tighten the clamp.
12. Connect the other end of the new hose to its fitting in the same manner.

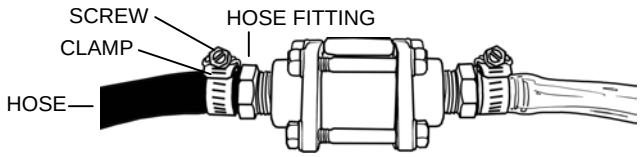

Figure 1. Replacing a Clamped-On Hose.

Push-On Hose Replacement:

Parts:
Replacement hose
Materials:
Glycerin (BII) (WP 0079, Table 1, item 14)
Equipment Condition:
TWPS in Standby Shutdown without Draining Down
Air bled from air system

Replace a hose that is pushed onto a barbed coupling as follows (see Figure 2):

1. Make sure the TWPS is in Standby Shutdown without Draining Down. Refer to WP 0017.
2. Make sure the air has been bled from the air system. Refer to WP 0042, **ENTIRE AIR SYSTEM BLEED DOWN**.
3. Cut the hose off the fitting.
4. Remove the hose from the fitting at the other end in the same manner.

NOTE

When measuring the length of a hose to be replaced, remember to include any portions of the old hose that you cut off in the total length for the replacement hose.

5. Measure the hose length.
6. Cut new hose to length from bulk.

NOTE

Failure to lubricate the inside of the hose may result in an inability to push the hose all of the way onto the hose barb.

7. Lubricate the inside of both ends of the hose with glycerin.
8. Push one end of the hose all the way onto its barbed coupling.
9. Connect the other end of the new hose to its barbed coupling in the same manner.

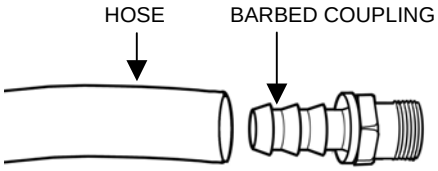

Figure 2. Replacing a Push-On Hose.

Tube Fitting-Connected Tube Replacement:

Parts:
Replacement tubing
Equipment Condition:
TWPS in Standby Shutdown without Draining Down
Air bled from air system

Replace a ¼-inch or a $^{3}/_{8}$-inch tube that is pushed onto a tube fitting as follows (see Figure 3):

1. Make sure the TWPS is in Standby Shutdown without Draining Down. Refer to WP 0017.
2. Make sure the air has been bled from the air system. Refer to WP 0042, **ENTIRE AIR SYSTEM BLEED DOWN**.
3. Push the tube fitting collet in and pull the tube out of the fitting.
4. Remove the tube at the other end in the same manner.
5. Measure the tube and cut new tube to length.
6. Push the ends of the new tube all the way into each of the tube fittings and twist back and forth once.

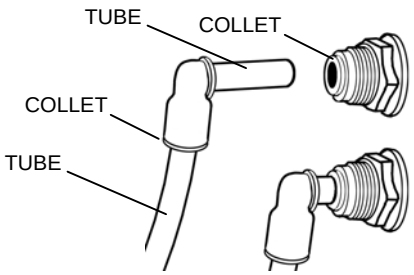

Figure 3. Disconnecting Tubing from a Tube Fitting.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0045 00**
OPERATOR MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Grooved Couplings Replacement:

Parts:
Grooved Flexible Coupling with Vic-Plus Gasket System (TM 10-4610-309-24P)
Vic-Plus Gasket System (TM 10-4610-309-24P)
Materials:
Clean, dry, lint-free rags (WP 0079, Table 1, item 23)
Five-gallon container or drip pan
Glycerin (BII) (WP 0079, Table 1, item 14)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace a grooved flexible coupling and gasket as follows (see Figure 4):

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the grooved flexible coupling as follows:
    a. Place a fluid container under the coupling to catch any fluid in the line.
    b. Slowly loosen the nuts and bolts that hold the coupling in place.
    c. Completely remove the nuts and bolts and then remove the flexible coupling and gasket.

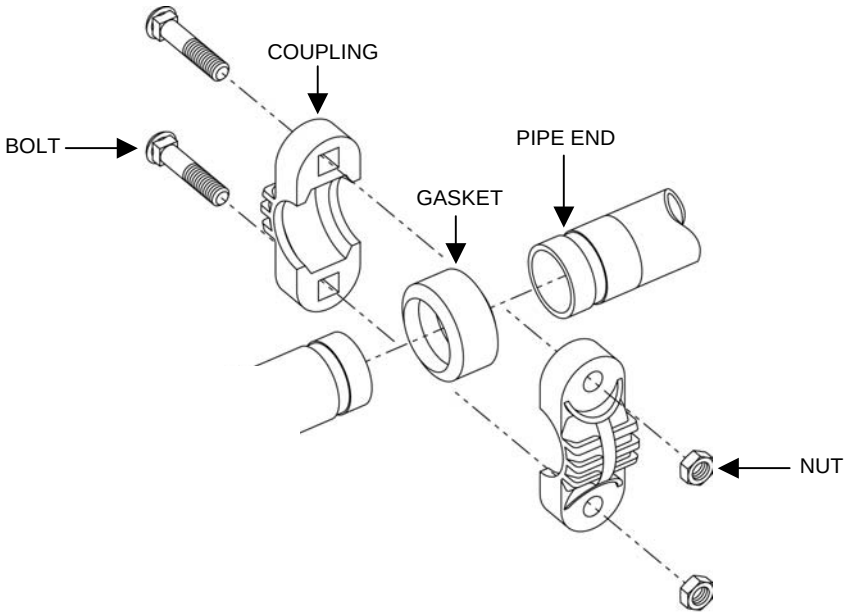

Figure 4. Grooved Flexible Coupling and Gasket.

3. Using clean, lint-free rags, clean and inspect the area where the coupling connects and check it for obvious signs of cracks and damage.
4. Install the new grooved flexible coupling and gasket as follows:
    a. Lubricate the gasket and pipe ends with glycerin. Place the new gasket around the two pipe halves.
    b. Make sure that the gasket does not slide into the grooves on either of the pipe ends.

c. Install the flexible coupling over the gasket and install the bolts and nuts but do not tighten.
d. Inspect the coupling and gasket to ensure that the gasket is properly fitted around the piping and not in the coupling grooves. Rotating the coupling back and forth will set the gasket.
e. Tighten the coupling nuts and bolts.

Pipe Coupling Replacement:

Parts:
Pipe Coupling (TM 10-4610-309-24P)
Materials:
Clean, dry lint-free rags (WP 0079, Table 1, item 23)
Corrosion preventive compound (WP 0079, Table 1, item 12)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace an pipe coupling as follows (see Figure 5):

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the pipe coupling as follows:
   a. Remove the nuts and bolts that secure the clamps to the pipe joint at both ends of the pipe joint. Remove the clamps and set aside.
   b. With a screw driver and hammer, tap the gasket retainers loose from the gaskets at both ends. Push the pipe joint and gasket back onto one of the pipes until it clears the end of the other pipe.
   c. Remove pipe support clamps and loosen other connections as needed to free one or both pipes to move or rotate enough to move the ends clear of each other. Remove the gaskets, gasket retainers and pipe joint from the pipes.

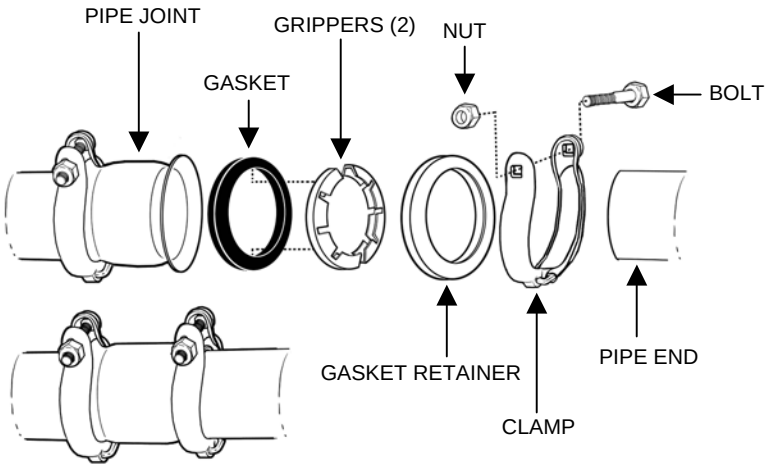

Figure 5. Pipe Coupling Replacement.

3. Clean the pipe ends with a clean, lint-free rag and inspect for rust, corrosion and damage that would prevent the pipe coupling from sealing.
4. Install a new pipe coupling as follows:
    a. Insert the two gripper sections into the inner diameter of a gasket.
    b. Insert the gasket into the gasket retainer.
    c. Slide the retainer, gasket, and gripper assembly over one of the two pipe ends (retainer side first).
    d. Repeat a, b, and c for the other pipe end. One side must be pushed far enough on to allow the pipe joint to clear the other pipe end.
    e. Fit the pipe joint onto one pipe end. Move the pipes back into alignment.
    f. Slide the assemblies at both ends up to the pipe joint so that both gaskets fit up against the flanges of the pipe joint.
    g. Position the clamps over the pipe joint flanges and gasket retainers and secure loosely with a bolt and nut. When both are installed loosely, tighten the bolt and nut on both clamps.
    h. Tighten the pipe connections and pipe support clamps which were loosened to move the pipes.
    i. Spray the gasket retainers and clamps with the corrosion preventive compound.
    j. Run the unit and check the joint for leaks.

Sanitary Clamp and Gasket Replacement:

Parts:
Sanitary Clamp (TM 10-4610-309-24P)
Sanitary Clamp Gasket (TM 10-4610-309-24P)
Materials:
Clean, dry lint-free rags (WP 0079, Table 1, item 23)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace a sanitary clamp and gasket as follows (see Figure 6):

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the sanitary clamp as follows:
    a. Ensure that the section of piping where the sanitary clamp is to be replaced has been depressurized and drained.
    b. Unscrew the wing nut.
    c. Lift the wing nut out of the notch in the clamp.
    d. Open and remove the clamp and gasket from the pipe ends.
3. Clean the pipe end flanges with a clean, lint-free rag and inspect the piping and pipe flange connections for rust, corrosion and damage that would prevent the sanitary clamp from sealing.
4. Install the sanitary clamp as follows:
    a. Insert the new sanitary clamp gasket between the two pipe ends.
    b. Open the new sanitary clamp and place it around the pipe end flanges and gasket.
    c. Flip the wing nut over and insert it in the notch in the clamp.
    d. Tighten the wing nut. Use a screwdriver in the slot to tighten. Tap with the hammer all around and tighten again.
    e. Run the unit and check the joint for leaks.

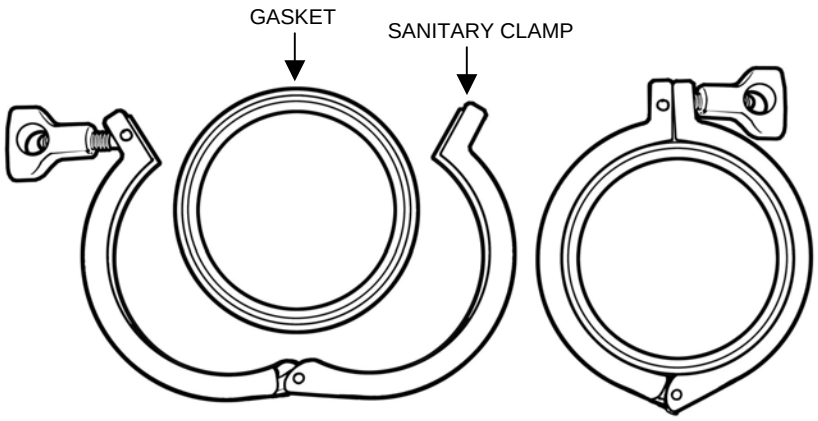

Figure 6. Sanitary Clamp and Gasket Replacement.

Solenoid Coil Replacement:

Parts (TM 10-4610-309-24P):
Solenoid Coil (BII)
Equipment Condition:
TWPS in Standby Shutdown without Drain-Down

There are 6 solenoid coils on the TWPS. Three spare coils are provided in the BII that can be used to replace the 6 coils on the TWPS as follows:

Spare Solenoid Coil	TWPS Coil(s) It Can Replace
276000-32-D, black body	XV-912 on the Feed Flow Control Panel
238610-032D, larger green body	XV-902 on air system section 4 15 psig air control valve
	XV-903 on air system section 3 15 psig air control valve
	XV-910 on air compressor intermediate filter automatic drain valve
	XV-911 on CO1 coalescer automatic drain valve
238210-032D, smaller green body	XV-901 on air system section 3 100 psig air control valve

Each of the solenoid coils is replaced using the same procedures as follows (see Figure 7):

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Disconnect the solenoid coil wire connector.
3. Remove the plastic cap from the top of the solenoid coil.
4. Push the solenoid down, lift the slotted end of the keeper plate and slide the plate out and off the solenoid coil.
5. Lift the solenoid coil off its valve.
6. Set the new coil in place.
7. Install the keeper plate.
8. Install the plastic cap.
9. Connect the solenoid coil wire.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0045 00**
OPERATOR MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

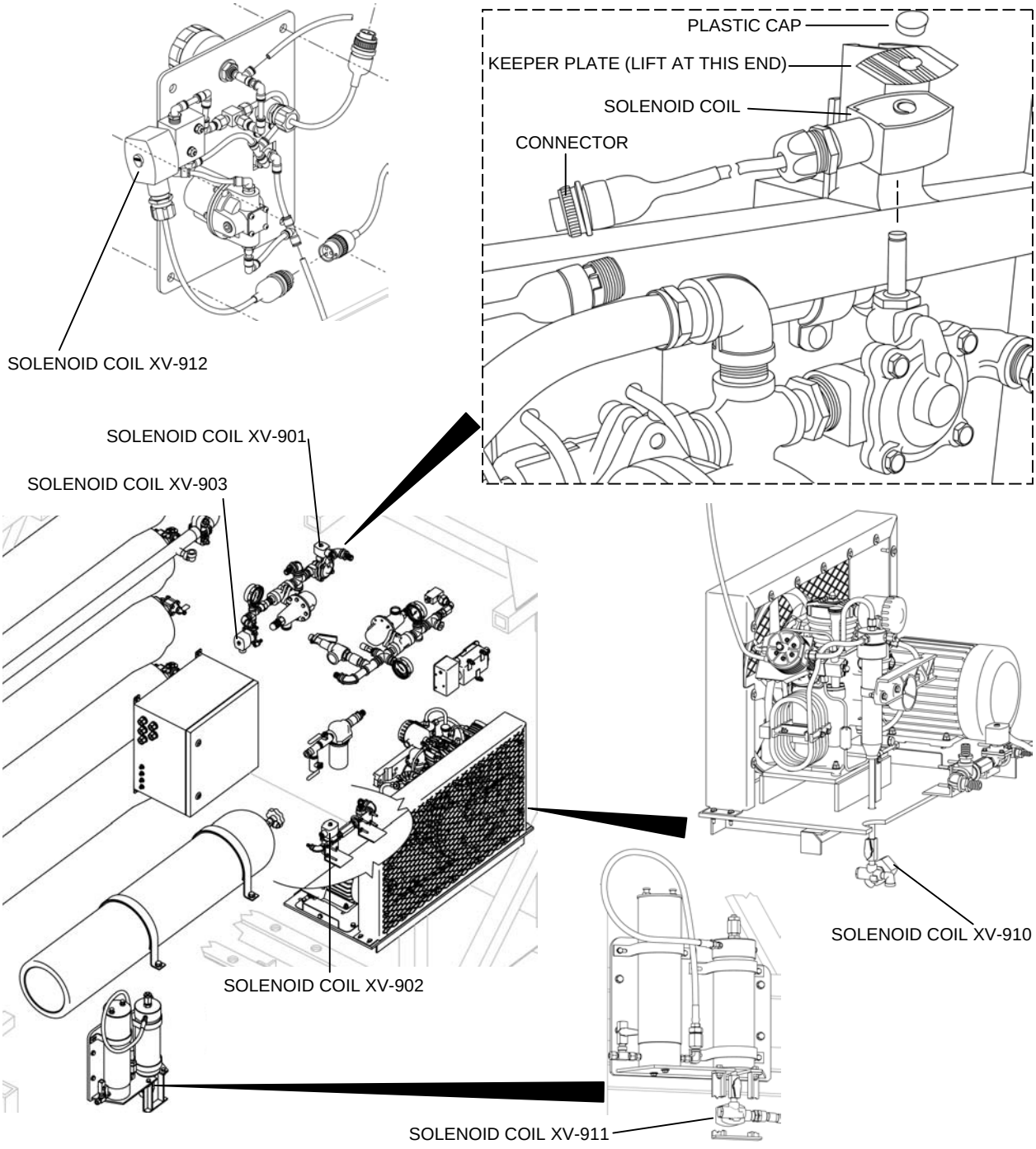

Figure 7. Solenoid Coil Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0045 00**
OPERATOR MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

ASSEMBLY

Antiseize Pipe Tape Installation:

Materials:
Antiseize pipe tape (BII) (WP 0079, Table 1, item 30, 31)

Install pipe tape on piping with external pipe threads as follows:

1. Select the correct pipe tape using the chart below.

FOR THIS PIPE SIZE	USE THIS PIPE TAPE
$^{1}/_{4}$" – $^{3}/_{8}$"	¼" tape
½" or larger	½" tape

NOTE
When threading piping together to which pipe tape has been applied, check the final position of the component before tightening. Over-tightening then backing off taped components can break the seal provided by the tape and result in leaks.

2. Wrap the external pipe threads with pipe tape as follows (see Figure 8):
   a. Start wrapping the threads one and a half threads back from the end of the pipe.
   b. Completely wrap the pipe tape around the pipe snug tight in a clockwise direction facing the end of the pipe.
   c. Continue a second complete turn around the pipe, but this time stretch the tape tight without breaking it.
   d. Continue with a third complete turn in the same manner.
   e. After completing the third turn, break off the tape and smooth the end against the threads.

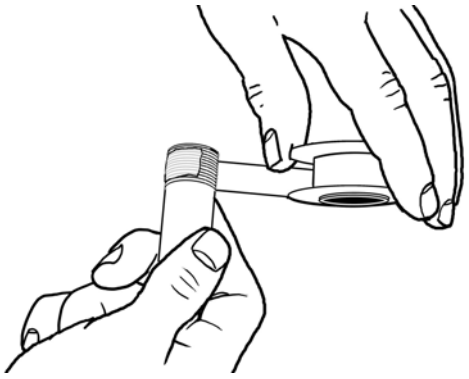

Figure 8. Installing Pipe Tape on External Pipe Threads.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0046 00**
UNIT MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)
INTRODUCTION

INTRODUCTION

Preventive Maintenance Checks and Services (PMCS) provide scheduled procedures to maintain the TWPS at a specified level of performance by providing systematic inspection, detection, servicing, condition monitoring, and/or replacement to prevent impending failures. A Unit level PMCS schedule is established for maintenance to perform PMCS at the periodic intervals of operation called out in Table 1.

PMCS TABLE FORMAT

Preventive Maintenance Checks and Services (PMCS) tables list inspection and care requirements to keep the TWPS in good operating condition. The following describes the purpose of each column in the PMCS Table.

1. ITEM NO: Each maintenance check is identified by a separate item number. The item column will be used as a source of item numbers for the "TM Number" on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.
2. INTERVAL: This column indicates when to perform the service check or maintenance.

   Periodic (see procedure for prescribed hourly intervals, quarterly, semi-annually)

3. ITEM TO BE CHECKED OR SERVICED: this column identifies the component, assembly, or system to be checked or serviced.
4. PROCEDURE: This column identifies what check or inspection task to perform and what action to take if corrections need to be made. Appropriate work packages are also referenced here.
5. EQUIPMENT NOT READY IF: This column indicates equipment conditions that make the equipment not capable of performing its assigned mission.

GENERAL INSPECTION AND MAINTENANCE

The following general inspection and maintenance procedures can be performed at any time. It is a good practice to perform these general procedures regularly to ensure that the TWPS remains in good operating condition.

1. Keep the TWPS clean. Dirt, grease, oil, and debris get in the way and may cover up serious problems.
2. Rust and Corrosion. Check the TWPS body and frame for rust and corrosion. If any bare metal or corrosion exists, clean and apply a thin coat of oil, report to supervisor, or prepare an SF 368, Products Quality Deficiency Report. Using key words such as "corrosion", "rust", "deterioration", or "cracking" will ensure that the information is identified as a Corrosion Prevention and Control (CPC) problem.
3. Bolts, Nuts, Screws. Check for obvious looseness, missing, bent or broken condition. Correct or report to supervisor.
4. Welds. Look for loose or chipped paint, rust, or gaps where parts are welded together. If a bad weld is located, report it to the supervisor.
5. Electrical Wires and Connections. Look for cracked, frayed, or broken insulation, bare wires and loose or broken connections. Correct or report to supervisor.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0046 00**
UNIT MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)
INTRODUCTION

6. Hoses and Fluid Lines. Look for wear, damage, and leaks. Make sure clamps and fittings are tight. Wet spots or stains around fittings and connectors indicate leaks. Correct or report to supervisor.
7. Leakage definitions are as follows:
    a. **Class I:** For oil and fuel: Seepage of fluid (as indicated by wetness) but not enough to form drops. For water: Seepage of fluid (as indicated by wetness) or leakage great enough to form drops, but not enough to cause drops to fall.
    b. **Class II:** For oil and fuel: Leakage of fluid great enough to form drops, but not enough to cause drops to fall. For water: Leakage great enough to result in more than a slow dripping from the leaking item.
    c. **Class III:** For oil and fuel: Leakage great enough to cause drops to fall from leaking item. For water: Rapid dripping or spray deemed to be a safety hazard or has the potential to damage other equipment.

CAUTION

Operation is allowable with Class I and II leakage. Class II leaks should be corrected when operational demands allow. Check regularly for any increase in leakage.

Do not continue operation with Class III leakage.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0047 00
UNIT MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

THIS SECTION COVERS:
Periodic Preventive Maintenance Checks and Services (PMCS)

INITIAL SETUP:
TWPS Shut Down and Cooled Off
Maintenance Level
Unit

Table 1. Periodic PMCS for TWPS.

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
1	First 50 hours of operation	Diesel engine	Change the lube oil and clean the filter for a new engine after the first 50 hours of operation (refer to WP 0050).	Maintenance log does not contain entries for these procedures after the first 50 hours of a new engine operation.
2	100 hours of operation	Diesel engine	Change the diesel engine oil (refer to WP 0050).	Maintenance log does not contain an entry for this procedure after each 100 hours of engine operation.
3	200 hours of operation	Diesel engine	Clean the fuel filter (refer to WP 0050.)	
4	400 hours of operation	Diesel engine	Replace the lube oil filter (refer to WP 0050).	
5	400 hours of operation	Diesel engine	Replace the fuel filter (refer to WP 0050).	
6	500 hours of operation of the diesel engine	Diesel engine	Clean the fuel injection valve nozzle. Adjust the intake and exhaust valve clearance. (Refer to WP 0050.)	
7	1000 hours	Air compressor	Replace the compressor oil (refer to WP 0056).	
8	1000 hours	HP Pumps	Replace the inlet and outlet valve cartridges and pistons (refer to WP 0053).	
9	1000 hours	Diesel engines	Notify Direct Support to service cylinder head (WP 0068) Notify Direct Support to replace piston rings (WP 0068)	
9	1500 hours	Air System	Inspect and clean the air compressor intermediate filter and the CO-1 coalescer filter elements (refer to WP 0054).	

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0047 00**
UNIT MAINTENANCE PROCEDURES
PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Table 1. Periodic PMCS for TWPS - Continued.

ITEM NO.	INTERVAL	ITEM TO BE CHECKED OR SERVICED	PROCEDURE	EQUIPMENT NOT READY IF:
10	2000 hours	HP Pumps	Replace the cluster plate and shaft seal. This will coincide with replacement of the pistons and the valves (refer to WP 0053).	
11	3000 hours	Air compressor	Replace valve head assemblies (refer to WP 0056).	
12	Quarterly when in use.	Diesel heater fuel filter	Clean. Replace if blocked (refer to WP 0064).	
13	Semi-annual	Diesel heater output air filter	Replace (refer to WP 0064).	
14	Annually	High pressure pump motors, MF pump motor, RO pump motor, and air compressor motor	Apply GAA grease (WP 0079, Table 1, item 15) through the zirk grease fittings. The zirk for the MF and RO pump motors is located at the top of the motor at the end closest to the motor/pump adapter and has a plastic cap over it. Remove a plastic grease (drain) plug on the same end of the motor near the 7 o'clock position. Apply grease to the zirk until clean grease exits the opening where the grease plug was removed. Then reinstall the grease plug. The zirk for high pressure pump motor and the compressor motor is located at the top of the motor at the end closest to the motor shaft and has a plastic cap over it. Remove a grease plug near the bottom of the motor opposite the zirk. Apply grease to the zirk until clean grease exits the opening where the grease plug was removed. Then reinstall the grease plug.	

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0048 00**
UNIT MAINTENANCE PROCEDURES
RAW WATER SYSTEM

THIS SECTION COVERS:
Inspect, Repair, Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS removed from service or during operation as required

GENERAL:

This work package contains information and instructions for repairing and replacing components in the Raw Water System. These include:

- Floating Inlet Strainer, Anchor, Pulley and Rope System Replacement
- Suction and Discharge Hose Replacement
- P-1 Skid Frame Replacement
- P-1 Skid Junction Box Replacement
- P-1 Diesel Engine-Driven Pump Replacement
- P-2 Skid Frame Replacement
- P-2 Skid Junction Box Replacement
- P-2 Skid Power Cable Replacement
- P-2 Pump Motor Cable Replacement
- P-2 Electric Motor-Driven Pump Replacement
- P-2 Pump Motor Replacement
- Adaptor Assembly A-01 Repair/Replacement
- Adaptor Assembly A-02 Repair/Replacement
- Adaptor Assembly A-03 Repair/Replacement
- Adaptor Assembly A-04 Repair/Replacement
- Adaptor Assembly A-05 Repair/Replacement
- Cyclone Separator Repair/Replacement
- P-1 and P-2 Pump Overhaul

For maintenance and replacement procedures for the P-1 Pump diesel engine, refer to WP 0050.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0048 00**
UNIT MAINTENANCE PROCEDURES
RAW WATER SYSTEM

REPLACE

Floating Inlet Strainer, Anchor, Pulley and Rope System Replacement:

Parts (TM 10-610-309-24P):
Floating inlet strainer
Anchor
Pulley
Rope
Equipment Condition:
TWPS removed from service

Inspect each of the following components for damage that can prevent it from functioning properly and replace if necessary:

- floating inlet strainer
- anchor
- connection to the anchor
- rope
- pulley

Suction and Discharge Hose Replacement:

Parts (TM 10-610-309-24P):
Suction hoses
Discharge hoses
Gaskets
Equipment Condition:
TWPS removed from service

Inspect the raw water system hoses and hose connectors for leaks, cracks or other damage. Replace the entire hose assembly if damage is found. Check the female connectors of all hose assemblies for missing or damaged gaskets and replace as necessary.

P-1 Skid Frame Replacement:

Parts (TM 10-4610-309-24P):
P-1 pump skid frame
Equipment Condition:
P-1 pump assembly removed from service and drained

Inspect the P-1 pump skid frame for damage. If frame damage is repairable by welding, contact Direct Support Maintenance. Replace the frame if it is beyond repair as follows:

1. Remove the fuel tank assembly from the skid as follows (see Figure 1):
    a. Close the fuel tank fuel cock.
    b. Uncouple the fuel supply and return line quick disconnect couplings.

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CAUTION

Potential cause of fuel pump and injection valve failure. Do not leave the fuel lines for the diesel engine and fuel tank disconnected. Failure to observe this caution may allow sand and dirt to enter the fuel system and result in fuel pump and injection valve failure.

c. Couple the two tank fuel lines together and the two diesel engine fuel lines together.
d. Lift the fuel tank assembly off the skid.

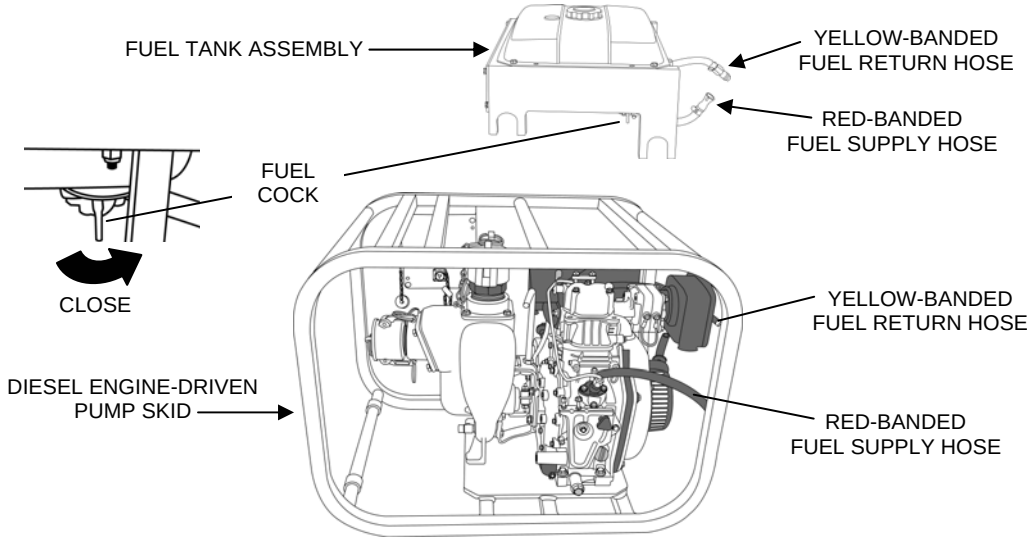

Figure 1. Raw Water Pump P-1 Skid Fuel Tank Assembly Removal.

2. Remove the junction box. Refer to **REPLACE** and **P-1 Skid Junction Box**.
3. Pull the recoil starter rope out a little, secure the rope, slip the handle down the rope and untie or cut off the knot at the end of the rope (see Figure 2).
4. Remove the handle from the rope and pull the rope end out of the eye bolt.
5. Slide the handle back onto the rope end and knot the end of the rope. Let the rope and handle retract to the recoil starter.

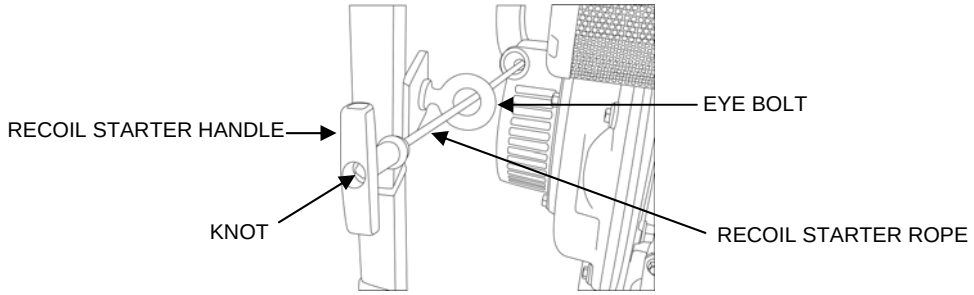

Figure 2. Recoil Starter Rope Removal / Installation from / into Rope Guide.

6. Remove the four bolts, flat washers, and lock washers that secure the engine/pump assembly to the skid (see Figure 3).

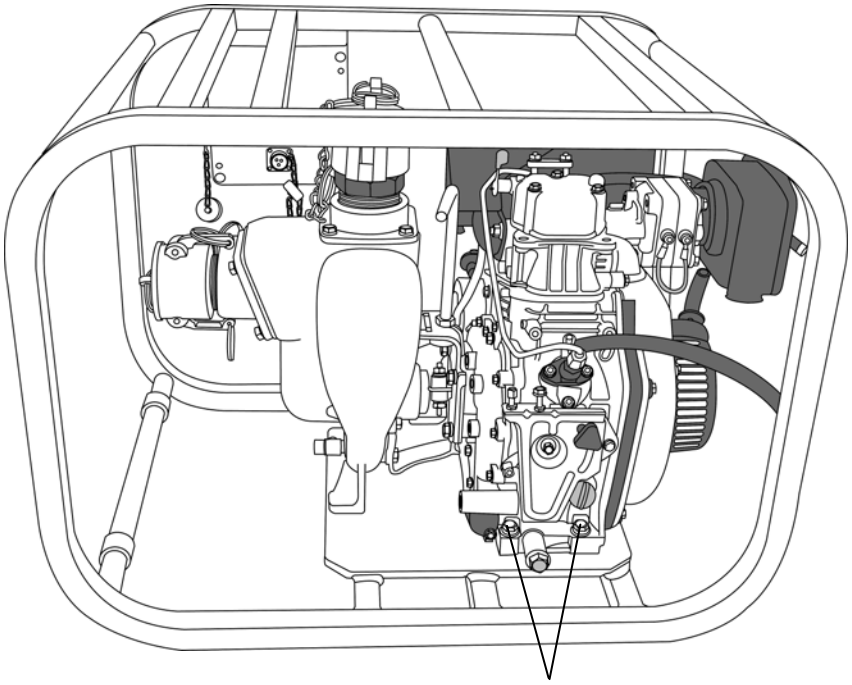

Figure 3. Raw Water Pump P-1 Engine Mounting Hardware Removal.

WARNING

Two person lift. Two people are required to safely move the engine/pump unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

7. Slide the engine/pump unit out the side of the skid.
8. Position the engine/pump assembly onto the new skid.
9. Pull the recoil starter rope out past the skid frame, secure the rope, slip the handle down the rope and untie or cut off the knot at the end of the rope (see Figure 2).
10. Remove the handle from the rope and thread the rope through the eye bolt.
11. Slide the handle back onto the rope end and knot the end of the rope. Let the rope and handle retract to the eye bolt.
12. Secure the assembly to the skid with four bolts, flat washers, and lock washers.
13. Install the junction box. Refer to **REPLACE** and **P-1 Skid Junction Box**.
14. Mount the fuel tank assembly on the skid frame and connect the fuel tank and diesel engine fuel supply and return lines.

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P-1 Skid Junction Box Replacement:

Parts (TM 10-4610-309-24P):
P-1 pump skid junction box
Equipment Condition:
P-1 pump assembly removed from service

Inspect the junction box for damage or corroded connectors. Replace the box if damage or corrosion is severe enough to make it unsafe or non-functional as follows (see Figure 4):

1. Disconnect the yellow cable wire from the engine air heaters, and the blue and red wires from the terminals of the starter solenoid.
2. Remove the two clamps and screws that secure the cable to the skid frame.
3. Remove four screws and washers that attach the junction box to the skid frame. Remove the junction box and cable.

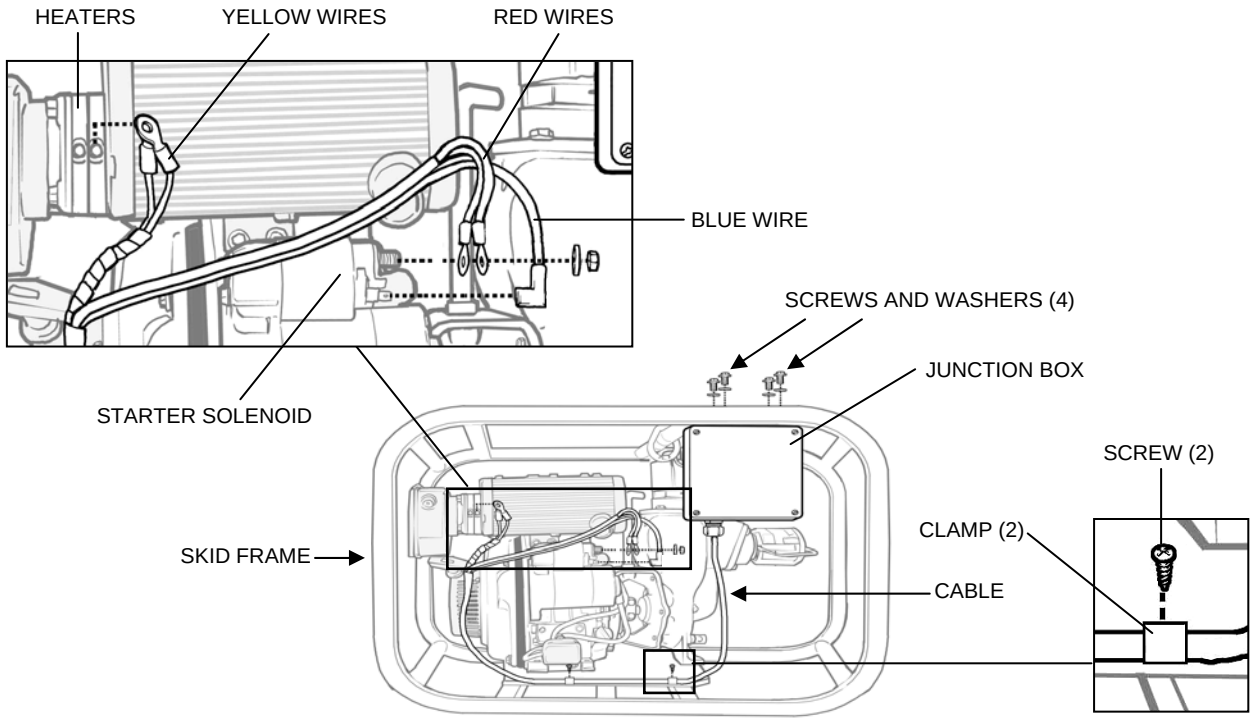

Figure 4. P-1 Skid Junction Box Replacement.

4. Attach the new junction box and cable to the frame using the four screws and washers. Be sure to orient the box so the toggle switch on the side faces toward the diesel engine.
5. Route the junction box cable along the skid frame and attach it to the frame using the two clamps and screws.
6. Attach the yellow cable wire to the engine air heater and the blue and red wires to the terminals on the starter solenoid.

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P-1 Diesel Engine-Driven Pump Replacement:

Parts (TM 10-4610-309-24P):
P-1 Pump
Material:
Cloth, Abrasive (WP 0079, Table 1, item 15)
Corrosion Preventive Compound (WP 0079, Table 1, item 17)
Sealing Compound (WP 0079, Table 1, item 36)
Clean, dry rags (WP 0079, Table 1, item 33)
Equipment Condition:
P-1 Pump assembly removed from service and drained

Replace the P-1 pump as follows (see Figure 5):

WARNING

Burn hazard. Make sure the diesel engine and its parts are cool before performing maintenance on the pump. Failure to observe this warning may result in serious personal injury from touching hot surfaces.

1. Remove the fuel tank from the skid. Refer to **REPLACE** and **P-1 Skid Frame**.
2. Remove the pump and adapter from the diesel engine as follows:
   a. Remove the six nuts that attach the pump housing to the adapter, then loosen and remove the pump housing.
   b. Remove and discard the coupling clamp assembly.
   c. Carefully pry the impeller/drive sleeve assembly off the engine drive shaft and discard it.
   d. Remove the four bolts, four lock washers, and four flat washers that attach the adapter to the engine. Remove and discard the adapter.

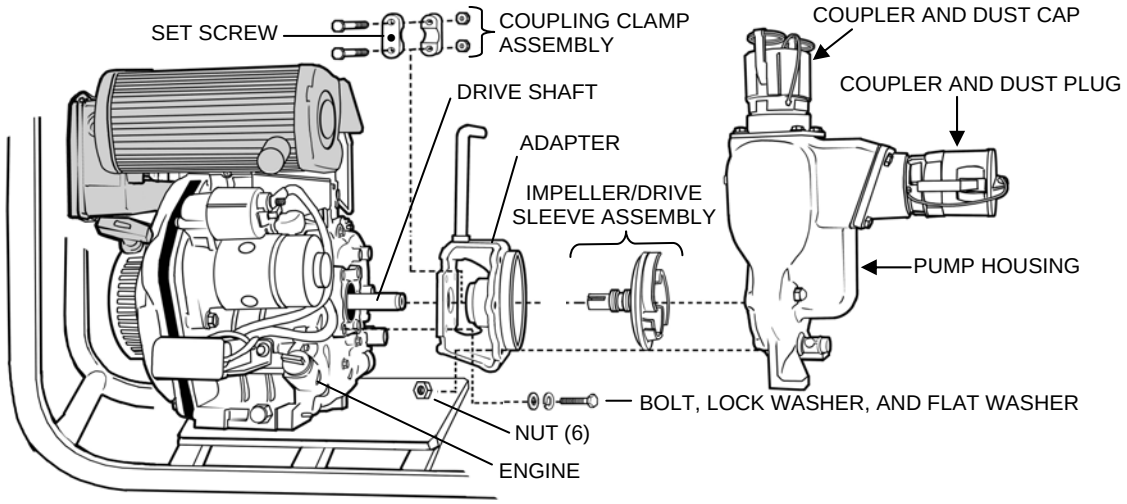

Figure 5. P1 Pump Replacement.

3. Install the new adapter and pump as follows:
    a. Polish the engine drive shaft with fine abrasive cloth to remove any rust or corrosion.
    b. Lubricate the drive shaft and the inside diameter of the drive sleeve on the new pump with corrosion preventive compound.

CAUTION

Improper assembly can result in damage to the drive sleeve and the engine drive shaft. Do NOT place a key between the drive shaft and the drive sleeve. Do NOT force the drive sleeve onto the shaft. Failure to observe this caution can make impeller clearance adjustments and future removal of the drive sleeve difficult, and may result in damage to the drive sleeve and/or the engine drive shaft.

Replacement pump assemblies come with a pump housing, impeller, drive sleeve assembly, coupling clamp assembly, and adapter already assembled together. A temporary impeller spacer is installed inside the pump between the impeller and wear plate. Do NOT rotate the pump before removing the spacer or equipment damage may result. Do NOT remove the spacer until the pump has been mounted to the engine and the coupling clamp assembly has been tightened.

    c. Loosen but do not remove the coupling clamp assembly on the new pump.
    d. Position the replacement pump, align the coupling clamp set screw, a drive sleeve slat, and the engine drive shaft keyway and slide the drive sleeve onto the drive shaft.

NOTE

If the sleeve does not easily slide onto the shaft, it may be necessary to remove burrs from the shaft.

    e. Attach the pump and adapter to the engine using four bolts, four lock washers, and four flat washers.
    f. Torque the coupling clamp assembly nuts to 216 in.-lbs.
    g. Tighten the coupling clamp set screw into the drive shaft keyway.
    h. Remove the plastic protective caps from the pump inlet and outlet openings.
    i. Remove the temporary impeller spacer by pulling it out through the pump outlet opening.
4. Remove the coupler and dust cap from the outlet connection of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 26).
5. Remove the coupler and dust plug from the inlet connection of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 26).
6. Remove the drain valve from the old pump. Remove the drain plug from the new pump and install the drain valve on the new pump. Use sealing compound on the valve threads (WP 0079, Table 1, item 26).
7. Place the pump back into service and inspect it for leaks and proper operation.

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P-2 Skid Frame Replacement:

Parts (TM 10-4610-309-24P):
P-2 pump skid frame
Equipment Condition:
P-2 Pump assembly removed from service and drained

Inspect the P-2 pump skid frame for damage. If the frame damage is repairable by welding, contact Direct Support Maintenance. Replace the frame if it is beyond repair as follows (see Figure 6):

1. Disconnect the motor cable at the junction box.
2. Remove the four screws and washers that secure the junction box to the skid frame. Remove the junction box.
3. Remove the four bolts and washers that secure the pump/motor unit to the frame.

WARNING

Two person lift. Two people are required to safely move the pump/motor unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

4. Slide the pump/motor unit out the side of the frame.
5. Position the pump/motor unit onto the new frame and secure it using the four bolts, flat washers, and lock washers.
6. Secure the junction box to the new frame using the four screws and washers. Be sure to orient the box so the side with two receptacles is facing inward.
7. Connect the motor cable to the proper receptacle on the junction box.

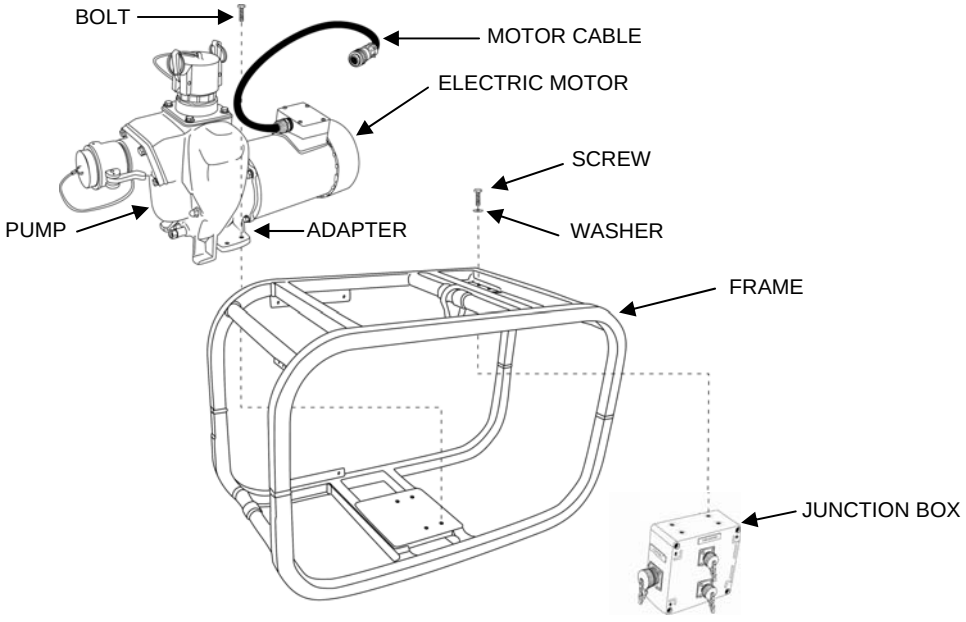

Figure 6. P-2 Pump Assembly Components.

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P-2 Skid Junction Box Replacement:

Parts (TM 10-4610-309-24P):
P-2 pump skid junction box
Equipment Condition:
P-2 Pump assembly removed from service

Inspect the P-2 skid junction box for damage or corroded connectors. If damage or corrosion is severe enough to make it unsafe or non-functional, replace the box as follows (see Figure 6):

1. Disconnect the motor cable from the junction box.
2. Remove the screws and washers that secure the junction box to the skid frame. Remove the junction box.
3. Secure the new junction box to the frame using the retained hardware. Be sure to orient the box so the side with two receptacles is facing inward.
4. Connect the motor cable to the proper receptacle on the junction box.

P-2 Skid Power Cable Replacement:

Parts (TM 10-610-309-24P):
P-2 skid power cable
Equipment Condition:
P-2 Pump assembly removed from service

Inspect the power cable that connects the P-2 pump junction box to the Power Distribution Panel for damage. If the cable or the cable connectors are damaged so that it is unsafe to use, replace the cable.

P-2 Pump Motor Cable Replacement:

Parts (TM 10-4610-309-24P):
P-2 Pump Motor Cable
Equipment Condition:
P-2 Pump assembly removed from service

Inspect the P-2 electric motor cable for damage. If the cable or connector is damaged so that it is unsafe to use, replace the cable as follows (see Figure 7):

1. Disconnect the motor cable at the junction box.
2. Remove the motor terminal box cover.
3. Inspect the terminal box gasket and replace if needed.
4. Tag and disconnect the motor terminal wires from the motor cable wires.
5. Unscrew the cable ring nut from the terminal box.
6. Pull the cable end out of the terminal box and discard the old motor cable.
7. Insert the wire end of the new cable into the terminal box and secure with the ring nut.
8. Connect the motor cable wires to the motor terminal wires in accordance with the tags.
9. Install the terminal box cover gasket and cover and secure with the two nuts.

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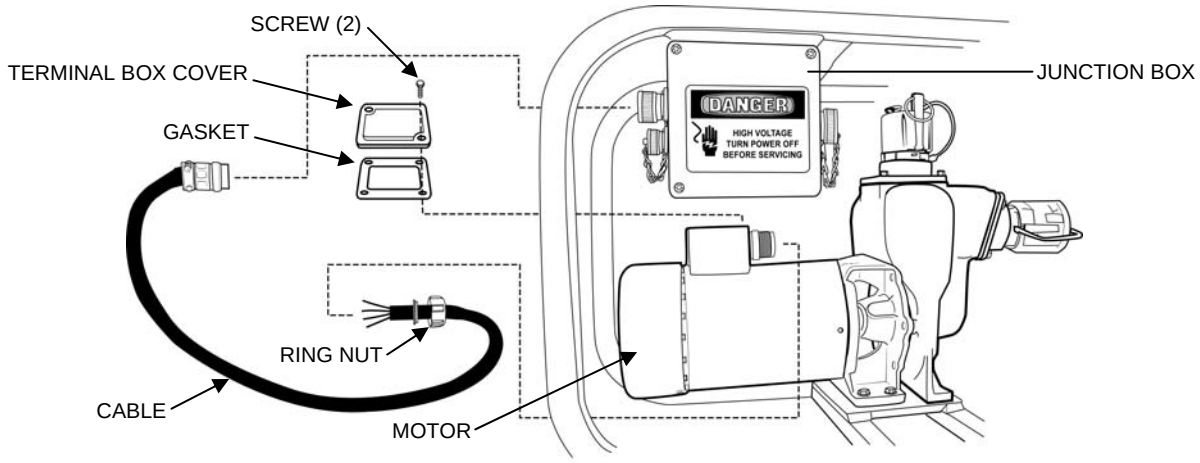

Figure 7. P-2 Pump Electric Motor Cable Replacement.

P-2 Electric Motor-Driven Pump Replacement:

Parts (TM 10-4610-309-24P):
P-2 Pump
Material:
Cloth, Abrasive (WP 0079, Table 1, item 15)
Corrosion Preventive Compound (WP 0079, Table 1, item 17)
Glycerin (WP 0079, Table 1, item 21)
Sealing Compound (WP 0079, Table 1, item 36)
Clean, dry rags (WP 0079, Table 1, item 33)
Equipment Condition:
P-2 Pump assembly removed from service and drained

Replace the P-2 pump as follows (see Figure 8):

1. Remove the pump as follows:
   a. Disconnect the pump motor cable from the junction box.
   b. Remove the four bolts and washers that attach the pump/motor unit to the skid.

WARNING

Two person lift. Two people are required to safely move the pump/motor unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   c. Slide the pump/motor unit out the side of the skid.
   d. Remove the six nuts that attach the pump housing to the adapter, then loosen and remove the pump housing.
   e. Remove and discard the coupling clamp assembly.

f. Carefully pry the impeller/drive sleeve assembly off the motor drive shaft and discard it.
g. Remove the four cap screws and lock washers that attach the adapter to the motor.
h. Discard the adapter.

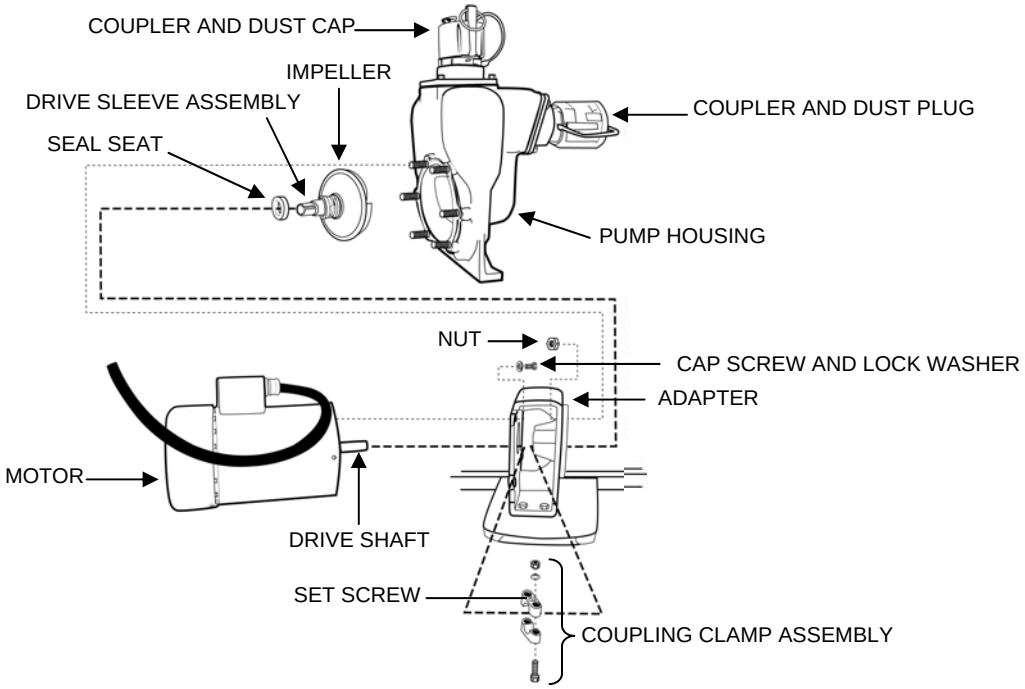

Figure 8. P-2 Pump and Motor Removal.

2. Install a new pump as follows:
   a. Polish the motor shaft with fine abrasive cloth to remove any rust or corrosion.
   b. Lubricate the shaft and the inside diameter of the drive sleeve on the new pump with corrosion preventive compound.

CAUTION

Improper assembly can result in damage to the drive sleeve and the motor drive shaft. Do NOT place a key between the drive shaft and the sleeve. Do NOT force the shaft into the sleeve. Failure to observe this caution can make impeller clearance adjustments and future removal of the drive sleeve difficult and may result in damage to the drive sleeve and/or the motor drive shaft.

Replacement pump assemblies come with a pump housing, impeller, drive sleeve assembly, coupling clamp assembly, and adapter already assembled together. A temporary impeller spacer is installed inside the pump between the impeller and wear plate. Do NOT rotate the pump until the spacer has been removed, or equipment damage may result. Do NOT remove the spacer until the motor has been mounted to the pump and the coupling clamp assembly has been tightened.

c. Loosen but do not remove the coupling clamp assembly on the new pump.
d. Position the replacement pump, align the coupling clamp set screw, a drive sleeve slat, and the engine drive shaft keyway and slide the drive sleeve onto the drive shaft.

NOTE

If the shaft does not easily slide into the drive sleeve, it may be necessary to remove burrs from the shaft.

e. Attach the motor to the pump adapter using the four cap screws and four lock washers.
f. Torque the coupling clamp assembly nuts to 216 in.-lbs.
g. Tighten the coupling clamp set screw into the drive shaft keyway.

WARNING

Two person lift. Two people are required to safely move the pump/motor unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

h. Position the pump/motor unit on the skid and bolt it in place using four bolts and washers.
i. Remove the plastic protective caps from the pump inlet and outlet openings.
j. Remove the temporary impeller spacer by pulling it out through the pump outlet opening.

3. Remove the coupler and dust cap from the outlet of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 36).
4. Remove the coupler and dust plug from the inlet of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 36).
5. Remove the drain valve from the old pump. Remove the drain plug from the new pump and install the drain valve on the new pump. Use sealing compound on the valve threads (WP 0079, Table 1, item 36).
6. Connect the motor cable to the proper receptacle on the junction box.
7. Place the pump back into service and inspect it for leaks.

P-2 Pump Motor Replacement:

Parts (TM 10-4610-309-24P):
P-2 Electric Motor
Kit, Seal Repair
Material:
Cloth, Abrasive (WP 0079, Table 1, item 15)
Corrosion Preventive Compound (WP 0079, Table 1, item 17)
Glycerin (WP 0079, Table 1, item 21)
Clean, dry rags (WP 0079, Table 1, item 33)
Sealing Compound (WP 0079, Table 1, item 35)
Equipment Condition:
P-2 Pump assembly removed from service and drained.

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NOTE

The pump must be taken apart to separate it from the motor. This is because the impeller clearance must be set when the pump is installed on the new motor. The seal seat, seal assembly, housing gasket, and drive sleeve will also be replaced.

Replace the P-2 Pump electric motor as follows (see Figure 9 and Figure 10):

1. Remove the pump motor as follows:
   a. Disconnect the motor cable at the skid junction box.
   b. Remove the six nuts that attach the pump housing to the adapter.
   c. Loosen and remove the pump housing and gasket. Discard the gasket.
   d. Remove the coupling clamp assembly.

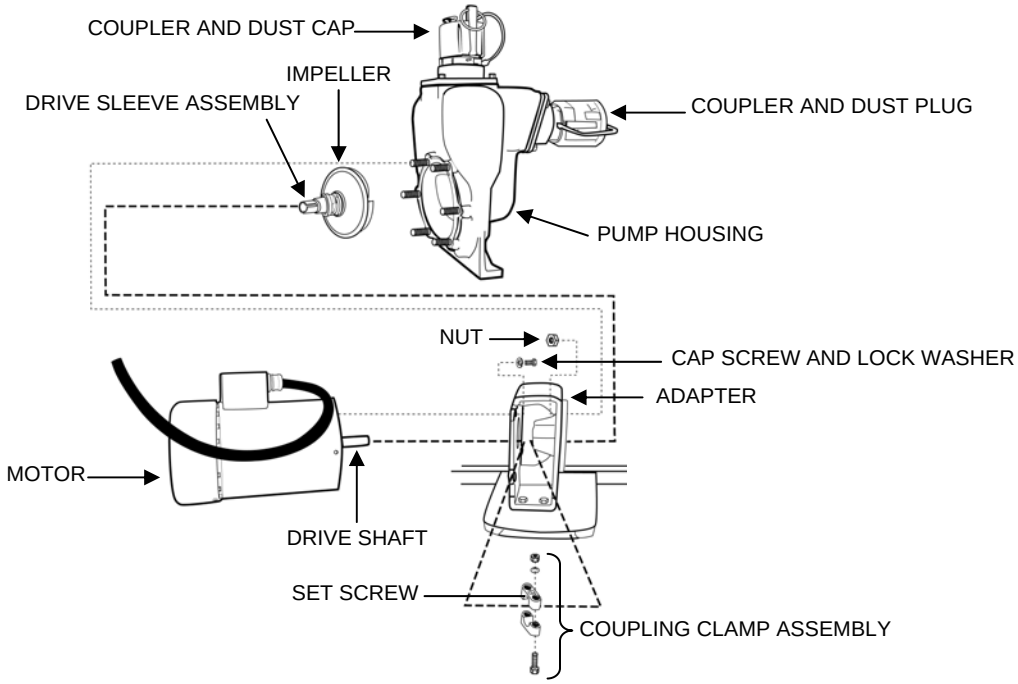

Figure 9. Pump P-2 Electric Motor Replacement.

   e. Carefully pry the drive sleeve off the motor drive shaft.
   f. Remove the lock nut and drive sleeve from the impeller (see Figure 10). Discard the sleeve and seal assembly. Attach the new sleeve to the impeller using the lock nut.
   g. Lubricate inner diameter of the new seal assembly with glycerin. With the rubber boot end toward the impeller, twist and slide the assembly onto the drive sleeve.
   h. Remove the four cap screws and four lock washers that attach the motor to the adapter and remove the motor.
   i. Push the seal seat out of the adapter and discard it.
   j. Clean the adapter bore and mounting faces.
   k. Clean the new seal seat and lubricate it with glycerin. Insert the beveled end of the seal seat into the adapter bore and press it into the adapter.

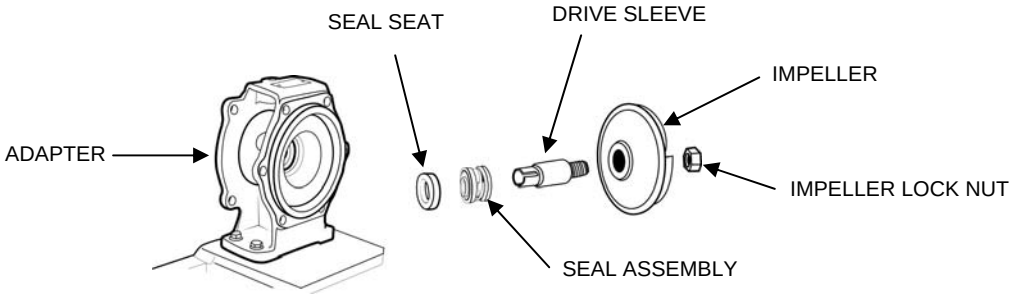

Figure 10. Drive Sleeve, Impeller, and Seal Assembly.

2. Install the new motor as follows:
   a. If necessary, polish the new motor's drive shaft with fine abrasive cloth to remove any rust or corrosion.
   b. Attach the new motor to the adapter using the four cap screws and four lock washers.
   c. Disconnect the motor cable from the old motor and attach it to the new motor. Refer to **REPLACE** and **P-2 Pump Motor Cable**.
   d. Lubricate the motor drive shaft and the inside diameter of the drive sleeve with corrosion preventive compound.

CAUTION

Improper assembly can result in damage to the drive sleeve and the motor drive shaft. Do NOT place a key between the drive shaft and the sleeve. Do NOT force the shaft into the sleeve. Failure to observe this caution can make impeller clearance adjustments and future removal of the drive sleeve difficult and may result in damage to the drive sleeve and/or the motor drive shaft.

NOTE

If the sleeve does not easily slide onto the shaft, it may be necessary to remove burrs from the shaft.

   e. Slide the drive sleeve/impeller assembly onto the drive shaft.
   f. Install the coupling clamp assembly but do not tighten it.
   g. Place a new housing gasket between the adapter and the pump housing.
   h. Fit the pump onto the adapter and thread a nut on two opposing threaded studs to secure the pump to the adapter. Tighten the two nuts.
3. Set the gap between the impeller and the pump wear plate as follows (see Figure 11):
   a. Remove the 4 cap screws and 4 lock washers that secure the outlet flange to the pump housing.
   b. Carefully remove the pump flange to avoid damaging the gasket between the flange and the pump housing.
   c. If the gasket is damaged, replace it.
   d. Look through the outlet into the pump. Turn the impeller drive sleeve and impeller by hand until you see the impeller near the wear plate.

e. Insert a 0.015 – inch feeler gauge between the impeller and wear plate. Move the impeller forward or backward as needed to provide a gap of 0.015 to 0.017-inch.
f. Turn the impeller drive sleeve / impeller assembly by hand to make sure that there is a minimum gap of 00.015-inch through the entire rotation of the impeller.
g. Make sure the coupling clamp set screw, a drive sleeve slat, and the motor shaft keyway are aligned.
h. Tighten the coupling clamp assembly to secure the impeller drive sleeve to the motor drive shaft. Torque the nuts to 216 in.-lbs.
i. Tighten the coupling clamp set screw into the drive shaft keyway.

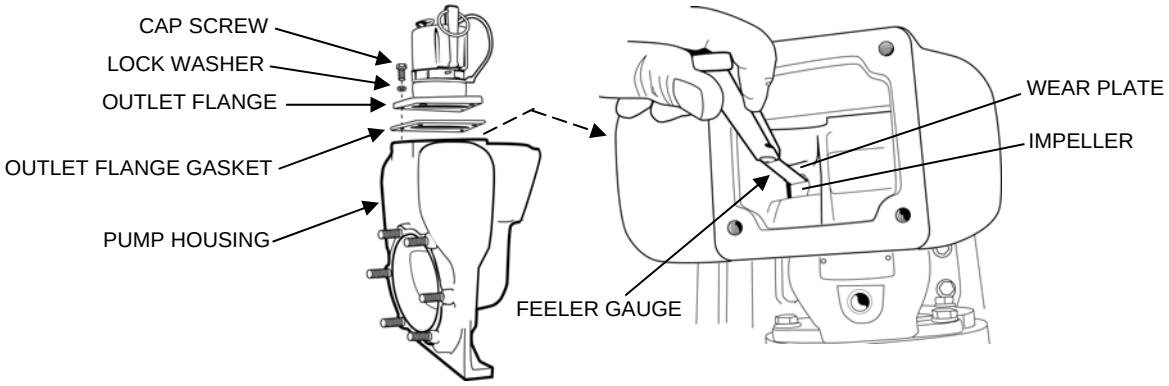

Figure 11. P2 Pump Impeller Clearance Adjustment.

4. Complete the installation as follows:
    a. Apply sealing compound to the threads of the remaining four threaded studs extending from the pump housing through the adapter (WP 0079, Table 1, item 25). Install the nuts onto the studs.
    b. Remove the two nuts initially installed onto opposing studs. Apply sealing compound to the stud threads and reinstall the nuts (WP 0079, Table 1, item 25).
    c. Reinstall the pump outlet flange and gasket.
5. Connect the motor cable to the proper receptacle on the junction box.
6. Place the pump back into service and inspect it for proper rotation and leaks.

Adaptor Assembly A-01 Repair / Replacement:

Parts (TM 10-610-309-24P):
Adaptor assembly A-01
Equipment Condition:
TWPS removed from service

Inspect the adaptor assembly, including valve V-101, for leaks. If a leak is found at a coupler, replace damaged or missing gaskets as necessary. If a significant leak cannot be stopped by gasket replacement, or if the valve does not function properly, replace the entire assembly.

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Adaptor Assembly A-02 Repair / Replacement:

Parts (TM 10-610-309-24P):
Adaptor assembly A-02
Gaskets
Equipment Condition:
TWPS removed from service

Inspect the adaptor assembly, including valve V-102, for leaks. If a leak is found at a coupler, replace damaged or missing gaskets as necessary. If a significant leak cannot be stopped by gasket replacement, or if the valve does not function properly, replace the entire assembly.

Adaptor Assembly A-03 Repair / Replacement:

Parts (TM 10-610-309-24P):
Adaptor assembly A-03
Gasket
Equipment Condition:
TWPS removed from service

Inspect the adaptor assembly, including valve V-104, for leaks. If a leak is found at a coupler, replace damaged or missing gaskets as necessary. If a significant leak cannot be stopped by gasket replacement, or if the valve does not function properly, replace the entire assembly.

Adaptor Assembly A-04 Repair / Replacement:

Parts (TM 10-610-309-24P) :
Adaptor assembly A-04
Gasket
Equipment Condition:
TWPS removed from service

Inspect the adaptor assembly for leaks. If a leak is found at a coupler, replace damaged or missing gaskets as necessary. If a significant leak cannot be stopped by gasket replacement, replace the entire assembly.

Adaptor Assembly A-05 Repair / Replacement:

Parts (TM 10-610-309-24P):
Adaptor assembly A-05
Gasket
Equipment Condition:
TWPS removed from service

Inspect the adaptor assembly, including valve V-107, for leaks. If a leak is found at a coupler, replace damaged or missing gaskets as necessary. If a significant leak cannot be stopped by gasket replacement, or if valve v-107 does not function properly, replace the entire assembly.

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Cyclone Separator Repair / Replacement:

Parts (TM 10-610-309-24P):
- Cyclone separator
- Couplers
- Gaskets

Material:
- Sealing compound (WP 0079, Table 1, item 36)

Equipment Condition:
- TWPS removed from service

Inspect the cyclone separator for leaks, cracks or other damage. Refer any metal repairs to Direct Support maintenance. Inspect the couplings for damage and damaged or missing gaskets and replace as necessary, using sealing compound on the coupling threads. Replace the entire assembly if the separator has excessive leakage, if structural damage is significant enough that the assembly cannot be repaired, or if the separator is inoperable.

REPAIR

P-1 and P-2 Pump Overhaul:

Parts (TM 10-4610-309-24P):
- Kit, Pump Overhaul
- Flapper Assembly
- Outlet Flange Gasket

Material:
- Cloth, Abrasive (WP 0079, Table 1, item 15)
- Corrosion Preventive Compound (WP 0079, Table 1, item 17)
- Glycerin (WP 0079, Table 1, item 21)
- Clean, dry rags (WP 0079, Table 1, item 33)
- Sealing Compound (WP 0079, Table 1, item 35)

Equipment Condition:
- Pump assembly removed from service

Pump Overhaul

This section provides instructions for overhauling the P-1 or P-2 pump by replacing the internal components. A pump should be overhauled if its flow rate has noticeably decreased, or if inspection of the pump during disassembly for some other maintenance task (such as engine/motor replacement) shows that the impeller or wear plate is damaged or badly corroded. Additional instructions in this section describe how to replace the pump inlet flapper assembly and the outlet flange gasket.

NOTE

Whenever the P-1 or P-2 pump is disassembled for any of the maintenance tasks in this work package, replace the drive sleeve, seal seat, seal assembly, and housing gasket regardless of their condition. These components are included in the seal repair kit. The overhaul kit includes these components plus the impeller, wear plate, and wear plate mounting screws and gaskets.

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1. (P-1 Pump Skid only) Remove the fuel tank assembly from the skid as follows (see Figure 12):
   a. Close the fuel tank fuel cock.
   b. Uncouple the fuel supply and return line quick disconnect couplings.

CAUTION

Potential cause of fuel pump and injection valve failure. Do not leave the fuel lines for the diesel engine and fuel tank disconnected. Failure to observe this caution may allow sand and dirt to enter the fuel system and result in fuel pump and injection valve failure.

   c. Couple the two tank fuel lines together and the two diesel engine fuel lines together.
   d. Lift the fuel tank assembly off the skid.

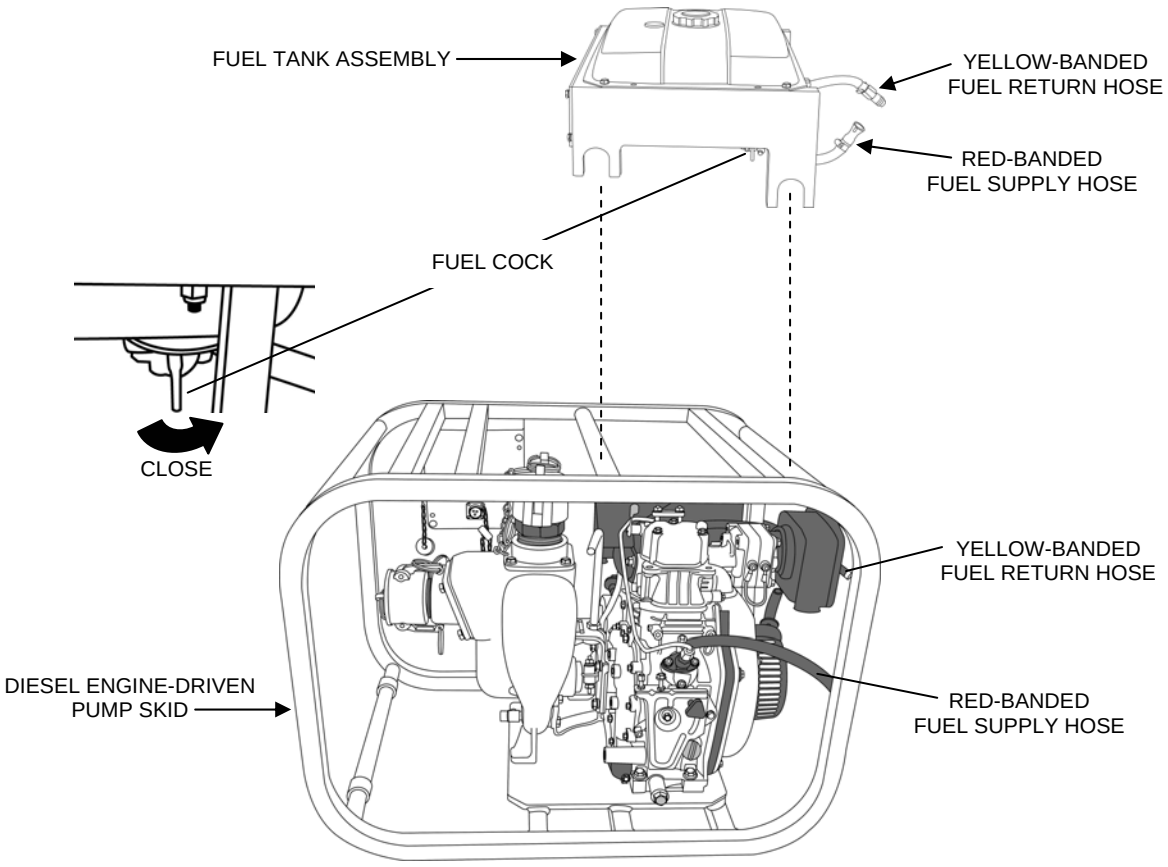

Figure 12. Raw Water Pump P-1 Skid Fuel Tank Assembly Removal.

2. Remove the pump from the diesel engine (P-1 Pump skid) or remove the pump from the motor (P-2 Pump skid) as follows (see Figure 13):
    a. Open the pump drain valve and drain any remaining water from the pump.
    b. Remove the six nuts that attach the pump housing to the adapter.
    c. Loosen and remove the pump housing and gasket. Discard the gasket.
    d. Remove and retain the coupling clamp assembly.
    e. Carefully pry the drive sleeve/impeller assembly off of the diesel engine (P-1) or electric motor (P-2) drive shaft. Discard the drive sleeve/impeller assembly.
    f. Remove the four cap screws, four lock washers, and four flat washers that attach the adapter to the diesel engine (P-1), or the four cap screws and four lock washers that attach the adapter to the electric motor (P-2) and remove the adapter.
    g. Push the seal seat out of the adapter and discard the seal seat.
    h. Remove and discard the two acorn nuts and two gaskets from the back of the pump housing.
    i. Remove and discard the two flat head screws and the wear plate.

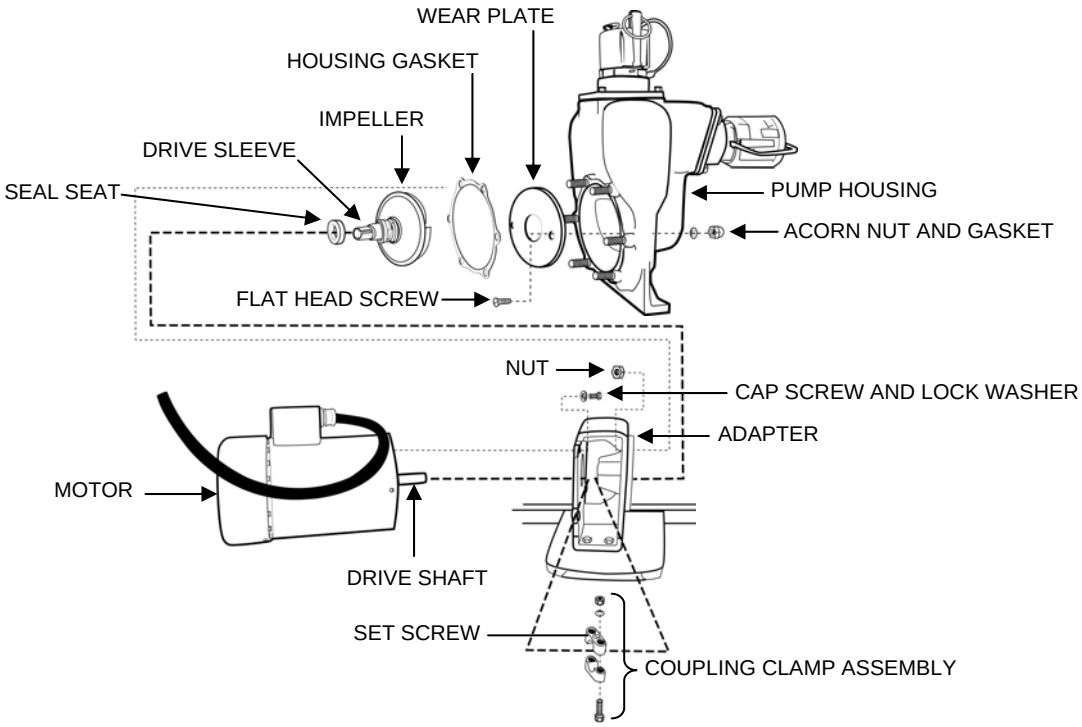

Figure 13. P-1 and P-2 Pump, Adapter, and Wear Plate Removal.

3. Assemble the pump with replacement parts as follows (see Figure 14):
    a. Insert the new wear plate into the pump housing and secure it to the housing with the new flat head screws and gaskets and the acorn nuts.
    b. Insert the new drive sleeve into the new impeller and secure it to the impeller using the impeller lock nut.
    c. Lubricate the inner diameter of the new seal assembly with glycerin or a comparable lubricant.
    d. With the rubber boot end of the seal assembly toward the impeller, twist and slide the seal assembly onto the drive sleeve.
    e. Clean the adapter bore and mounting faces.
    f. Clean the new seal seat and lubricate it with glycerin or a comparable lubricant.
    g. Insert the beveled end of the seal seat into the bore of the adapter and press it in until it is seated.

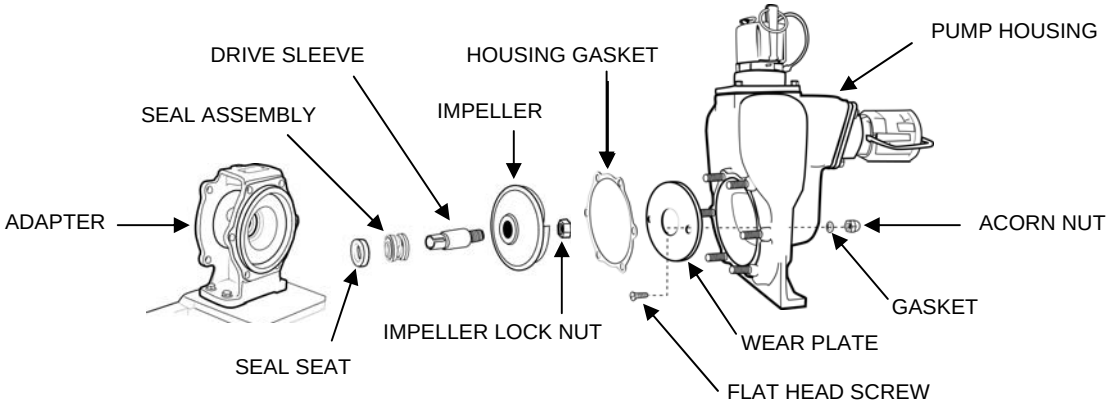

Figure 14. P1/P2 Pump Assembly.

4. Install the adapter and pump onto the diesel engine (P-1) or the electric motor (P-2) as follows (see Figure 15):
    a. Polish the engine/motor drive shaft with a fine abrasive cloth to remove any rust or corrosion.
    b. Attach the adapter to the engine (P-1) to the adapter using the four cap screws, four lock washers, and four flat washers or attach the adapter to the motor (P-2) using the four cap screws and four lock washers.
    c. Lubricate the engine/motor drive shaft and the inside diameter of the new drive sleeve with corrosion preventive compound.
    d. Slide the impeller and drive sleeve assembly onto the drive shaft.
    e. Install the coupling clamp assembly but do not tighten it.
    f. Place a new housing gasket between the adapter and the pump housing.
    g. Fit the pump onto the adapter and thread a nut on two opposing threaded studs to secure the pump to the adapter. Tighten the two nuts.

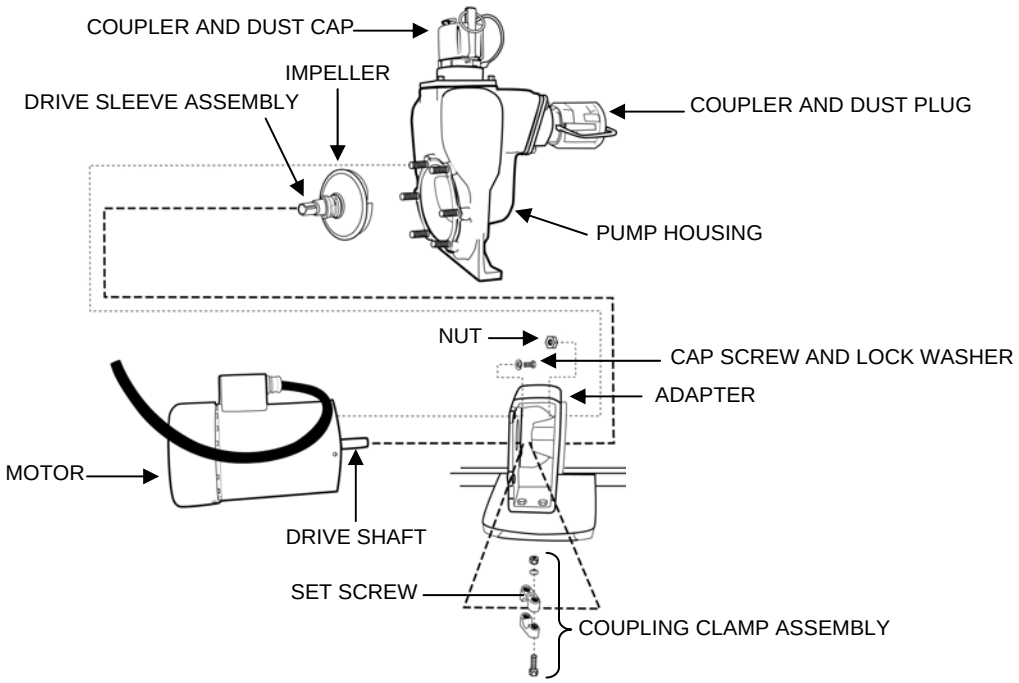

Figure 15. Pump P-2 Adapter and Pump Installation.

5. Set the gap between the impeller and the pump wear plate as follows (see Figure 16):
    a. Remove the four cap screws and four lock washers that secure the outlet flange to the pump housing.
    b. Carefully remove the pump flange to avoid damaging the gasket between the flange and the pump housing.
    c. If the gasket is damaged, replace it.
    d. Look through the outlet into the pump. Turn the impeller drive sleeve and impeller by hand until you see the impeller near the wear plate.
    e. Insert a 0.015 – inch feeler gauge between the impeller and wear plate. Move the impeller forward or backward as needed to provide a gap of 0.015 to 0.017-inch.
    f. Make sure the coupling clamp set screw, a drive sleeve slat, and the motor shaft keyway are aligned.
    g. Tighten the coupling clamp assembly to secure the impeller drive sleeve to the engine/motor drive shaft.
    h. Turn the drive shaft slowly to rotate the impeller and make sure that there is a minimum gap of 00.015-inch through the entire rotation of the impeller as follows:
        1) Turn the diesel engine (P-1) drive shaft by slowly pulling on the hand starter.
        2) Turn the electric motor (P-2) drive shaft by hand.
    i. Torque the coupling clamp nuts to 216 in.-lbs.
    j. Tighten the coupling clamp set screw into the drive shaft keyway.

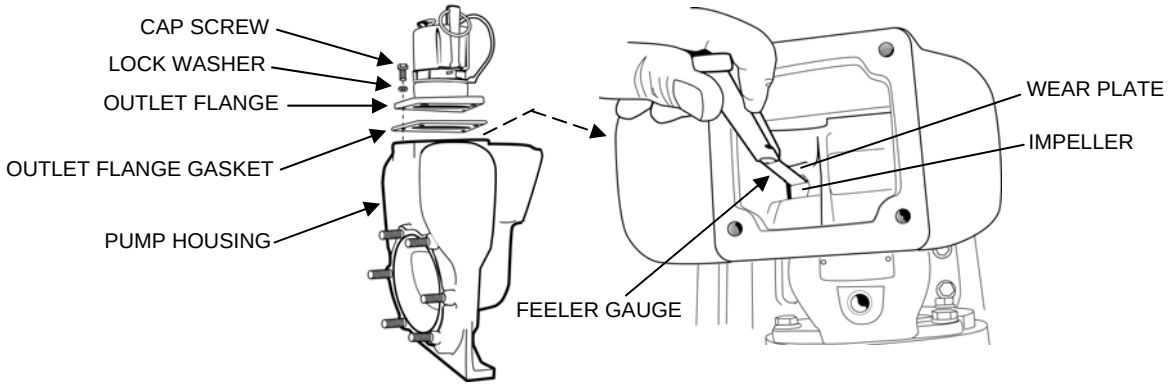

Figure 16. Pump Impeller Clearance Adjustment.

6. Complete the installation as follows:
    a. Apply sealing compound to the threads of the remaining four threaded studs extending from the pump housing through the adapter (WP 0079, Table 1, item 25). Install the nuts onto the studs.
    b. Remove the two nuts initially installed onto opposing studs. Apply sealing compound to the stud threads and reinstall the nuts (WP 0079, Table 1, item 25).
    c. Reinstall the pump outlet flange and gasket.
7. Connect the motor cable to the proper receptacle on the junction box.
8. Mount the fuel tank assembly on the skid frame and connect the fuel tank and diesel engine fuel supply and return lines.
9. Place the pump back into service and check it for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0048 00**
UNIT MAINTENANCE PROCEDURES
RAW WATER SYSTEM

Inlet Flapper or Outlet Flange Gasket Replacement

Replace the inlet flapper assembly on the P1 or P2 pump as follows (see Figure 17):

1. Remove the four cap screws and four lock washers that attach the inlet flange to the pump housing.
2. Remove the inlet flange and the flapper assembly.
3. Clean the flange and pump housing surfaces that come in contact with the flapper assembly.
4. Install a new flapper assembly, making sure the flapper opens into the pump housing.
5. Reattach the inlet flange using the four cap screws and four lock washers.

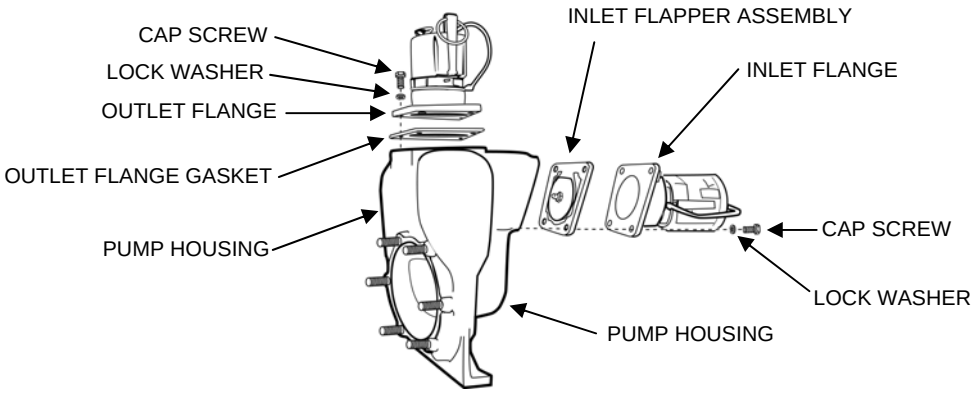

Figure 17. P1/P2 Pump Inlet Flapper Assembly and Outlet Flange Gasket Replacement.

Replace the outlet flange gasket on the P1 or P2 pump as follows (see Figure 17):

1. Remove the four cap screws and four lock washers that hold the outlet flange to the pump housing.
2. Remove the outlet flange and gasket.
3. Clean the flange and pump housing surfaces that come in contact with the gasket.
4. Install a new outlet flange gasket.
5. Reattach the outlet flange using the four cap screws and four lock washers.
6. Place the pump back into service and inspect it for leaks.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0049 00**
UNIT MAINTENANCE PROCEDURES
OCEAN INTAKE STRUCTURE SYSTEM (OISS)

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Parts (TM 10-4610-309-24P):
Backwash valve assembly
Wellpoint pipe (TM 10-4610-309-24P)
1.5 x .45 x 60 stainless steel pipe
1.5 x .45 x 24 stainless steel pipe
1.5 NPT stainless steel coupling
2.0 90-degree stainless steel elbow pipe assembly
OISS suction hose assembly
2.0 stainless steel threaded straight tee pipe assembly
3.0 stainless steel tee pipe assembly
Material:
Antiseizing tape (WP 0079, Table 1, item 30)
Personnel Required
One
Equipment Condition
OISS removed from service

GENERAL:
This procedure contains information and instructions for replacing components in the Ocean Intake Structure System (OISS) of the TWPS. If you are unable to return a component or assembly to workable condition by following the repair procedure, notify Unit Maintenance (UM).

REPLACE

Inspect each of the components of the Ocean Intake Structure System for damage that can prevent it from functioning properly and replace if necessary (see Figure 1).

Replace damaged threaded OISS components as follows:
1. Unthread the damaged threaded component from the undamaged component.
2. Discard the damaged component.
3. Clean the threads of the undamaged component using a wire brush.
4. Install pipe tape on the male threads of the components to be connected as described in General Operator Maintenance Procedures WP 0045 00.
5. Thread the female and taped male pipe sections together.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0049 00**
UNIT MAINTENANCE PROCEDURES
OCEAN INTAKE STRUCTURE SYSTEM (OISS)

Replace a damaged suction hose assembly by unclamping it from its fittings. Discard and replace the damaged hose.

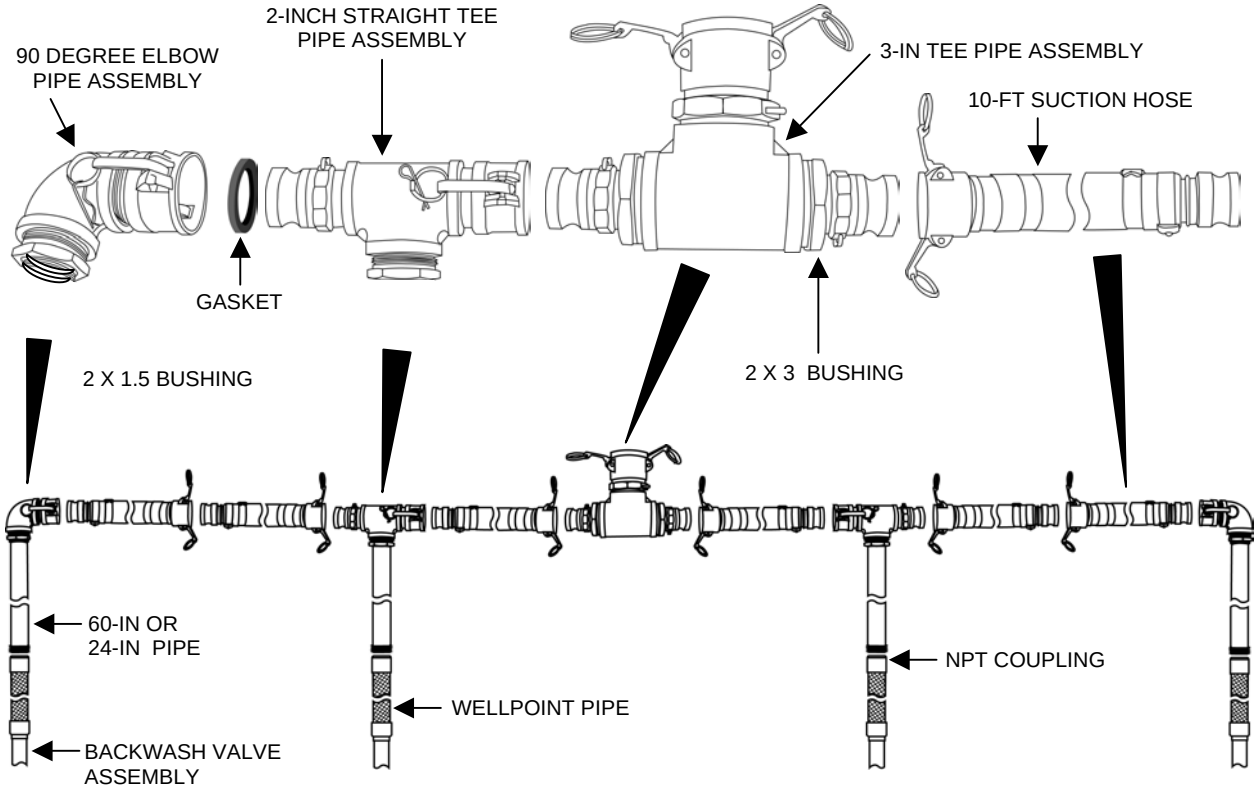

Figure 1. Ocean Intake Structure System (OISS) Components.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) UNIT MAINTENANCE PROCEDURES DIESEL ENGINE AND FUEL TANK ASSEMBLY

0050 00

THIS SECTION COVERS
Replace, Repair, Service, Adjust

INITIAL SETUP

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Torque Wrench (minimum 0-250 in.-lbs)
Reference
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS removed from service or during operation as required

GENERAL

This work package contains information and procedures for replacing and servicing/adjusting components and assemblies of the diesel engine and the removable fuel tank assembly. These procedures apply to Raw Water System pump assembly P1 and Extended Product Water Distribution System pump assembly P8.

The procedures in this work package include:

- Diesel Engine Replacement
- Air Cleaner Assembly Replacement
- Air Heater Assembly Replacement
- Electric Starter Assembly Replacement
- Muffler Assembly Replacement
- Fuel Injection Pump Replacement
- Fuel Injection Valve Replacement
- Fuel Line Assemblies Replacement
- Fuel Tank Replacement
- Fuel Filter Service/Replacement
- Fuel Cock Replacement
- Engine Oil and Oil Filter Replacement
- Recoil Starter Replacement
- Fuel Injection Valve Service
- Intake/Exhaust Valve Clearance Adjustment
- Oil Level Service (Check/Add Oil)
- Bleed the Fuel System

All procedures in this work package, except diesel engine replacement, can be performed without removing the engine/pump unit from the skid.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

REPLACE

Diesel Engine Replacement:

Parts (TM 10-4610-309-24P):
- Diesel engine
- Gasket, Outlet Flange
- Kit, Pump Seal Repair

Materials:
- Cloth, Abrasive (WP 0079, Table 1, item 15)
- Engine Lubricating Oil, 1 qt. (WP 0079, Table 1, item 27)
- Corrosion Preventive Compound (WP 0079, Table 1, item 17)
- Glycerin (WP 0079, Table 1, item 21)
- Container for collecting engine lubricating oil
- Clean, dry rags (WP 0079, Table 1, item 33)
- Sealing Compound (WP 0079, Table 1, item 35)

Equipment Condition:
- Diesel engine shut off and removed from the system

WARNING

If the engine has been running, the engine, its muffler and other components may be hot. Allow the engine and its components to cool before handling. Failure to observe this warning can result in burns.

NOTE

The engine and pump are bolted together. In order to replace the engine, the engine and pump assembly must be removed from the skid as a unit.

1. Remove the engine/pump assembly from the skid as follows:
   a. On the fuel tank assembly, close the fuel cock and uncouple the fuel supply and return line quick disconnect couplings (see Figure 1).

CAUTION

Potential cause of fuel pump and injection valve failure. Do not leave the fuel lines for the diesel engine and fuel tank disconnected. Failure to observe this caution may allow sand and dirt to enter the fuel system and result in fuel pump and injection valve failure.

   b. Couple the two tank fuel lines together and the two diesel engine fuel lines together.
   c. Lift the fuel tank assembly off the skid.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

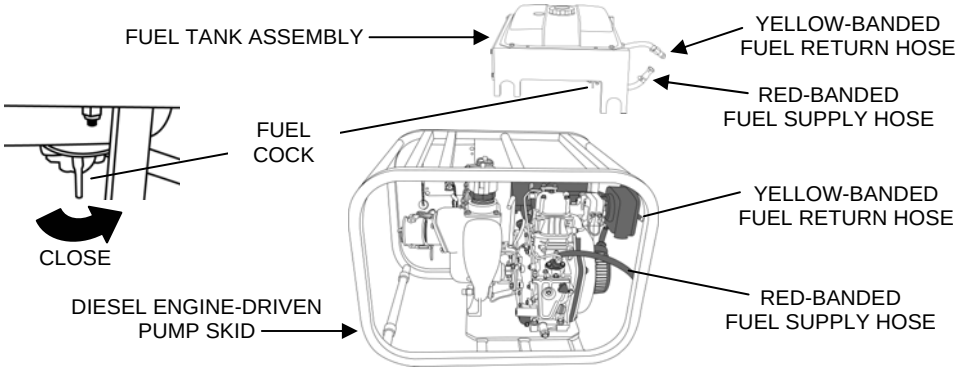

Figure 1. Diesel Engine Fuel Tank Assembly Removal.

d. Pull the recoil starter cord out a little, secure the rope, slip the handle down the rope and untie or cut off the knot at the end of the rope (see Figure 2).
e. Remove the handle from the rope and pull the rope end out of the eye bolt.
f. Slide the handle back onto the rope end and knot the end of the rope. Let the rope and handle retract to the recoil starter.

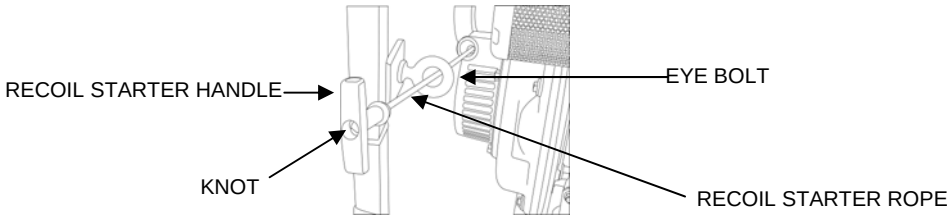

Figure 2. Recoil Starter Cord Removal / Installation from / into Rope Guide.

g. Open the pump drain valve and drain any water remaining in the pump, then close the valve (see Figure 3).
h. Drain the oil from the engine as described elsewhere in this work package.
i. Remove the oil drain extension and gaskets. Reinstall the drain plug on the engine so any remaining oil does not drip out.
j. Remove the exhaust shield plate that is attached to the top of the muffler assembly.

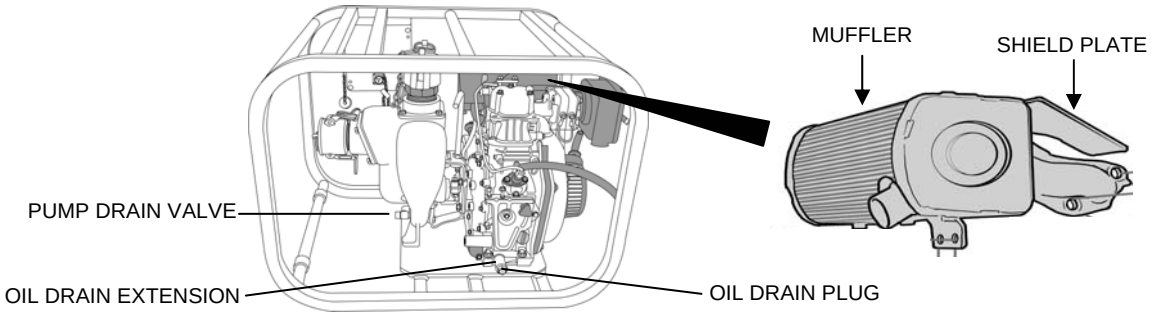

Figure 3. Diesel Engine Pump Drain, Oil Drain Extension, and Muffler Shield Plate.

k. Tag and disconnect the blue, red, and red-banded gray wires from the two terminals on the engine starter solenoid (see Figure 4).
l. Tag and disconnect the yellow wire from the front terminal of the air heater.
m. Disconnect the green ground wire from the rear terminal of the air heater, and the yellow jumper wire between the two terminals on the opposite side of the air heater.
n. Remove the green and black-banded gray wires from the ground connection on the engine case.
o. Remove the two bolts, flat washers, and lock washers that attach the power connector assembly to the side of the engine. Remove the connector assembly.
p. Remove the fuel supply and return line assemblies and clamps.
q. Remove the 4 bolts, flat washers, and lock washers that secure the engine/pump unit to the skid.

WARNING

Two person lift. Two people are required to safely move the engine/pump unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

r. Slide the engine/pump assembly out the side of the skid.

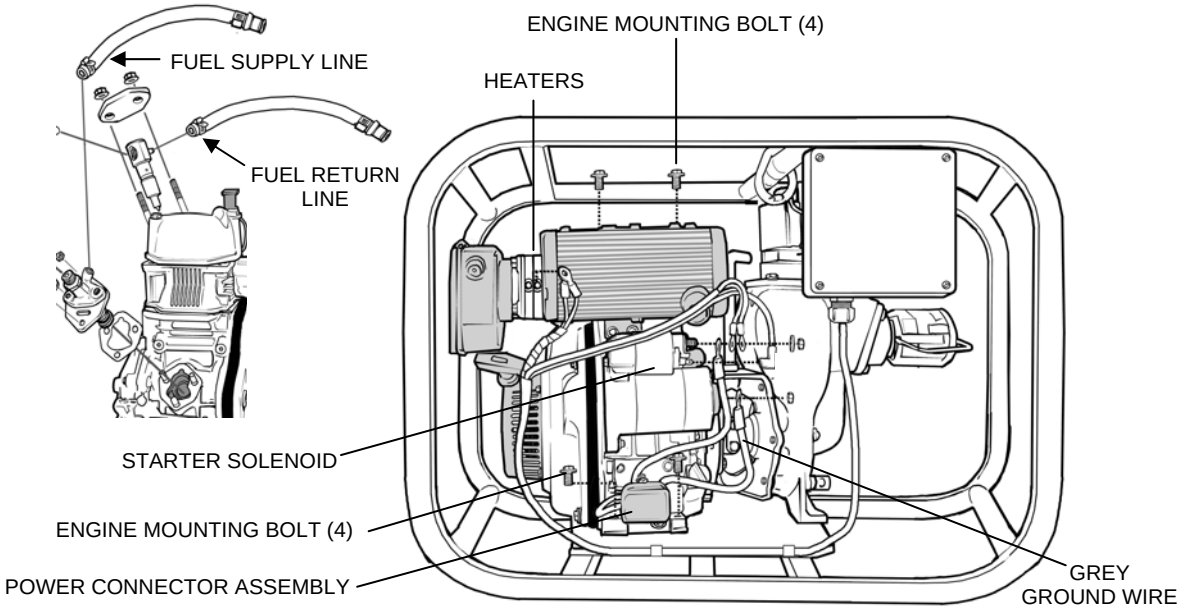

Figure 4. Removal of Diesel Engine from Skid.

NOTE

The pump must be taken apart to disconnect it from the engine. This is because the impeller clearance must be set when the pump is installed on the new engine. The pump seal seat, seal assembly, drive sleeve, and housing gasket will also be replaced.

2. Remove the pump and adapter from the engine as follows (see Figure 5):
    a. Remove the six nuts that attach the pump housing to the adapter.
    b. Loosen and remove the pump housing and gasket. Discard the gasket.
    c. Remove the coupling clamp assembly.
    d. Carefully pry the drive sleeve/impeller assembly off the engine drive shaft.
    e. Remove the retaining nut that attaches the drive sleeve to the pump impeller. Remove and discard the drive sleeve and the seal assembly.
    f. Remove the four bolts, four lock washers, and four flat washers that attach the adapter to the engine.
    g. Push the seal seat out of the adapter and discard it.

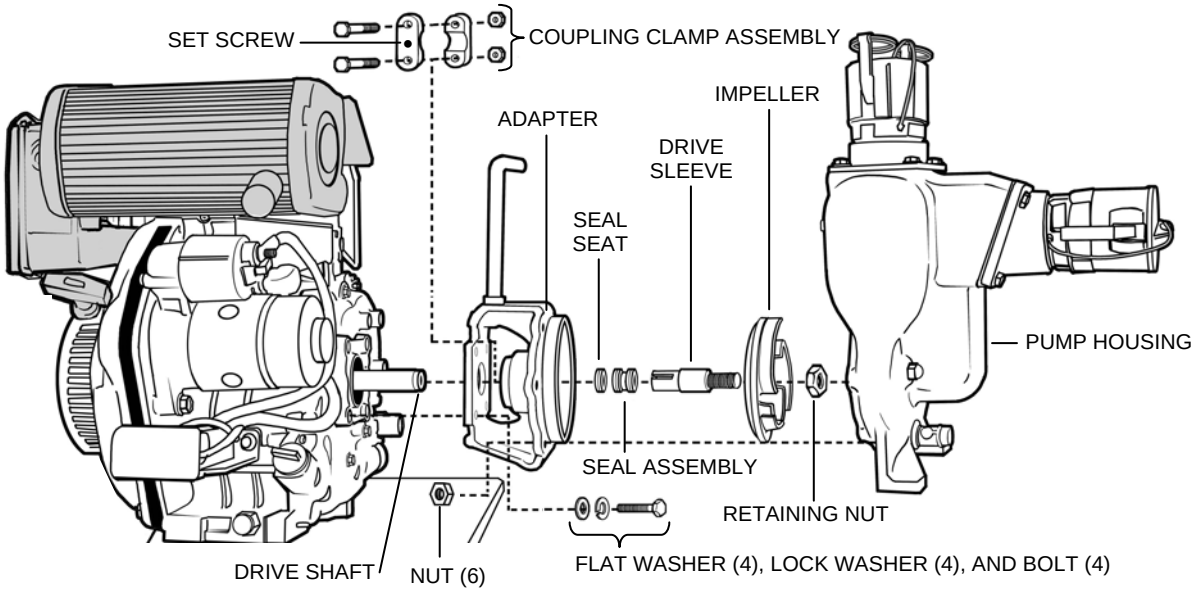

Figure 5. Pump Removal.

3. Prepare the new engine for installation as follows:
    a. Remove the oil drain plug from the new engine. Install the oil drain extension and washers that were removed from the old engine. Install the drain plug on the extension (see Figure 3).
    b. Install the power connector assembly onto the side of the engine using the two bolts, two flat washers, and two lock washers (see Figure 4).
    c. Install the fuel supply and return lines (see Figure 4).

NOTE

The fuel lines are color coded and are not interchangeable. Install the red-coded (supply) line on the fuel injection pump and the yellow-coded (return) line on the fuel injection valve.

    d. Install the exhaust shield plate on the top of the muffler assembly (see Figure 3).
4. Install the adapter and pump onto the new engine as follows (see Figure 5):
    a. Polish the engine drive shaft with fine abrasive cloth to remove any rust or corrosion.

b. Clean the bore and mounting faces of the adapter.
c. Lubricate the new seal seat with glycerin.
d. Insert the beveled end of the seal seat into the adapter bore and press it in until it is seated.
e. Attach the adapter to the engine using 4 bolts, 4 flat washers, and 4 lock washers.
f. Insert the new drive sleeve into the impeller from the flat side and secure it with the retaining nut.
g. Lubricate the inner diameter of the new seal assembly with glycerin. With the rubber boot end toward the impeller, twist and slide the seal assembly onto the drive sleeve.
h. Lubricate the engine drive shaft and the inside diameter of the new drive sleeve with corrosion preventive compound.

CAUTION

Improper assembly can cause damage to the drive sleeve and engine drive shaft. Do NOT place a key between the drive shaft and drive sleeve. Do NOT force the sleeve onto the shaft. Failure to observe this caution can make impeller clearance adjustments and future removal of the drive sleeve difficult, and may cause damage to the drive sleeve and/or engine drive shaft.

NOTE

If the drive sleeve does not easily slide onto the shaft, it may be necessary to remove burrs from the shaft.

i. Slide the impeller and drive sleeve assembly onto the engine drive shaft.
j. Place a new housing gasket between the adapter and the pump housing.
k. Fit the pump onto the adapter and thread a nut on two opposing threaded studs to secure the pump to the adapter. Tighten the two nuts.

5. Set the gap between the impeller and the pump wear plate as follows (see Figure 6):
   a. Remove the four cap screws and four lock washers that secure the outlet flange to the pump housing.
   b. Carefully remove the pump flange to avoid damaging the gasket between the flange and the pump housing.
   c. If the gasket is damaged, replace it.
   d. Look through the outlet into the pump. Turn the impeller drive sleeve and impeller by hand until you see the impeller near the wear plate.
   e. Insert a 0.015 – inch feeler gauge between the impeller and wear plate. Move the impeller forward or backward as needed to provide a gap of 0.015 to 0.017-inch.
   f. Make sure the coupling clamp set screw, a drive sleeve slat, and the motor shaft keyway are aligned.
   g. Tighten the coupling clamp assembly to secure the impeller drive sleeve to the engine drive shaft.

CAUTION

New engines are shipped without lubricating oil. Add oil to the engine before operating it or equipment damage will result.

h. Add oil to the new engine. Refer to **SERVICE/ADJUST** and **Oil Level**.
i. Turn the engine drive shaft slowly to rotate the impeller by pulling on the hand starter.
j. Make sure that there is a minimum gap of 00.015-inch between the impeller and wear plate through the entire rotation of the impeller.
k. Torque the coupling clamp assembly nuts to 216 in.-lbs.
l. Tighten the coupling clamp set screw into the drive shaft keyway.

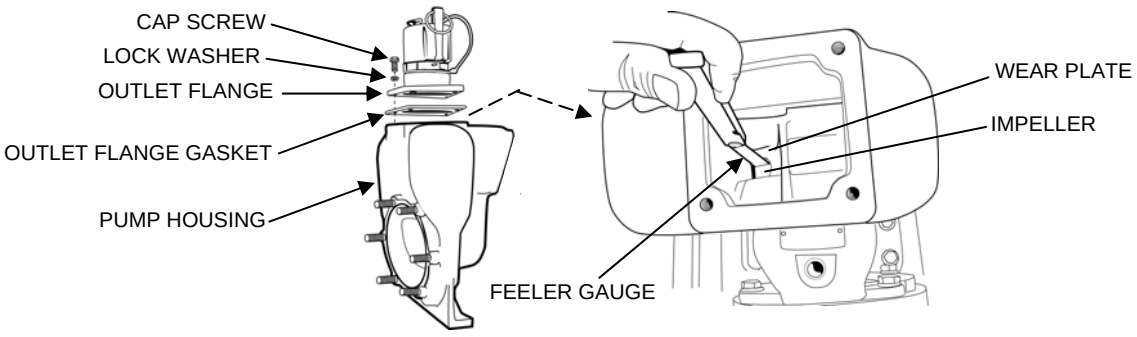

Figure 6. Impeller Clearance Adjustment.

6. Complete the pump installation as follows:
   a. Apply sealing compound to the threads of the remaining four threaded studs extending from the pump housing through the adapter (WP 0079, Table 1, item 25). Install the nuts onto the studs.
   b. Remove the two nuts initially installed onto opposing studs. Apply sealing compound to the stud threads and reinstall the nuts (WP 0079, Table 1, item 25).
   c. Reinstall the pump outlet flange and gasket.
7. Install the engine/pump assembly on the pump skid as follows (see Figure 4):

WARNING

Two person lift. Two people are required to safely move the engine/pump assembly. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   a. Position the engine/pump unit on the skid and bolt it in place using four bolts, flat washers, and lock washers.
   b. Connect the blue, red, and red-banded gray wires to the two terminals on the engine starter solenoid.
   c. Connect the green and black-banded gray wires to the ground connection on the engine case. Connect the other end of the green wire to the rear terminal of the air heater.
   d. Connect the yellow wire to the front terminal of the air heater.
   e. Connect the yellow jumper wire between the two terminals on the opposite side of the air heater.
   f. Pull the recoil starter rope out past the skid frame, secure the rope, slip the handle down the rope and untie or cut off the knot at the end of the rope (see Figure 2).
   g. Remove the handle from the rope and thread the rope through the eye bolt.
   h. Slide the handle back onto the rope end and knot the end of the rope. Let the rope and handle retract to the eye bolt.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Air Cleaner Assembly Replacement:

Parts (TM 10-4610-309-24P):
Air cleaner assembly
Gasket

Replace the air cleaner assembly as follows (see Figure 7):
1. Remove the air cleaner cover nut and pull off the cover.
2. Remove the air filter element.
3. Remove the three bolts that secure the air cleaner case to the air intake bend cap. Remove the case and gasket.
4. Install the new air cleaner case and gasket and secure with the three bolts.
5. Reinstall the air filter element or replace with a new element.
6. Install the new air cleaner cover and secure it with the cover nut.

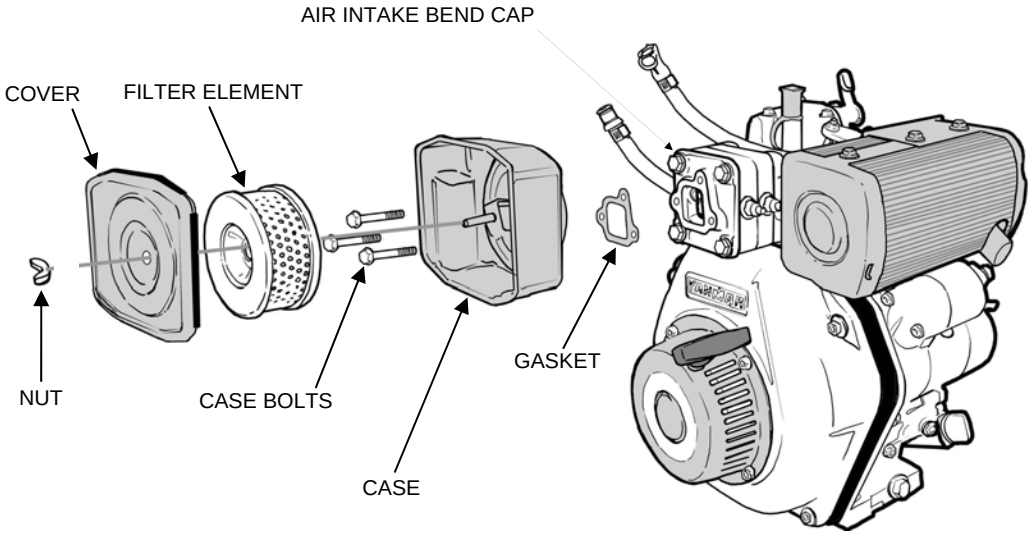

Figure 7. Air Cleaner Assembly Removal.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Air Heater Assembly Replacement:

Parts (TM 10-4610-309-24P):
Heating Element (one or two as required)
Gasket (as required)

Replace the air heaters as follows (see Figure 8):
1. Remove the air cleaner assembly. Refer to **REPLACE** and **Air Cleaner Assembly**.
2. Tag and disconnect the yellow (power) and green (ground) wires from the heating elements. Remove the short yellow jumper wire between the terminals of the two elements.
3. Remove the four bolts that secure the heating elements to the air intake bend cap. Remove the cap, elements, and metal gaskets.
4. Inspect the metal gaskets for damage and replace as required.
5. Install the air intake bend cap, gaskets, and heating elements, and secure them with the four bolts.
6. Reattach the power, ground, and jumper wires to the heating elements.
7. Reinstall the air cleaner assembly.

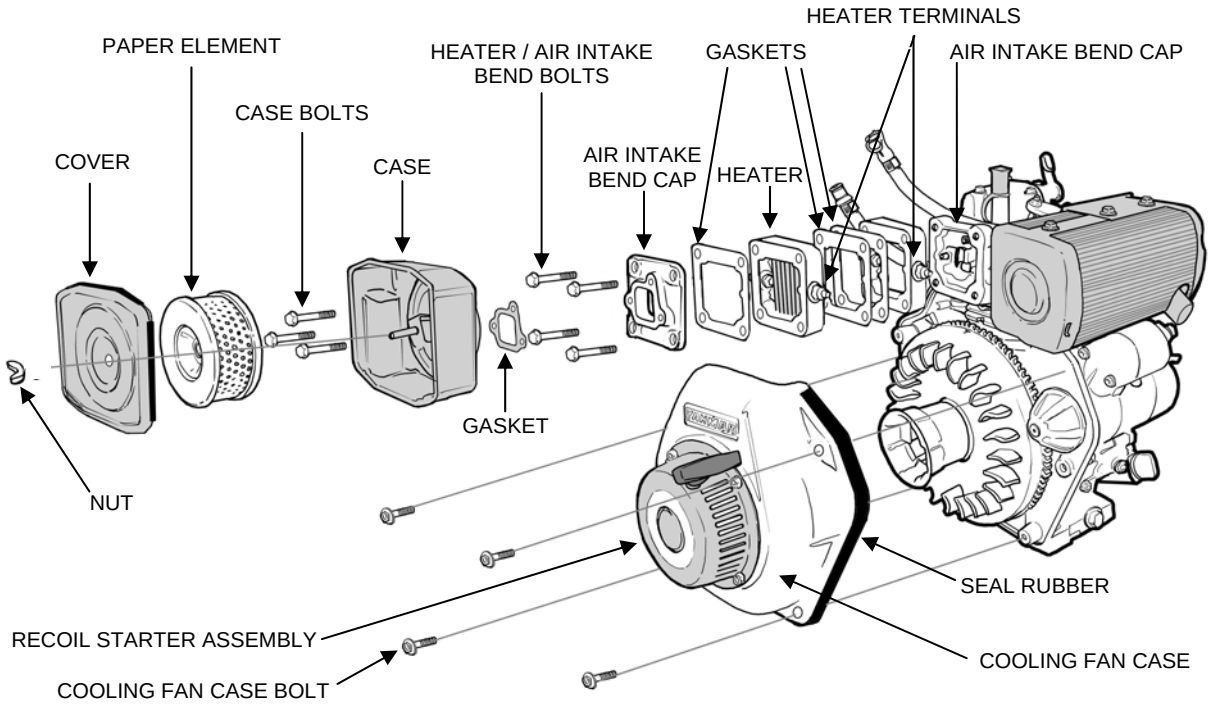

Figure 8. Air Heater Assembly Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Electric Starter Assembly Replacement:

Parts(TM 10-4610-309-24P):
Starter assembly

Replace the electric starter assembly as follows (see Figure 9):

1. Tag and disconnect the blue and red, and black-banded gray wires from the two terminals on the starter solenoid.
2. Unbolt and remove the starter assembly.
3. Install the new starter using the two bolts.
4. Connect the wires to the two terminals on the starter solenoid.

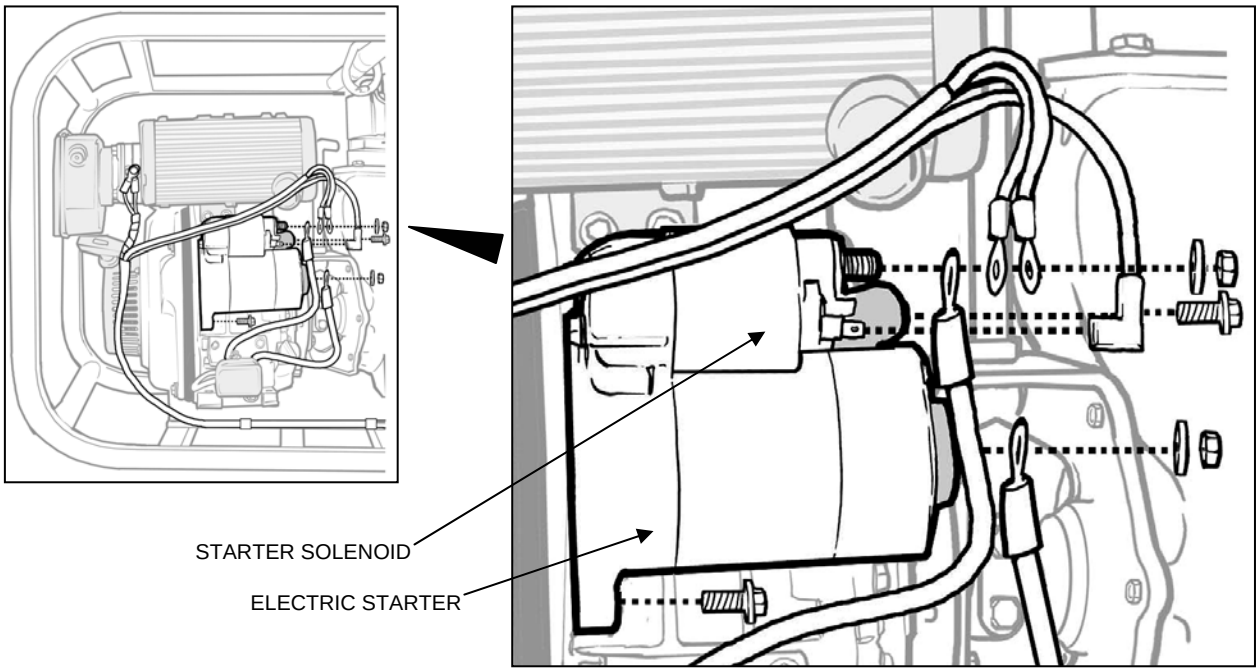

Figure 9. Electric Starter Removal.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Muffler Assembly Replacement:

Parts (TM 10-4610-309-24P):
Muffler assembly
Gasket

Replace the muffler assembly as follows (see Figure 10):

WARNING

If the engine has been running, the muffler may be hot. Allow the muffler to cool before handling. Failure to observe this warning can result in burns.

1. Remove the fuel tank assembly. Refer to **REPLACE** and **Diesel Engine**.
2. Unbolt and remove the exhaust shield plate from the top of the muffler assembly.
3. Remove the two nuts and the two bolts that attach the muffler assembly to the engine. Remove and discard the muffler assembly.
4. Scrape any remaining gasket material off the cylinder head.
5. Attach the new gasket and muffler assembly using the two nuts and two bolts.
6. Install the exhaust shield plate on the top of the muffler assembly with two bolts.
7. Install the fuel tank assembly.

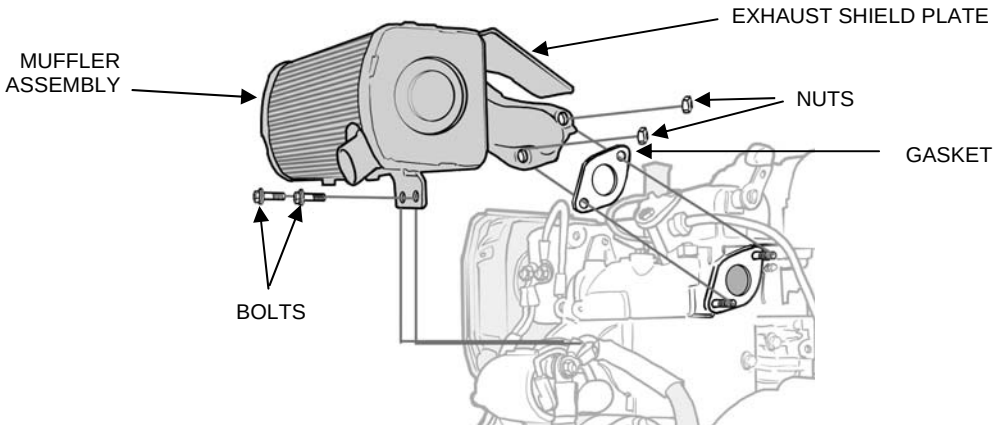

Figure 10. Muffler Assembly Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Fuel Injection Pump Replacement:

Parts (TM 10-4610-309-24P):
Fuel injection pump
Materials:
Dry rag (WP 0079, Table 1, item 33)

Replace the fuel injection pump as follows (see Figure 11):

WARNING

If the engine has been running, it may be hot enough to ignite any fuel that leaks out during fuel system maintenance. Make sure that the engine and its parts are cool to the touch before disassembling any part of the fuel system. Failure to observe this warning can result in a fire and serious personal injury.

1. Remove the fuel tank assembly from the pump skid. Refer to **REPLACE** and **Diesel Engine**.
2. Remove the fuel supply hose assembly, clamp, and fuel injection pipe.

NOTE
Be careful not to bend the fuel injection pipe while removing it.

3. Remove the three injection pump mounting nuts, inspection window cover, and gasket.
4. Pull the fuel injection pump out of the engine and set it aside, using a rag to catch any fuel that may drip out.

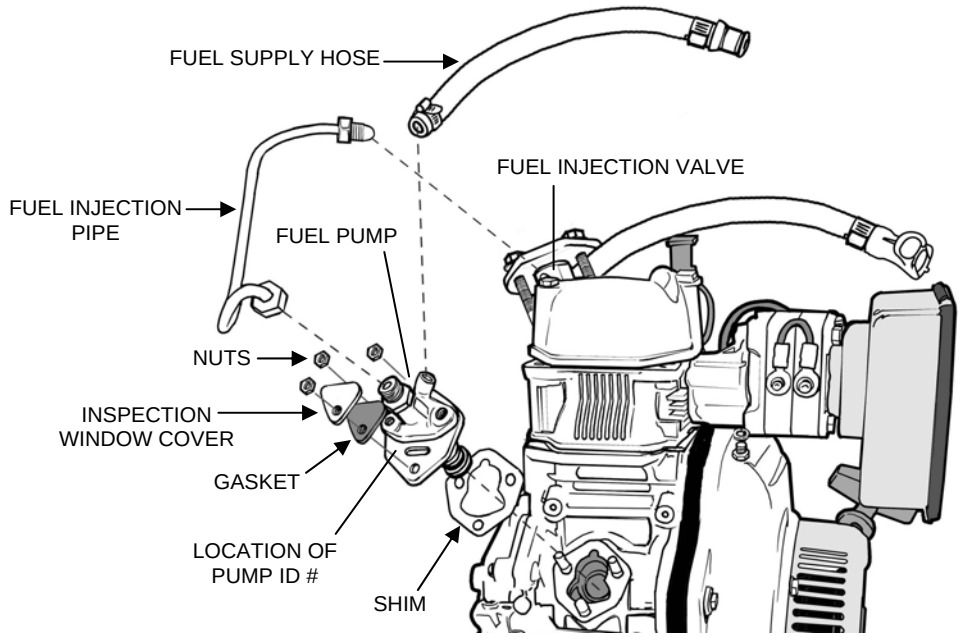

Figure 11. Fuel Injection Pump Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

NOTE

The metal shim under the fuel injection pump base plate is required for proper operation. Be sure the shim is in place when replacing the fuel injection pump.

5. Verify that the ID number stamped on the left side of the new pump's base plate matches the ID number (48R) on the old pump.

NOTE

Do NOT install the new pump if the ID number doesn't match. Fuel injection pumps are not interchangeable between engine models. Be sure to properly orient the pump when installing it.

6. Install the shim, the new pump and the inspection window cover and gasket. Fasten them in place using the three nuts. Torque the nuts to 95-113 in.-lbs.
7. Reattach the fuel injection pipe to the pump and fuel injection valve.
8. Reinstall the fuel supply hose assembly using the clamp.

After replacing the fuel injection pump, bleed the fuel system of trapped air as follows (see Figure 12):

1. Install the fuel tank assembly on the pump skid and connect the fuel supply and return line quick disconnect couplings.
2. If necessary, pour a small amount of fuel into the tank.
3. Open the fuel cock.
4. Place the engine speed control knob at the Start position.
5. Disconnect the fuel injection pipe from the fuel injection valve.
6. Push the engine decompression lever down (non-compression position) and hold it there.
7. Place a rag in front of the disconnected end of the fuel injection pipe.
8. Pull the recoil starter. Stop when you see fuel spraying out the fuel injection pipe.
9. Reconnect the fuel injection pipe to the fuel injection valve.

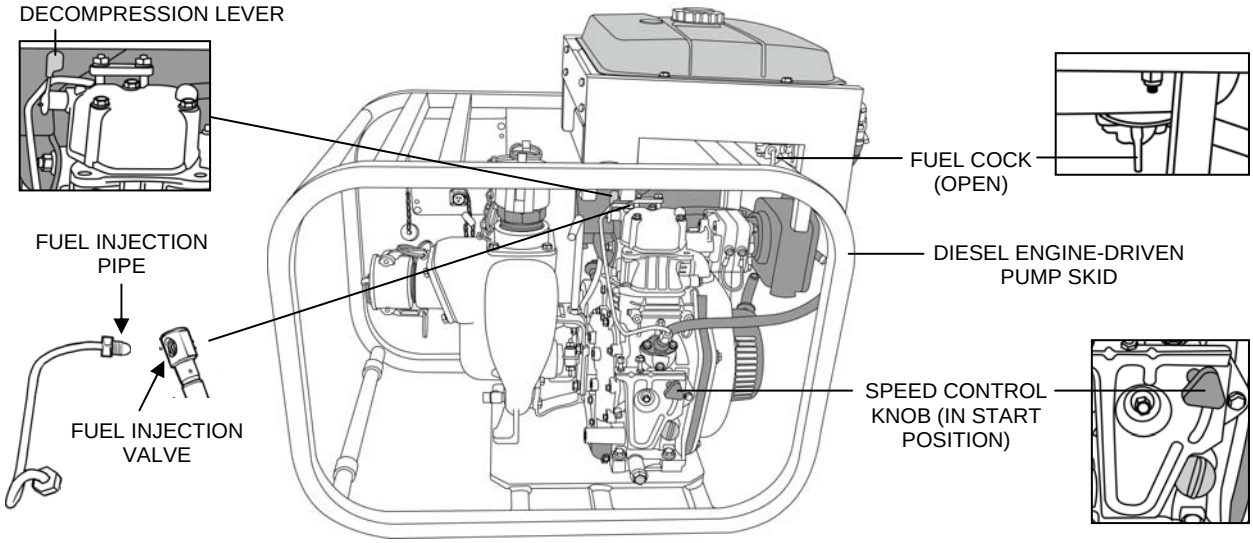

Figure 12. Diesel Engine Fuel System Bleed.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Fuel Injection Valve Replacement:

Parts (TM 10-4610-309-24P):
Fuel injection valve
Nozzle spacer sleeve
Materials:
Clean rags (WP 0079, Table 1, item 23)

Remove the fuel injection valve as follows (see Figure 13):

WARNING

If the engine has been running, it may be hot enough to ignite any fuel that leaks out during fuel system maintenance. Make sure that the engine and its parts are cool to the touch before disassembling any part of the fuel system. Failure to observe this warning can result in a fire and serious personal injury.

1. Remove the fuel tank assembly from the pump skid. Refer to **REPLACE** and **Diesel Engine**.
2. Remove the fuel return hose assembly and clamp.
3. Disconnect the fuel injection pipe from the fuel injection valve.
4. Remove the two nuts and retaining plate from the top of the valve.

CAUTION

When removing the fuel injection valve, be careful not to damage the nozzle spacer and nozzle spacer sleeve. When setting the valve down, wrap it in a cloth to protect the nozzle tip. Do not place the nozzle tip directly on the ground. Failure to observe this caution may result in damage to the nozzle tip or spacer sleeve.

5. Carefully pull the valve out of the cylinder head. If it does not come out easily, temporarily reconnect the fuel injection pipe and gently pry up on the connection nut to loosen the valve.
6. Remove the nozzle spacer sleeve.

NOTE

The spacer sleeve may stick in the cylinder head when you remove the fuel injection valve. Be sure to remove the spacer sleeve before installing the new valve.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

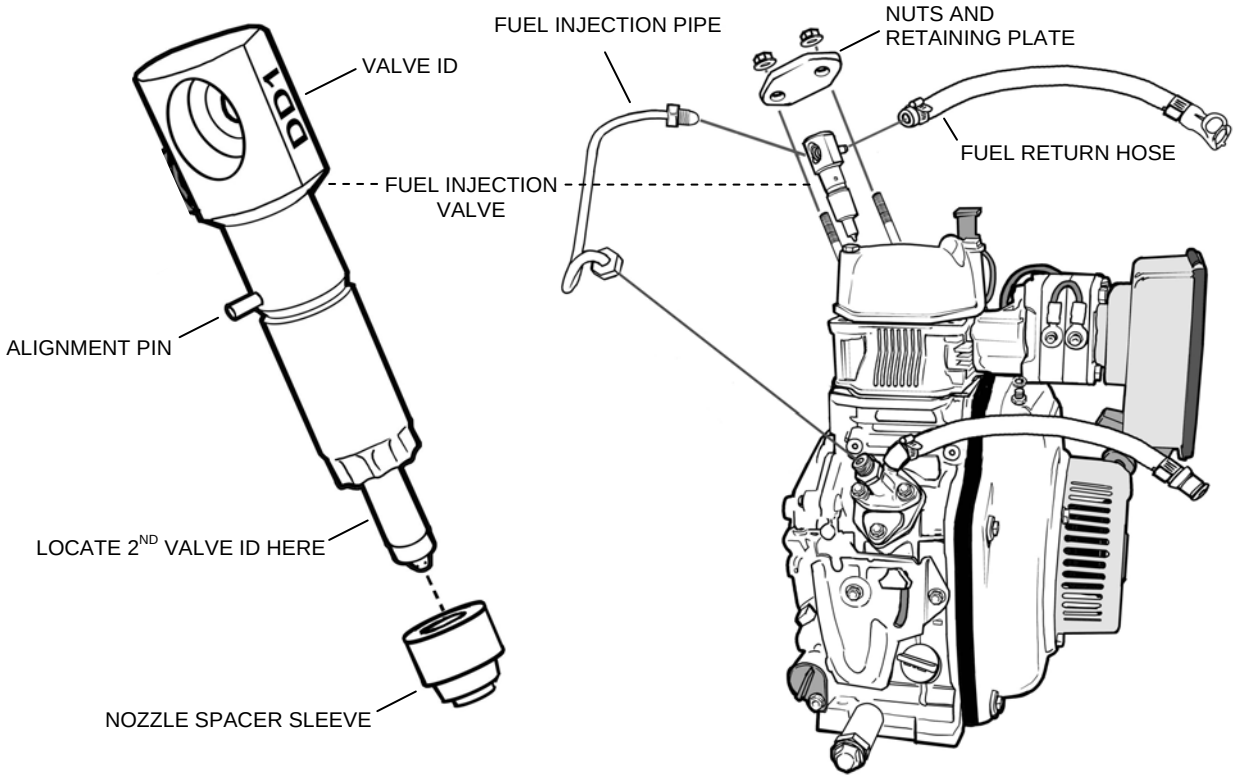

Figure 13. Fuel Injection Valve Replacement.

Install the new fuel injection valve as follows (see Figure 13):

NOTE
Wipe any dirt or residue from around the cylinder head sleeve where the fuel injection valve is inserted. Wipe out from the opening to prevent dirt from falling into the sleeve opening.

1. Verify that the two identification numbers on the new valve match those on the old valve.

NOTE
Do NOT install the new valve if the numbers don't match. Fuel injection valves are not interchangeable between engine models.

2. Install the nozzle spacer sleeve onto the valve.
3. Verify that the small alignment pin is in place on the side of the valve.
4. Line up the alignment pin with the slot in the cylinder head and insert the valve.
5. Install the retaining plate using two nuts. Torque the nuts to 95-113 in-lbs.
6. Attach the fuel injection pipe and fuel return hose assembly.
7. Reinstall the fuel tank assembly on the pump skid.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Fuel Line Assemblies Replacement:

Parts (TM 10-4610-309-24P):
- Engine fuel supply line assembly
- Engine fuel return line assembly
- Fuel tank fuel supply line assembly
- Fuel tank fuel return line assembly

Materials:
- Container for collecting drainage from the fuel tank
- Clean rags (WP 0079, Table 1, item 23)

Replace either fuel line assembly on the fuel tank as follows (see Figure 15):

1. Remove the fuel tank assembly from the pump skid. Refer to **REPLACE** and **Diesel Engine**.
2. If necessary, drain the contents of the tank into a container.
3. Loosen the screw clamp and remove the fuel line assembly. Discard the assembly and clamp.
4. Install the new fuel line assembly and clamp.

NOTE

The supply line (coded red) attaches to the fuel cock, and the return line (coded yellow) attaches to the fitting on the side of the fuel tank. The lines have different diameters and are not interchangeable.

5. Reinstall the fuel tank assembly onto the pump skid.

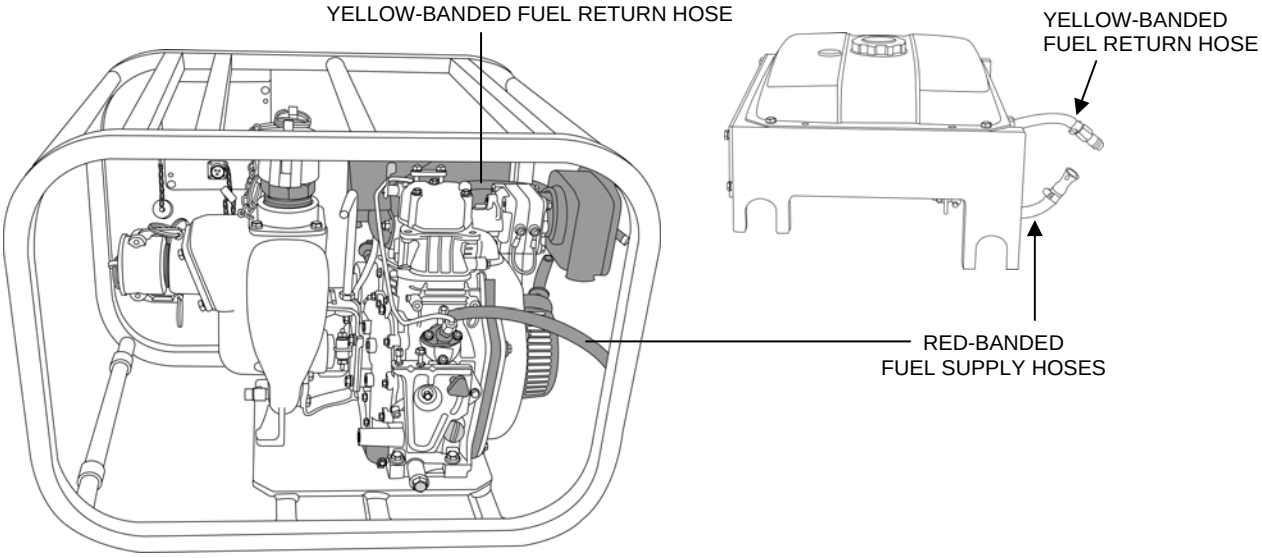

Figure 14. Diesel Engine Fuel Line Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Replace either fuel line assembly on the engine as follows (see Figure 14):

1. Loosen the screw clamp and remove the fuel line assembly. Discard the assembly and clamp.
2. Install the new fuel line assembly and clamp.

NOTE

The supply line (coded red) attaches to the fuel pump, and the return line (coded yellow) attaches to the fuel injection valve. The lines have different diameters and are not interchangeable.

Fuel Tank Replacement:

Parts (TM 10-4610-309-24P):
Fuel tank
Materials:
Container for collecting drainage from the fuel tank
Clean rags (WP 0079, Table 1, item 23)

Replace the fuel tank as follows (see Figure 15):

NOTE
The new fuel tank will already have a screen filter and fuel filter installed.

1. Remove the fuel tank assembly from the pump skid. Refer to **REPLACE** and **Diesel Engine**.
2. Remove the drain plug and drain the contents of the tank into a container.
3. Remove the supply and return fuel line assemblies and clamps.
4. Remove the four cap screws, four lock washers, and four flat washers that attach the fuel tank to the frame. Remove and discard the tank.
5. Attach the new tank to the frame using four cap screws, four lock washers, and four flat washers. Be sure the tank is oriented so the fuel cock is toward the end of the frame with the longer legs.
6. Attach the supply and return fuel line assemblies using the two clamps.

NOTE
The fuel lines are color coded and are not interchangeable. The supply line is coded red and the return line is coded yellow.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

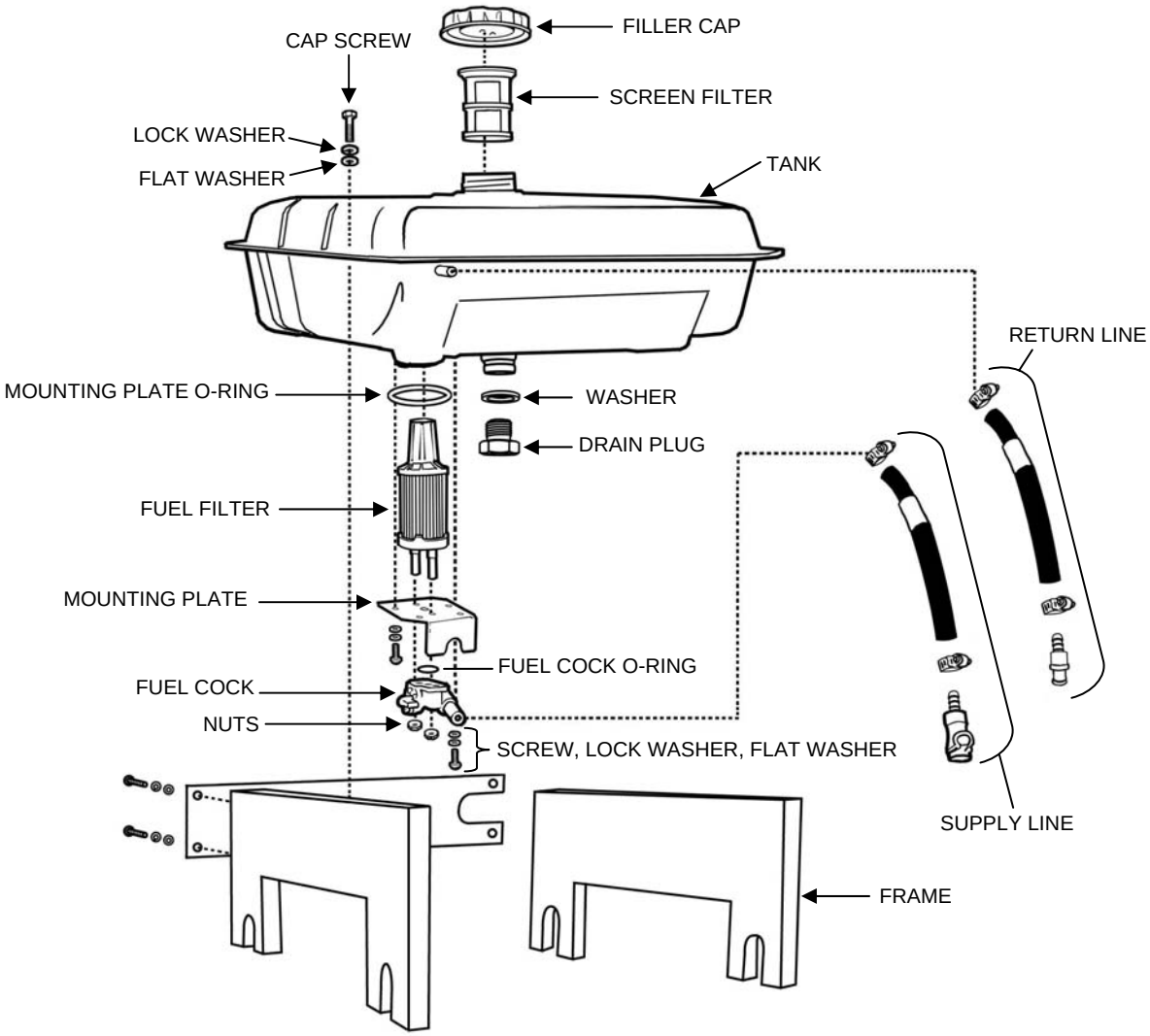

Figure 15. Fuel Tank Assembly Components.

Fuel Filter Service / Replacement:

Parts (TM 10-4610-309-24P):
- Screen filter
- Fuel Filter
- O-ring (mounting plate)

Materials:
- Container for collecting drainage from the fuel tank
- Clean diesel fuel for cleaning the filters

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Clean or replace the fuel filters as follows (see Figure 15):

1. Remove the fuel tank assembly from the pump skid. Refer to **REPLACE** and **Diesel Engine**.
2. Remove the drain plug and washer and drain the tank's contents into a container. Reinstall the plug and washer when the tank is empty.
3. Remove the filler cap and lift out the screen filter. Clean or replace it as necessary. Reinstall the screen filter and filler cap.
4. Remove the three screws, flat washers, and lock washers that attach the fuel cock assembly to the tank. Lift the assembly straight out until the fuel filter is clear of the tank. Remove and discard the mounting plate O-ring.
5. To replace the filter, remove the two nuts that attach it to the fuel cock. Remove and discard the filter. Attach a new filter to the fuel cock using the two nuts. Be sure that the small O-ring on the fuel cock is in place.
6. If the filter is not being replaced, clean it with clean diesel fuel.
7. Reinstall the fuel cock assembly on the tank using a new mounting plate O-ring and three screws, flat washers, and lock washers.

Fuel Cock Replacement:

Parts (TM 10-4610-309-24P):
Fuel Cock
O-ring
Materials:
Container for collecting drainage from the fuel tank
Clean rags (WP 0079, Table 1, item 23)

Replace the fuel cock as follows (see Figure 15):

1. Remove the fuel tank from the pump skid and drain. Refer to **REPLACE** and **Diesel Engine**.
2. Remove the fuel supply line and clamp from the fuel cock.
3. Remove the three screws, three lock washers, and three flat washers that attach the fuel cock assembly to the tank. Lift the assembly straight out until the fuel filter is clear of the tank. Remove and discard the mounting plate O-ring.
4. Remove the two nuts that attach the fuel cock to the fuel filter. Discard the fuel cock.
5. Attach the new fuel cock to the fuel filter using two nuts. Be sure the small O-ring on the fuel cock is in place.
6. Install the fuel cock assembly on the tank using a new mounting plate O-ring and three screws, three lock washers, and three flat washers.
7. Attach the fuel supply line assembly to the fuel cock using the clamp.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Engine Oil and Oil Filter Replacement:

Parts (TM 10-4610-309-24P)l:
Oil filter
Oil filter o-ring
Engine lubricating oil (BII) (WP 0079, Table 1, item 19)
Materials:
Approve container for collecting oil drained from the engine
Clean rags (WP 0079, Table 1, item 23)

Replace the engine oil and oil filter as follows (see Figure 16):

NOTE
Make sure the engine is sitting level so all of the oil will drain out.

1. Position a container below the oil drain plug.
2. Remove the oil filler cap/dipstick.
3. Remove the drain plug and drain the oil. Reinstall the drain plug after all the oil has drained out.
4. Remove the oil filter lock bolt.
5. Remove and discard the oil filter and the filter O-ring.
6. Install the replacement oil filter and O-ring and secure with the lock bolt.

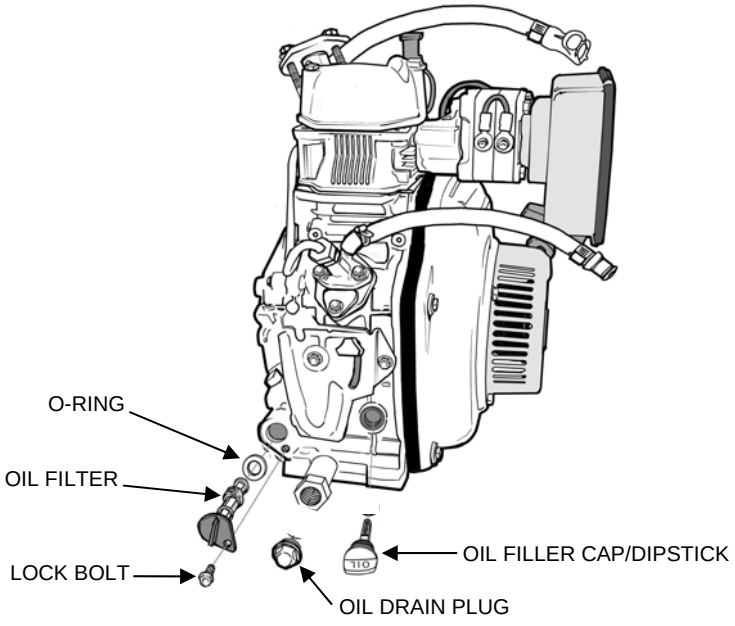

Figure 16. Engine Oil and Filter Replacement.

7. Fill the crankcase with oil until the level reaches the full mark on the dipstick (approximately 3/4 of a quart).
8. Screw the oil filler cap/dipstick back into the filler port.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Recoil Starter Replacement:

Parts (TM 10-4610-309-24P):
Recoil starter assembly

Replace the recoil starter as follows (see Figure 17):

1. Pull the recoil starter cord out a little, secure the rope, slip the handle down the rope and untie or cut off the knot at the end of the rope.
2. Remove the handle from the rope and pull the rope end out of the eye bolt.
3. Slide the handle back onto the rope end and knot the end of the rope. Let the rope and handle retract to the recoil starter.
4. Remove the 4 bolts that attach the recoil starter to the cooling fan case. Remove the starter.
5. Attach the new recoil starter to the cooling fan case with the four bolts.
6. Pull the recoil starter rope out past the skid frame, secure the rope, slip the handle down the rope and untie or cut off the knot at the end of the rope.
7. Remove the handle from the rope and thread the rope through the eye bolt.
8. Slide the handle back onto the rope end and knot the end of the rope. Let the rope and handle retract to the eye bolt.

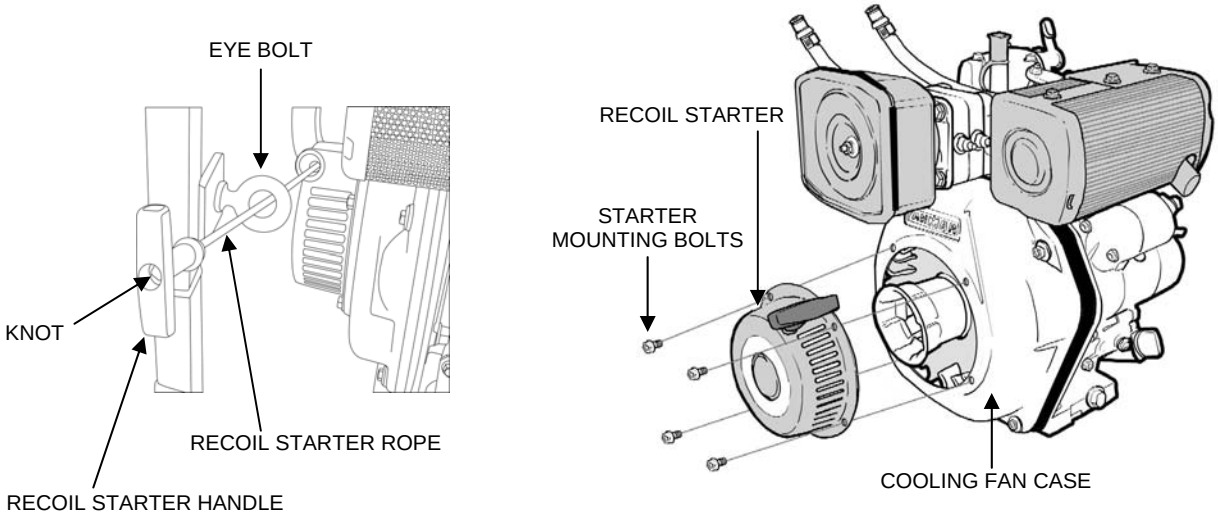

Figure 17. Recoil Starter Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

SERVICE/ADJUST

Fuel Injection Valve Service:

Parts (TM 10-4610-309-24P):
Nozzle gasket
Material:
Clean rags (WP 0079, Table 1, item 23)

Clean a clogged fuel injection valve as follows (see Figure 18):

WARNING

If the engine has been running, it may be hot enough to ignite any fuel that leaks out during fuel system maintenance. Make sure that the engine and its parts are cool to the touch before disassembling any part of the fuel system. Failure to observe this warning can result in a fire and serious personal injury.

1. Remove the fuel injection valve from the engine. Refer to **REPLACE** and **Fuel Injection Valve**.
2. Check the fuel injection valve nozzle tip for carbon deposits.

NOTE

Carbon deposits build up on the nozzle in the form of flowers. Flowering significantly lowers combustion performance.

3. Clean the carbon deposits off of the nozzle tip, and especially around the four fuel injection ports, by wiping the exterior with a clean rag.

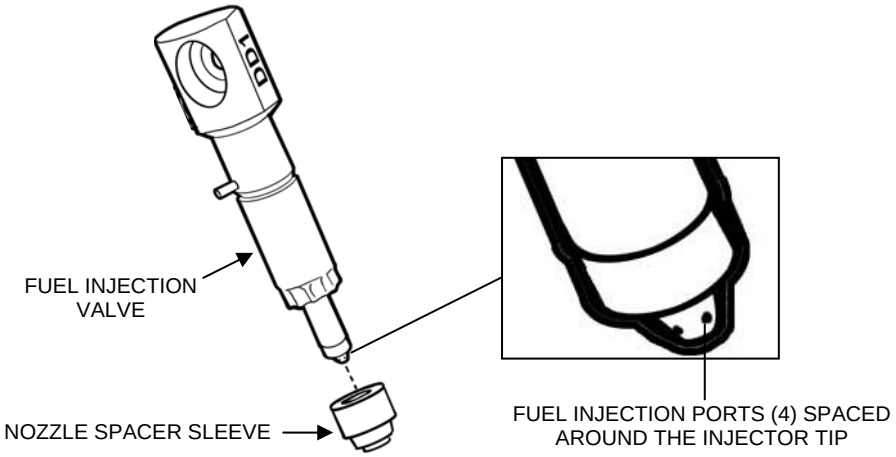

Figure 18. Fuel Injection Valve Nozzle Tip.

4. Reinstall the fuel injection valve. Refer to **REPLACE** and **Fuel Injection Valve**.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Intake and Exhaust Valve Clearance Adjustment:

Parts (TM 10-4610-309-24P):
Cylinder head cover gasket

Remove the cooling fan case and cylinder head cover as follows (see Figure 19):

1. Remove the four bolts with washers securing the cooling fan case and lift the cooling fan case off the engine.

CAUTION

Be careful not to damage the fins on the flywheel.

2. Remove the rubber detent plunger from the oil port.
3. Remove the three cylinder head cover bolts and lift cover off of the cylinder head. Remove and discard the cover gasket.

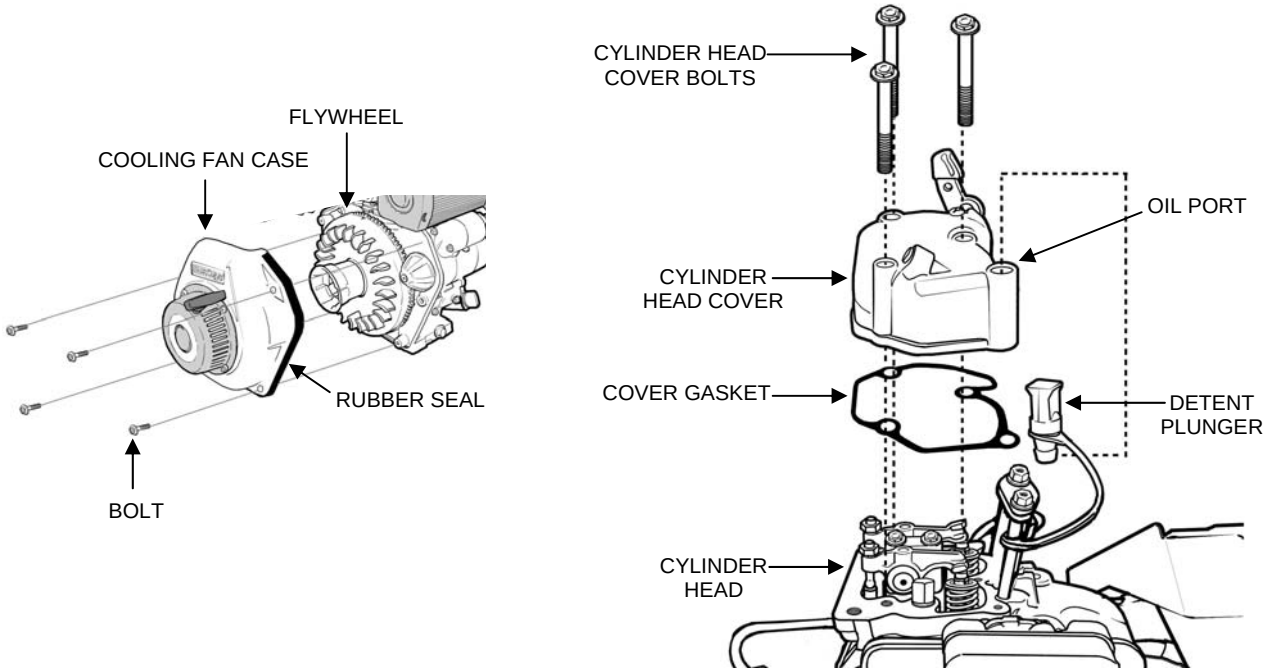

Figure 19. Cooling Fan Case and Cylinder Head Cover Removal.

Check/adjust the intake and exhaust valve clearances as follows (see Figure 20 and Figure 21):

1. Turn the flywheel by hand in the direction of least resistance until the “T” position mark on the flywheel lines up with the V notch on the cylinder body fin (see Figure 20). This places the engine crankshaft at T.D.C. (Top Dead Center). In this position, one of the valve rocker arms will have pressure on it and the other will not.

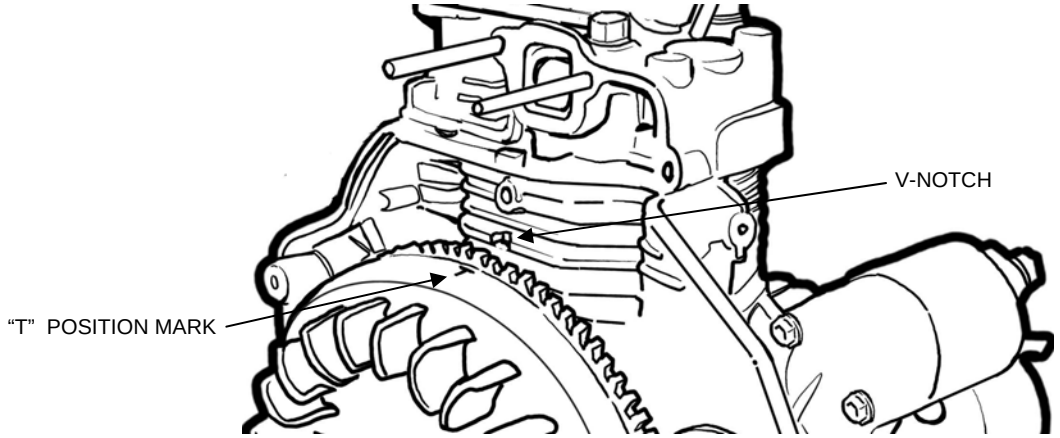

Figure 20. Setting the Crankshaft to Top Dead Center.

NOTE

To ensure accurate measurements, check the intake and exhaust valve clearances only when the engine is cold.

2. Using a thickness gauge, check the clearance between the rocker arm and valve stem for the rocker arm that has no pressure on it. The clearance should be 0.004" to 0.008".
3. If the clearance is out of specification, loosen the lock nut and turn the adjusting screw to set the correct clearance, then tighten the lock nut.
4. Rotate the flywheel 360 degrees and repeat steps 2 and 3 for the other valve.

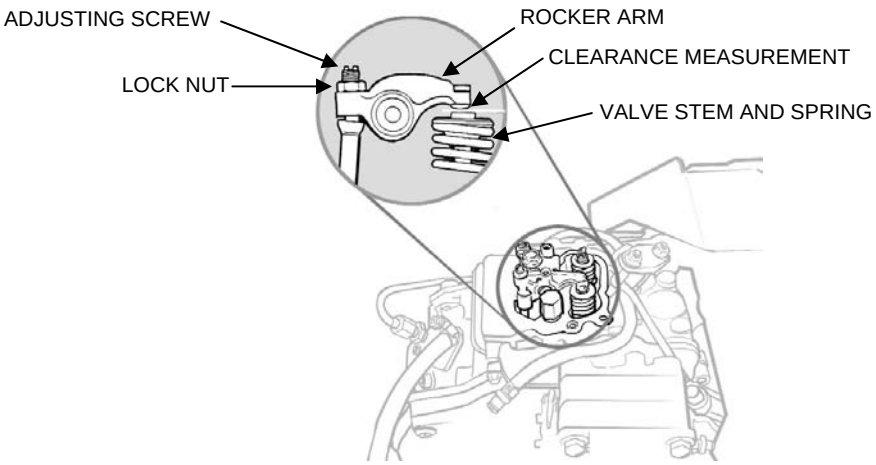

Figure 21. Intake/Exhaust Valve Clearance Adjustment.

5. Reinstall the cylinder head cover using a new gasket and the three bolts.
6. Insert the detent plunger into the port on the cover.
7. Reinstall the cooling fan case assembly with the four bolts, making sure the rubber seal is in the proper position.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0050 00**
UNIT MAINTENANCE PROCEDURES
DIESEL ENGINE AND FUEL TANK ASSEMBLY

Oil Level Service:

Materials:
Engine lubricating oil (WP 0079, Table 1 item 19)
Clean rags (WP 0079, Table 1, item 23)

Check the oil level as follows (see Figure 16):

NOTE
Make sure the engine is not running and is sitting level.

1. Remove the oil filler cap/dipstick and check the oil level. Add oil if necessary.
2. Screw the oil filler cap/dipstick back into the filler port.

Bleed the Fuel System:

Materials:
Clean rags (WP 0079, Table 1, item 23)

Bleed the fuel system of air as follows (see Figure 22):
1. Open the fuel cock.
2. Place the engine speed control knob at the Start position.
3. Disconnect the fuel injection pipe from the fuel injection valve.
4. Push the engine decompression lever down (non-compression position) and hold it there.
5. Place a rag in front of the disconnected end of the fuel injection pipe.
6. Pull the recoil starter. Stop when you see fuel spraying out the fuel injection pipe.
7. Reconnect the fuel injection pipe to the fuel injection valve.

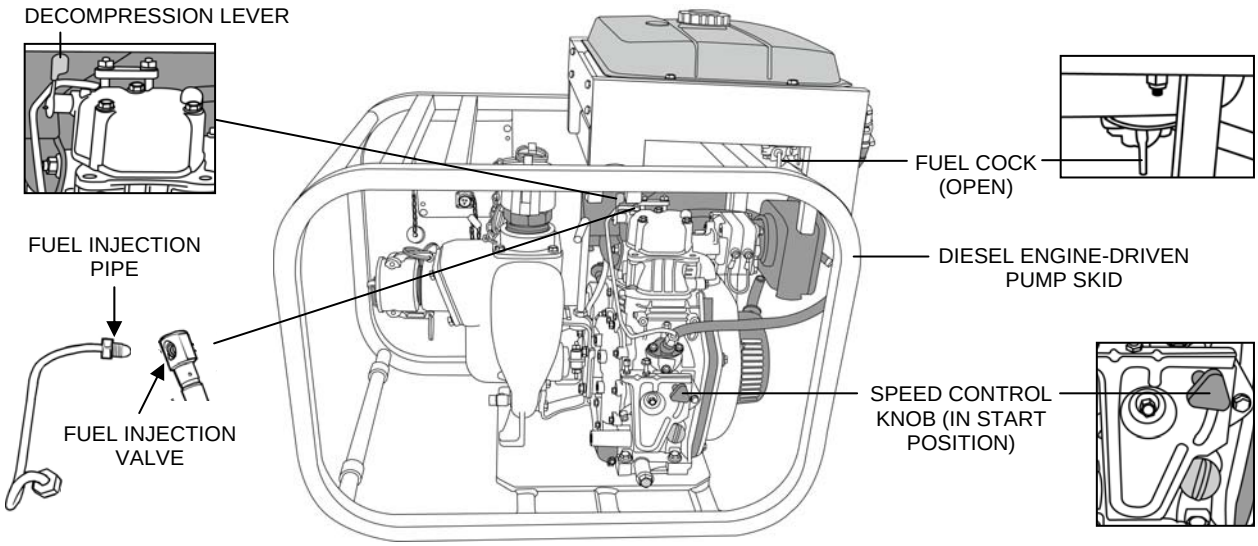

Figure 22. Diesel Engine Fuel System Bleed.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0051 00**
UNIT MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

THIS SECTION COVERS:
Replace, Repair

INITIAL SETUP:
Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS removed from service or during operation as required

GENERAL:

The procedures covered in this work package include:

- Basket Strainer S-2 Replacement
- P-3 Skid Frame Replacement
- P-3 Skid Junction Box Replacement
- P-3 Skid Power Cable Replacement
- MF Feed Pump P-3 Electric Motor Cable Replacement
- MF Feed Pump P-3 Pump/Motor Assembly Replacement
- MF Feed Pump P-3 Electric Motor Replacement
- Solenoid Valve Manifold Assembly Replacement
- Solenoid Coil Replacement
- Solenoid Valve Replacement
- Waste Outlet Hoses and Adaptor A-09 Replacement
- MF Feed Tank T-1 Repair
- MF Feed Pump P-3 Repair
- Waste Out Rupture Disk RD-401 Repair

Maintenance procedures for the following Micro-Filtration System components are described in the Control Instruments Unit Maintenance Procedures WP 0062 00:

- MF Feed Flow Element FE-101
- MF Feed Flow Transmitter FT-101
- MF Feed Pressure Transmitter PT–101
- Filtrate Pressure Indicator PI-201
- Filtrate Pressure Transmitter PT-102

Maintenance procedures for the following Micro-Filtration System components are described in the General Maintenance Unit Maintenance Procedures WP 0066 00:

- Strainer Vent Sample Ball Valve V-110
- Filtrate Sample Ball Valve V-204
- Shell Drain Ball Valve V-403
- MF Inlet Butterfly Valve V-111
- Upper Feed Inlet Butterfly Valve V-112

- Lower Feed Inlet Butterfly Valve V-113
- Upper Filtrate Butterfly Valve V-201
- Filtrate Drain Butterfly Valve V-203
- Upper Shell Backwash Outlet Butterfly Valve V-401
- Lower Shell Backwash Outlet Butterfly Valve V-402
- Morin Actuators

REPLACE

Basket Strainer S-2 Replacement:

Parts (TM 10-4610-309-24P):
S-2 Basket Strainer
Personnel:
One
Equipment Condition:
TWPS at standby or short-term shutdown

Replace MF Basket Strainer S-2 as follows (see Figure 1):

1. Remove the basket strainer S-2 as follows:
   a. Open Basket Strainer S-2 Drain Valve V-109 to begin draining the strainer and the elbow pipe above the strainer.
   b. Open Basket Strainer S-2 Vent/Sample Valve V-110 to allow air into the elbow pipe so that the pipe and the top of the strainer can completely drain.
   c. Remove the smaller sanitary clamp that secures the strainer outlet to the elbow pipe.
   d. Remove the grooved coupling at the other end of the elbow pipe and remove the pipe.
   e. Remove the larger sanitary clamp that secures the top of the strainer to the strainer body.
   f. Lift the top of the strainer and the attached strainer basket out of the strainer body.

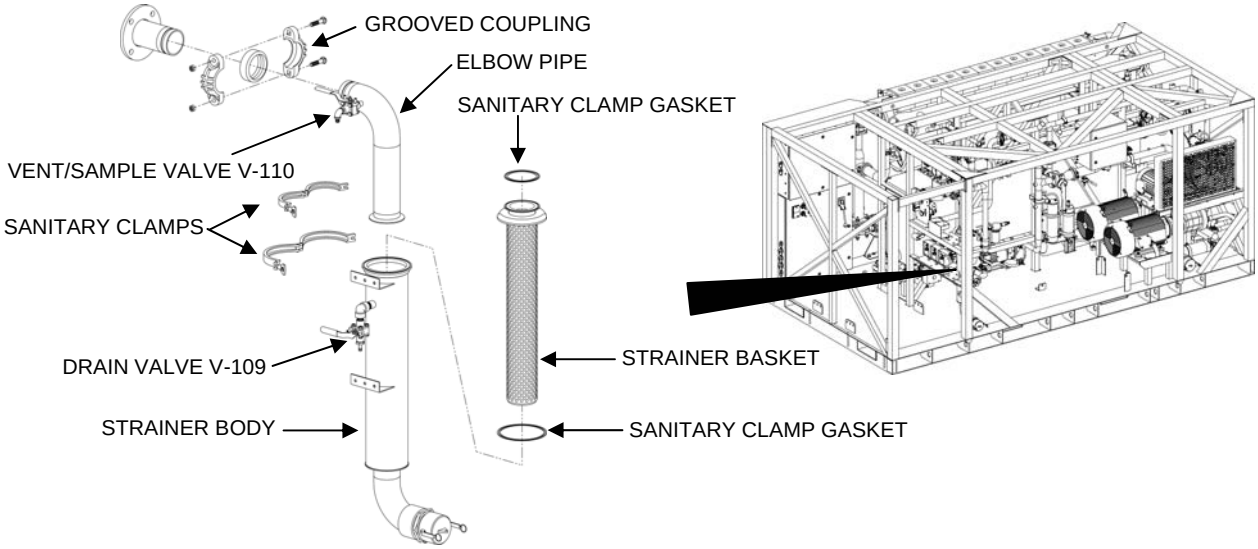

Figure 1. MF Basket Strainer S-2 Removal.

2. Install the new basket strainer as follows:
    a. Lower the strainer basket back into the strainer body.
    b. Inspect the gaskets for the grooved coupling and sanitary clamps. Replace if needed.
    c. Secure the top of the strainer to the body of the strainer using the larger sanitary clamp. Tap the clamp lightly around the circumference with a hammer and repeat tightening.
    d. Secure the lower end of the elbow pipe to the top of the strainer using the smaller sanitary clamp. Leave the clamp loose.
    e. Secure the upper end of the elbow pipe using the grooved coupling. Tighten the coupling.
    f. Tighten the smaller sanitary clamp. Tap the clamp lightly around the circumference with a hammer and repeat tightening.
    g. Close Strainer Drain Valve V-109.
    h. Close Strainer Vent/Sample Valve V-110.
    i. Start up the system and check for leaks at the valves and clamps.

P-3 Skid Frame Replacement:

Parts (TM 10-4610-309-24P):
P-3 pump skid frame
Equipment Condition:
P-3 Pump assembly removed from service and drained

Inspect the P-3 pump skid frame for damage. If the frame damage is repairable by welding, contact Direct Support Maintenance. Replace the frame if it is beyond repair as follows (see Figure 2):

1. Disconnect the motor cable at the junction box.
2. Remove the four screws and washers that secure the junction box to the skid frame. Remove the junction box.
3. Remove the four bolts, flat washers, and lock washers that secure the pump/motor unit to the frame.

WARNING

Two person lift. Two people are required to safely move the pump/motor unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

4. Slide the pump/motor unit out the side of the frame.
5. Position the pump/motor unit onto the new frame and secure it using the four bolts, flat washers, and lock washers.
6. Secure the junction box to the new frame using the four screws and washers. Be sure to orient the box so the side with two receptacles is facing inward.
7. Connect the motor cable to the proper receptacle on the junction box.

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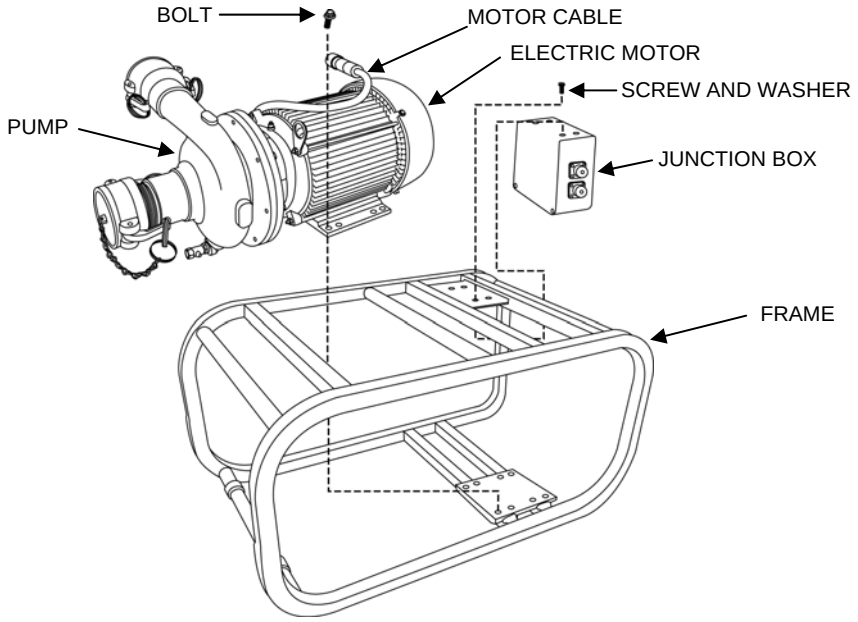

Figure 2. P-3 Pump Assembly Components.

P-3 Skid Junction Box Replacement:

Parts (TM 10-4610-309-24P):
P-3 pump skid junction box
Equipment Condition:
P-3 Pump assembly removed from service

Inspect the P-3 skid junction box for damage or corroded connectors. If damage or corrosion is severe enough to make it unsafe or non-functional, replace the box as follows (see Figure 2):

1. Disconnect the motor cable from the junction box.
2. Remove the screws and washers that secure the junction box to the skid frame. Remove the junction box.
3. Secure the new junction box to the frame using the retained hardware. Be sure to orient the box so the side with two receptacles is facing inward.
4. Connect the motor cable to the proper receptacle on the junction box.

P-3 Skid Power Cable Replacement:

Parts (TM 10-610-309-24P):
P-3 skid power cable
Equipment Condition:
P-3 Pump assembly removed from service

Inspect the power cable that connects the P-3 pump junction box to the Power Distribution Panel for damage. If the cable or the cable connectors are damaged so that it is unsafe to use, replace the cable.

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MF Feed Pump P-3 Electric Motor Cable Replacement:

Parts (TM 10-4610-309-24P):
P-3 Electric Motor Cable
Gasket, Terminal Box, P-3 Electric Motor
Equipment Condition:
MF Feed Pump Assembly P-3 removed from service.

Replace the MF Feed Pump P-3 electric motor cable as follows (see Figure 3):

1. Disconnect the electric motor cable at the P-3 skid junction box.
2. Remove the motor terminal box cover.
3. Inspect the terminal box gasket and replace if needed.
4. Tag and disconnect the motor terminal wires from the motor cable wires.
5. Unscrew the cable ring nut from the terminal box.
6. Pull the cable end out of the terminal box and discard the old electric motor cable.

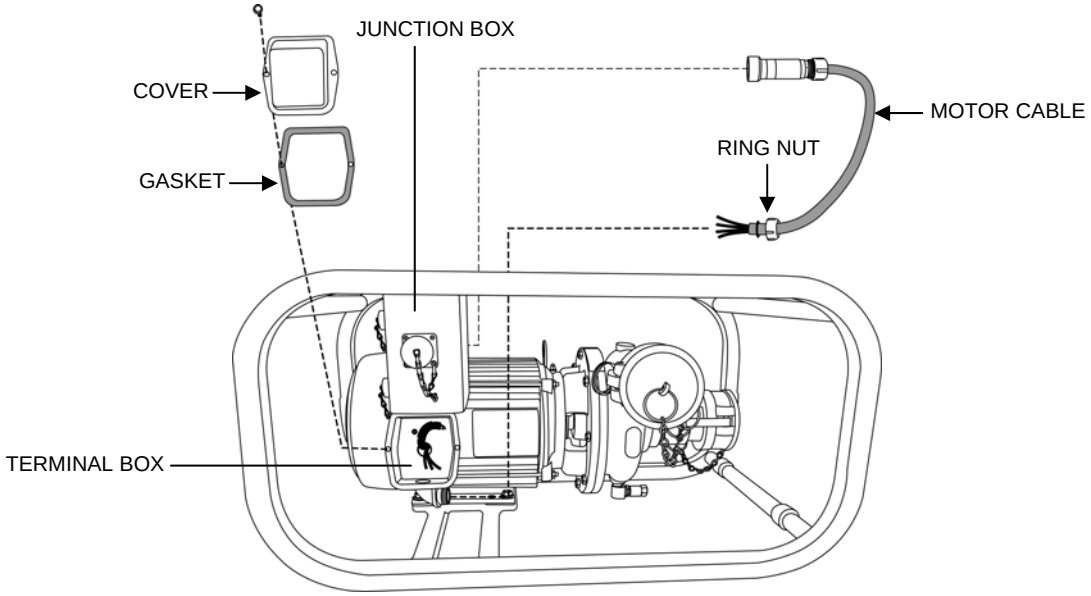

Figure 3. MF Feed Pump Electric Motor Cable Replacement.

7. Insert the wire end of the new cable into the terminal box and secure with the ring nut.
8. Connect the motor cable wires to the motor terminal wires in accordance with the tags.
9. Install the terminal box cover gasket and cover and secure with the two nuts.

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MF Feed Pump P-3 Pump/Motor Assembly Replacement:

Parts (TM 10-4610-309-24P):
P-3 pump/motor assembly
Materials:
Sealing Compound (WP 0079, Table 1, item 36)
Equipment Condition:
P-3 Pump assembly removed from service and drained

Replace the MF Feed Pump P-3 Pump/Motor Assembly follows (see Figure 2):

1. Disconnect the motor cable at the junction box.
2. Remove the four bolts, flat washers, and lock washers that secure the pump/motor unit to the frame.

WARNING

Two person lift. Two people are required to safely move the pump/motor unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

3. Slide the pump/motor unit out the side of the frame.
4. Position the new pump/motor unit onto the frame and secure it using the four bolts, flat washers, and lock washers.
5. Connect the motor cable to the proper receptacle on the junction box.
6. Remove the coupler and dust cap from the outlet connection of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 36).
7. Remove the coupler and dust plug from the inlet connection of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 36).
8. Remove the drain valve from the old pump. Remove the drain plug from the new pump and install the drain valve on the new pump. Use sealing compound on the valve threads (WP 0079, Table 1, item 36).
9. Place the pump back into service and inspect it for leaks and proper operation.

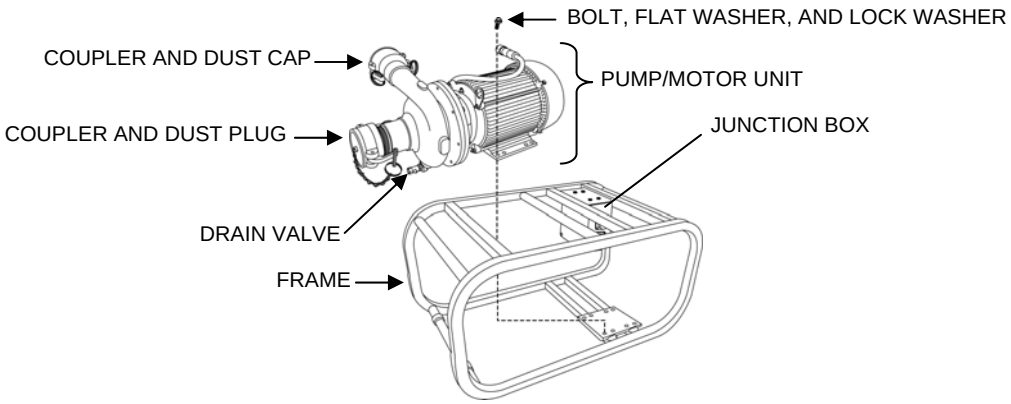

Figure 4. MF Feed Pump P-3 Pump/Motor Assembly Replacement.

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MF Feed Pump P-3 Electric Motor Replacement:

Parts (TM 10-4610-309-24P):
- P-3 Electric Motor Assembly
- Seal Kit
- Shaft Sleeve
- Wear Ring

Materials:
- Corrosion preventive compound (BII) (WP 0079, Table 1, item 17)
- Glycerin (BII) (WP 0079, Table 1, item 21)
- Sealing compound (WP 0079, Table 1, item 35)
- Clean, dry rags (WP 0079, Table 1, item 33)

Equipment Condition:
- MF Feed Pump Assembly P-3 removed from service

Replace the MF Feed Pump P-3 electric motor as follows:

1. Disconnect the electric motor cable at the P-3 skid junction box.
2. Remove the MF Feed Pump P-3 as follows (see Figure 5).

WARNING

Two-person lift. Two people are required to move the pump. Lift with your legs, not your back. Failure to observe this warning can result in back injury.

a. Open the pump drain and drain the pump casing. Then close the drain.
b. Remove the eight cap screws that hold the pump casing to the adapter and pull the casing off.
c. Remove and discard the pump casing gasket.
d. Remove the impeller screw. It may be necessary to hold the impeller using a strap wrench or a pipe wrench to keep the impeller from turning while loosening the screw with a socket wrench.
e. Remove and discard the screw gasket.
f. Ease the impeller off the shaft. If required, carefully pry the impeller off of the shaft.
g. Remove the spring and the impeller key.
h. Pull the shaft sleeve with the rotating parts of the mechanical seal off the shaft.
i. Lift the pump cover off the adapter. If required, carefully pry the cover off the adapter.

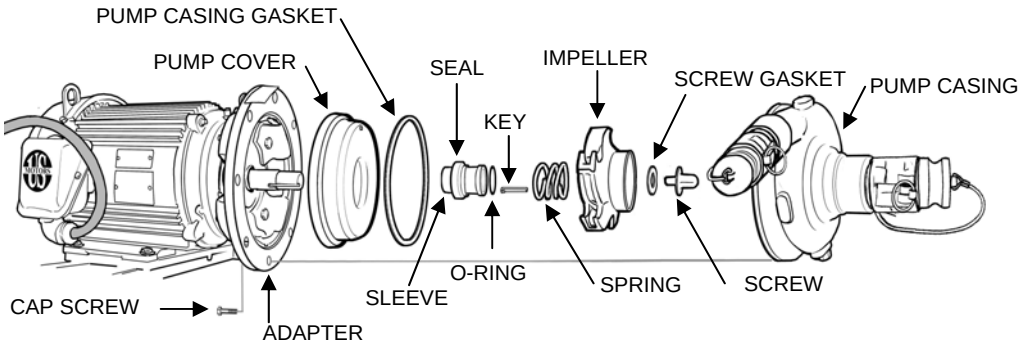

Figure 5. MF Feed Pump Removal.

3. Remove the four cap screws that hold the adapter to the motor (see Figure 6). Remove and retain the adapter.

WARNING

Two-person lift. Two people are required to safely move the motor. Lift with your legs, not your back. Failure to observe this warning can result in back injury.

4. Remove the four bolts and washers that hold the motor to its base and remove the motor (see Figure 6).

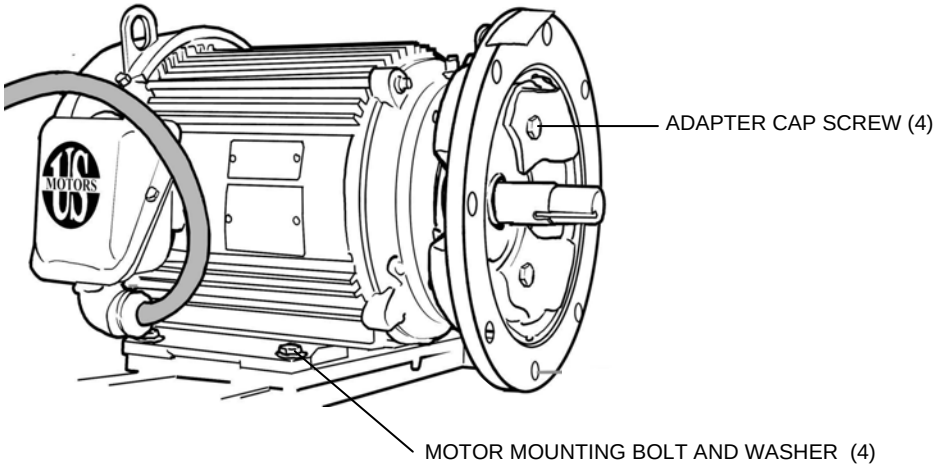

Figure 6. MF Feed Pump Motor Removal.

5. Secure the replacement motor to the motor base using the four bolts and washers.
6. Secure the adapter to the replacement motor using the four cap screws.
7. Inspect the MF Feed Pump components, replace parts as needed, and install the pump onto the adapter. Refer to **MF Feed Pump P-3 Repair** in this work package.

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Solenoid Valve Manifold Assembly Replacement:

Parts:
Solenoid Valve Manifold Assembly (TM 10-4610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the solenoid valve manifold assembly as follows:

WARNING

The air system must be bled prior to working on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

1. Bleed the entire air system as follows (see Figure 7)

    a. Turn off the air compressor by switching the Air Compressor control at the OCP from AUTO to OFF.
    b. If you don't want to bleed air out of the air receiver tank, close Air Receiver Tank Shut-Off Valve V-907.
    c. Make sure that Low Pressure Air Shut-Off Valve V-909 is open.
    d. Slowly open Low Pressure Air Vent Valve V-910 to bleed the air system.

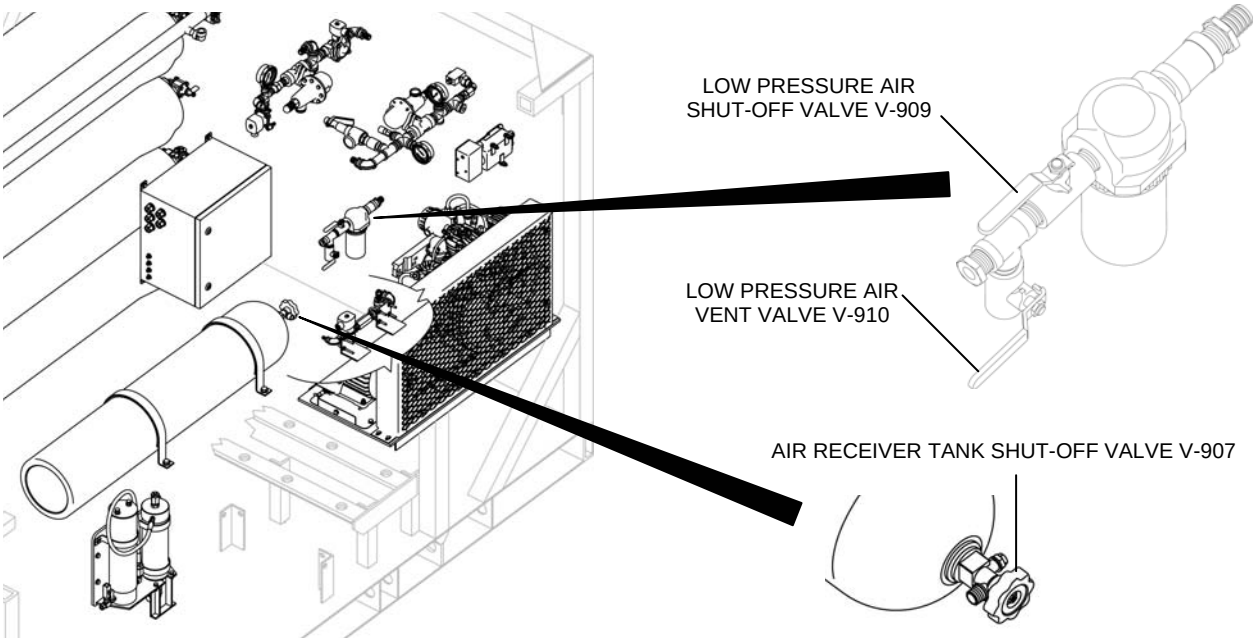

Figure 7. Valves for Bleeding the Air System.

2. Remove solenoid valve manifold assembly as follows (see Figure 8):
    a. Open the instrument/solenoid panel box to the solenoid valve manifold assembly.
    b. Tag and disconnect the 8 tubes that are connected to the top and left side of the solenoid valve manifold assembly.
    c. Tag and disconnect the 6 pairs of solenoid coil wires from the terminal strip.
    d. Remove the two mounting screws, lock washers, and flat washers that secure the solenoid valve manifold assembly to the box (one screw, lock washer, and flat washer at the top of the manifold and one at the bottom).
    e. Remove the solenoid valve manifold assembly.

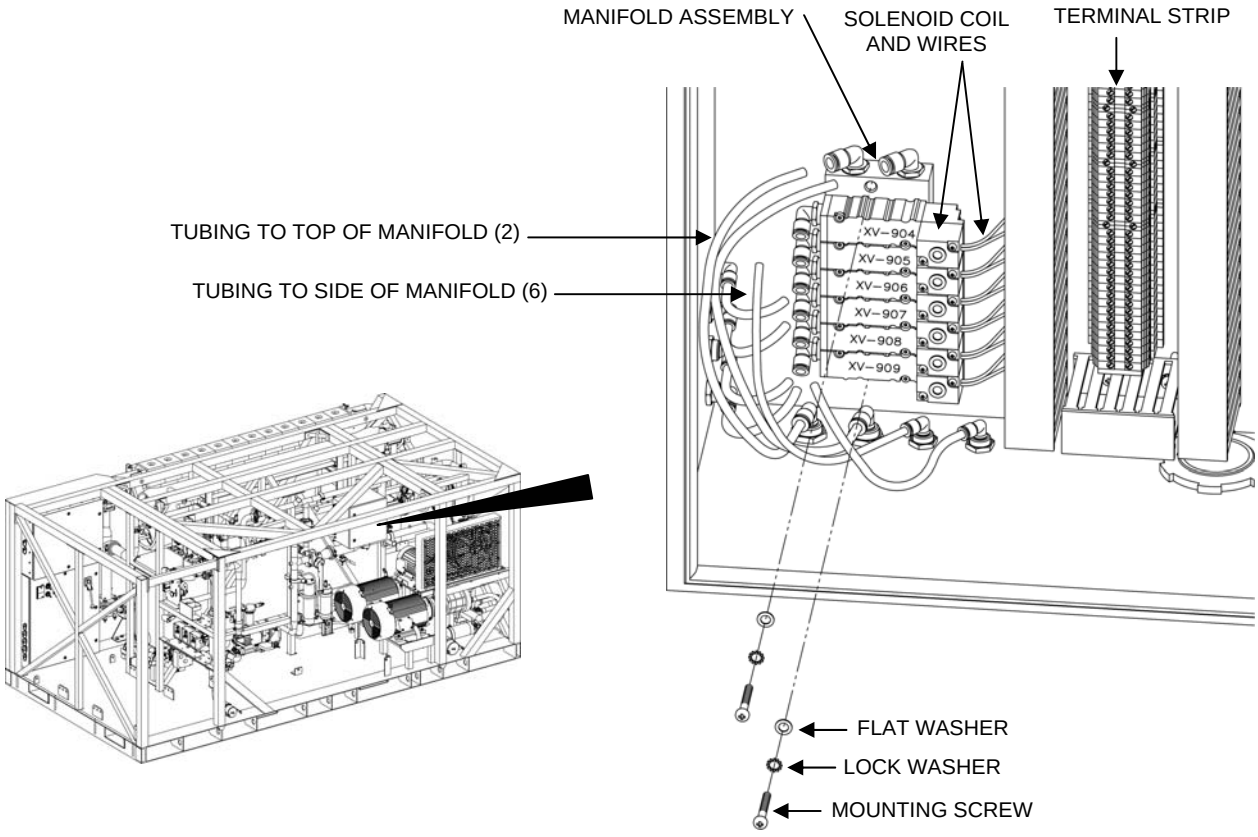

Figure 8. Solenoid Valve Manifold Assembly Removal.

3. Install a new solenoid valve manifold assembly as follows:
    a. Position the new solenoid valve manifold assembly in the instrument/solenoid panel box and secure using the two mounting screws, lock washers, and flat washers.
    b. Connect the 8 tubes to the top and left side of the new manifold according to the connection tags (see Figure 9).
    c. Match the tags on the wires of the solenoid coils that were removed to the wires on the new solenoid coils.
    d. Connect the wires of the new solenoid coils to the terminal strip according to the tags.
    e. Remove all tags.
    f. Close the instrument/solenoid panel box.

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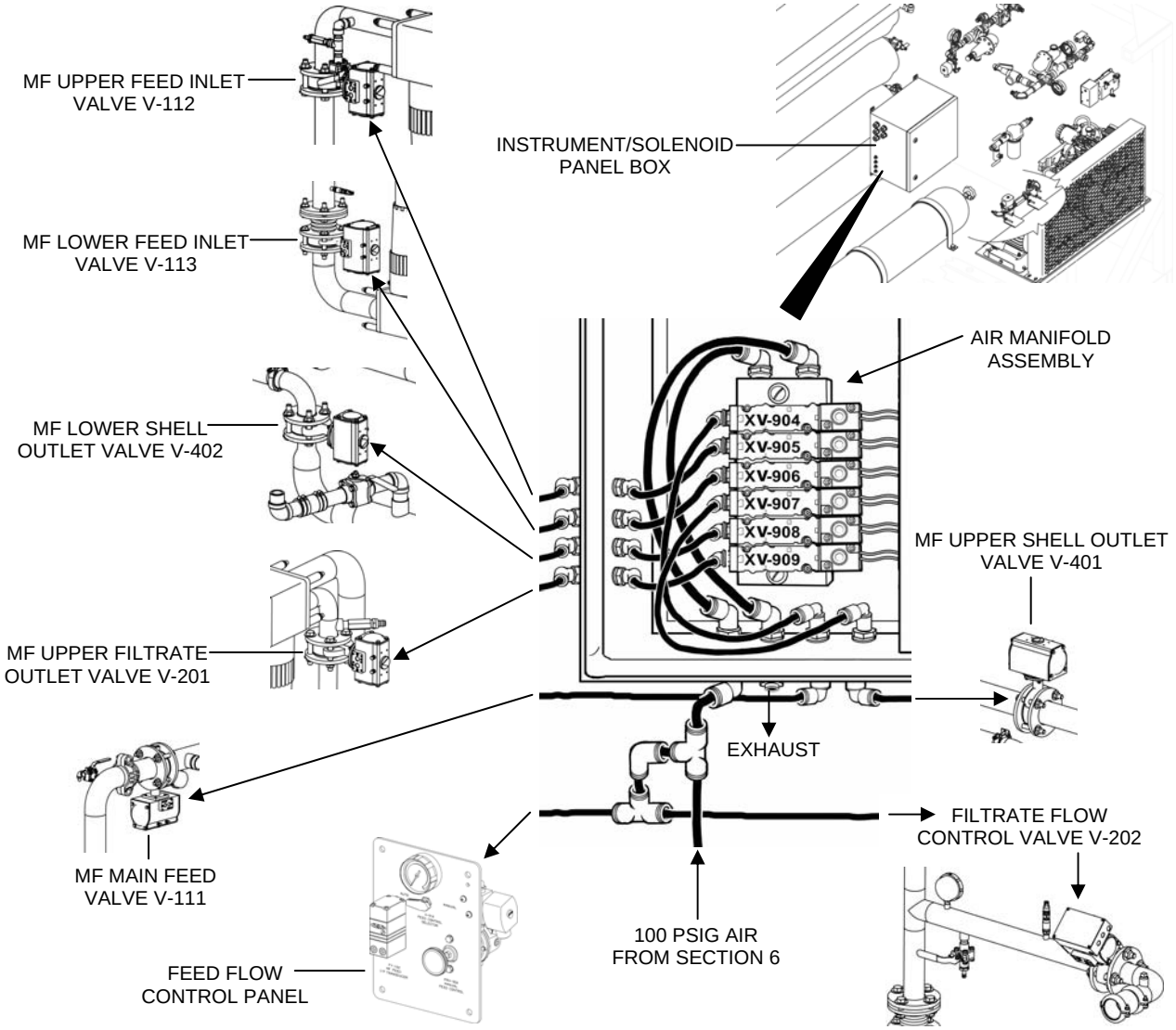

Figure 9. Air Manifold Assembly Air Tube Connection Arrangement.

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Solenoid Coil Replacement:

Parts:
Solenoid Coil (TM 10-4610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a solenoid coil in the instrument/solenoid panel box as follows:

WARNING

The air system must be bled prior to working on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

1. Bleed the air system. Refer to **REPLACE** and **Solenoid Valve Manifold Assembly**.
2. Remove a solenoid coil as follows (see Figure 10):
   a. Open the instrument/solenoid panel box cover.
   b. Loosen the two screws that secure the instrument panel and open the instrument panel to access the solenoid valve manifold assembly.
   c. Locate the solenoid coil to be replaced.
   d. Tag the wire connections from the solenoid coil at the terminal strip.
   e. Remove the two screws securing the solenoid coil to the valve.
   f. Carefully pull the solenoid coil from the valve.

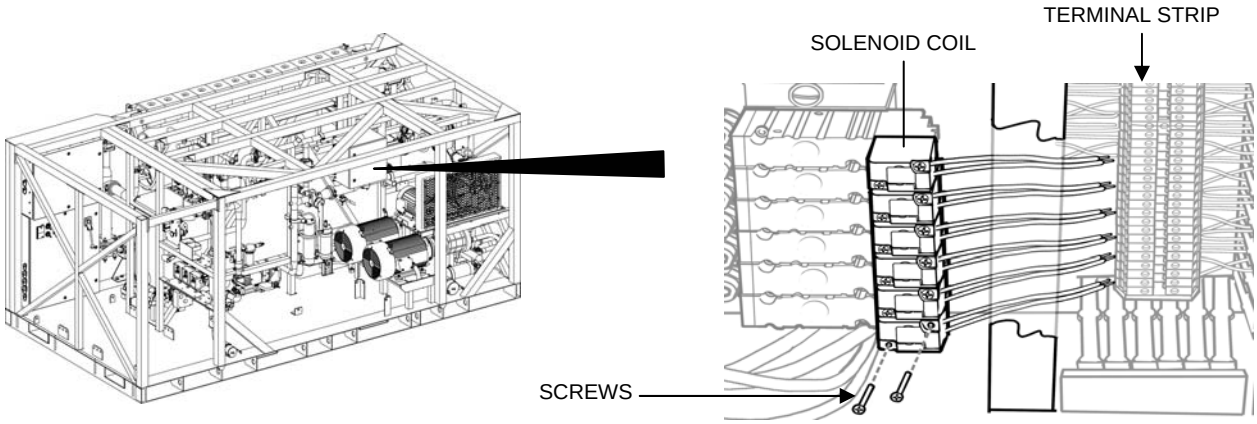

Figure 10. Solenoid Coil Replacement.

3. Install new solenoid coil.
   a. Position the new solenoid coil on the valve.
   b. Secure the solenoid coil to the valve using the two mounting screws.
   c. Connect the wires from the solenoid coil to the terminal strip.
   d. Remove wire tags.
   e. Close the instrument/solenoid panel box.

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Solenoid Valve Replacement:

Parts:
Solenoid Valve (TM 10-4610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a solenoid valve in the instrument/solenoid panel box as follows:

WARNING

The air system must be bled prior to working on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

1. Bleed the air system. Refer to **REPLACE** and **Solenoid Valve Manifold Assembly**.
2. Remove a solenoid valve as follows (see Figure 11):
   a. Open the instrument/solenoid panel box cover.
   b. Loosen the two screws that secure the instrument panel and open the instrument panel to access the solenoid valve manifold assembly.
   c. Locate the solenoid valve to be replaced.
   d. Remove the two screws securing the solenoid coil to the valve that is to be replaced.
   e. Carefully pull the solenoid coil from the valve.
   f. Remove the two screws securing the solenoid valve to the manifold and remove the valve.

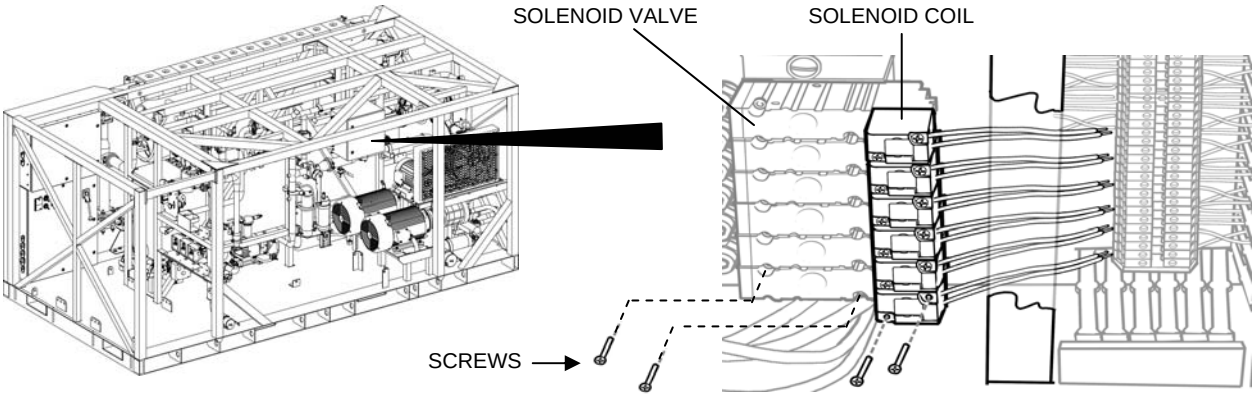

Figure 11. Solenoid Valve Replacement.

4. Install new solenoid valve.
   a. Secure the new solenoid valve to the manifold using the two mounting screws.
   b. Secure the solenoid coil to the valve using the two mounting screws.
   c. Close the instrument/solenoid panel box.

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Waste Outlet Hoses and Adaptor A-09 Replacement:

Parts (TM 10-4610-309-24P):
- 4-in. x 5-ft. waste outlet suction hose
- 4-in. suction hose gasket
- Adaptor A-09
- Gasket, 4-in. adaptor
- Gasket, 6-in. adaptor
- 6-in. x 50-ft. waste outlet discharge hose

Equipment Condition:
- TWPS in Standby Shutdown Without Draining Down
- Army TWPS: TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Inspect and replace the waste outlet hoses, Adaptor A-09, and hose and adaptor gaskets as follows (see Figure 12):

WARNING

High velocity discharge hazard. The blow back step of the automatic MF backwash operation results in a sudden and very high velocity surge in the waste outlet hoses. The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing reject hose or adaptor A-09. Failure to observe this warning can result in injury.

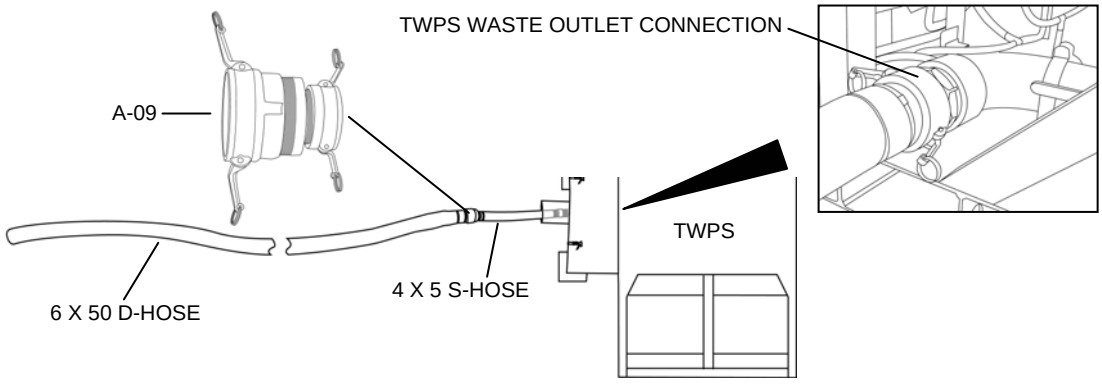

Figure 12. Waste Outlet Hoses and Adaptor A-09.

1. Inspect the 4-in. by 5-ft. waste outlet suction hose for leaks, cracks or other damage.
2. Replace the entire hose assembly if damage is found.
3. Inspect adaptor A-09 for leaks, cracks, or other damage.
4. Replace adaptor A-09 if damage is found.
5. Inspect the 6-in. by 50-ft. waste outlet discharge hose for leaks, cracks or other damage.
6. Replace the entire hose assembly if damage is found.
7. Check the female ends of the 4 x 5 hose and adaptor A-09 for missing or damaged gaskets.
8. If a gasket is missing or damaged, install a new gasket in the female end of the hose or adaptor.

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REPAIR

MF Feed Tank T-1 Repair:

Parts:
Collapsible MF feed tank (TM 10-4610-309-24P)
Material:
Army TM 10-5430-237-12&P for collapsible product water distribution tank repair
Or Marine Corps TM 01034E-12&P/1 for collapsible product water distribution tank repair

Inspect the tank for leaks, surface damage, and damaged hose connectors. Repair surface damage and minor leaks. Refer to **Collapsible Fabric Tank Repair** in WP 0066, General Maintenance.

MF Feed Pump P-3 Repair:

Parts (TM 10-4610-309-24P):
Seal Kit
Shaft Sleeve
Wear Ring
Materials:
Solvent (WP 0079, Table 1, item 19)
Glycerin (BII) (WP 0079, Table 1, item 21)
Clean, dry rags (WP 0079, Table 1, item 33)
Sealing compound (WP 0079, Table 1, item 35)
Equipment Condition:
MF Feed Pump Assembly P-3 removed from service.

Repair MF Feed Pump P-3 (including inspecting and replacing the pump seal, shaft sleeve, and wear ring) as follows:

1. Remove the MF Feed Pump P-3 from the adapter as follows (see Figure 13).

WARNING

Two-person lift. Two people are required to move the pump. Lift with your legs, not your back. Failure to observe this warning can result in back injury.

a. Open the pump drain and drain the pump casing. Then close the drain.
b. Remove the eight cap screws that hold the pump casing to the adapter and pull the casing off.
c. Remove and discard the pump casing gasket.
d. Remove the impeller screw. It may be necessary to hold the impeller using a strap wrench or a pipe wrench to keep the impeller from turning while loosening the screw with a socket wrench.
e. Remove and discard the screw gasket.
f. Ease the impeller off the shaft. If required, carefully pry the impeller off of the shaft.
g. Remove the spring and the impeller key.
h. Pull the shaft sleeve with the seal off the shaft.
i. Lift the pump cover off the adapter. If required, carefully pry the cover off the adapter.

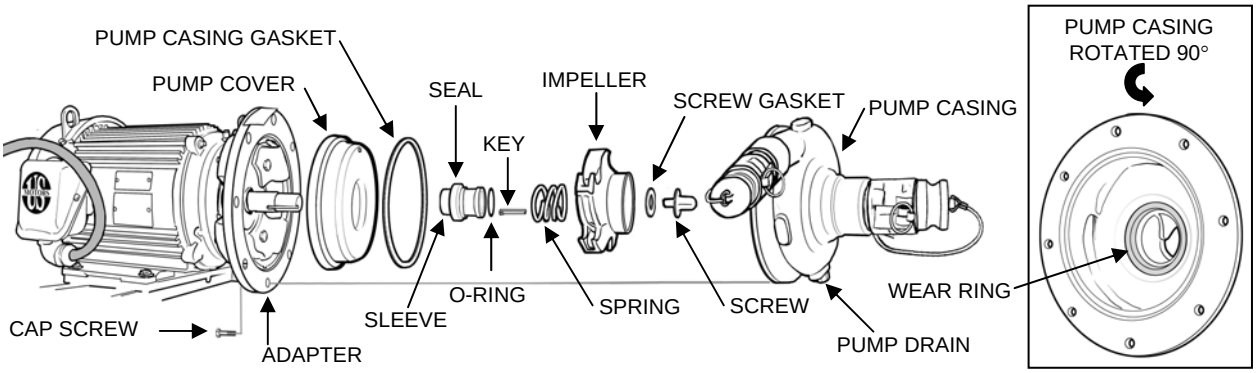

Figure 13. MF Feed Pump Removal.

2. Inspect the following parts for wear or damage:
    a. Seal on the shaft sleeve (do not remove the seal parts if not replacing).
    b. Stationary seat and stationary seat gasket in the pump cover (do not remove the stationary seat and seat gasket from the pump cover if not replacing them).
    c. Shaft sleeve.
    d. Wear ring.
3. If the seal kit (seal, stationary seat, seat gasket, and spring) and shaft sleeve need to be replaced, remove them as follows (see Figure 14):

NOTE

If the seal sticks tightly to the sleeve, it may be necessary to bathe it in oil to loosen the adhesive, or you may have to cut the seal away with a knife.

    a. Twist and slide the seal off the sleeve.
    b. Pry the stationary seat and seat gasket out of the bore of the pump cover.

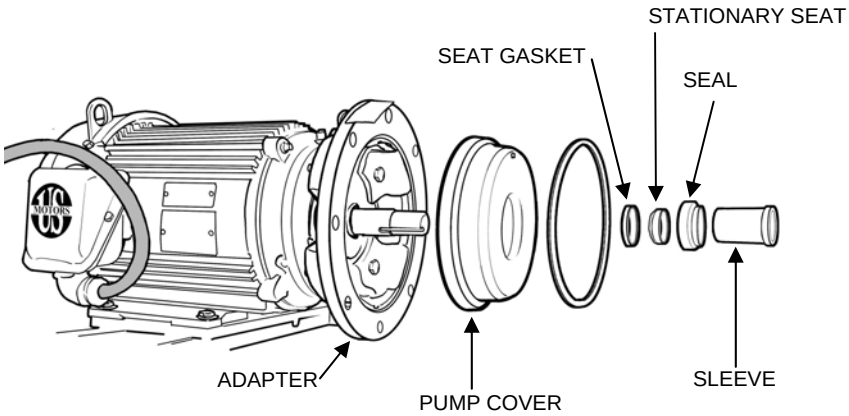

Figure 14. Seal Kit Component Removal.

4. Install a new seal kit (seal, stationary seat, seat gasket, and spring) and shaft sleeve as follows (see Figure 15):
    a. Clean the sleeve, pump cover bore, and pump shaft thoroughly with solvent, and dry with a clean cloth.

NOTE

Do not use grease to lubricate the sleeve and seal parts. Grease will prevent the seal from setting and result in leakage around the shaft.

Once the seal is placed onto the sleeve the rest of the assembly must be completed without delay to ensure that the seal sets properly.

    b. Lightly lubricate the bore of the pump cover with glycerin.

NOTE

If necessary, the seat can be tapped lightly with the handle end of a screwdriver or similar tool. Do not force the seat so that it gets damaged.

    c. Press the stationary seat gasket and then the stationary seat into the bore so that they are seated firmly and squarely.
    d. Lightly lubricate the new seal with glycerin and slide it onto the new sleeve with the carbon side facing the small end of the sleeve. Complete the rest of the assembly without delay.
    e. Slide the pump cover with the stationary seat over the shaft. Avoid bumping the seat as you slide it over the shaft.
    f. Position the pump cover so that the internal bypass hole in the cover is between the 1 and 2 o'clock position for top discharge.
    g. Tap the cover with a rubber mallet if necessary to seat the cover securely.
    h. Insert the new sleeve O-ring into the inner diameter of the sleeve if not already in place.
    i. Lubricate the inner diameter of the sleeve and the outer diameter of the shaft with glycerin.
    j. Slide the sleeve with the seal onto the shaft with the small end of the sleeve going onto the shaft first. Push the sleeve all the way onto the shaft.
    k. Align the shaft and sleeve keyways.
    l. Position the key with the thick end of the key toward the motor and the flat back of the key against the motor shaft.
    m. Insert the key in the keyway.
    n. Discard the seal spring retainer and place the new spring over the end of the sleeve and over the seal assembly.
    o. Slide the impeller onto the shaft over the key.
    p. Place sealing compound on the impeller screw threads (WP 0079, Table 1, item 25).
    q. Place the impeller screw gasket onto the impeller.
    r. Push down on the impeller and thread the impeller screw into the end of the shaft.
    s. Tighten the impeller screw.
    t. Check the freedom of the rotating parts by hand-rotating the impeller. If the impeller rubs against the pump cover, try tapping the cover down again with the rubber mallet to seat the cover on the adapter.

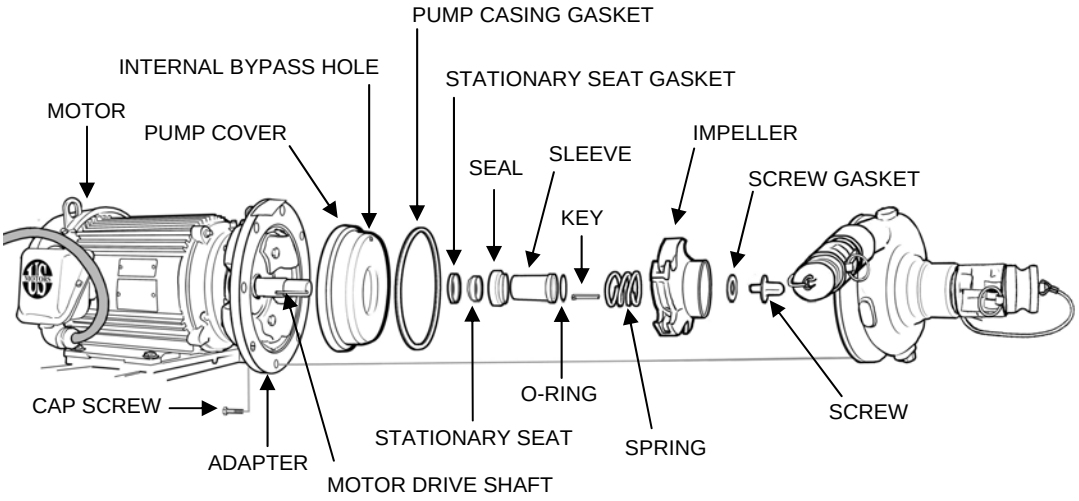

Figure 15. Seal Kit and Shaft Sleeve Installation.

5. If the wear ring is damaged, replace it as follows:
    a. Drill a hole through the wear ring in two places opposite each other. Be careful not to damage the pump casing (see Figure 16).
    b. Crack the remaining ring wall and remove the wear ring.
    c. Make sure the surfaces of the new wear ring and the pump casing where the ring is to be installed are free of burrs. Remove any burrs with a fine emery cloth.
    d. Press the new wear ring into place.
    e. Evenly drive the ring into place.

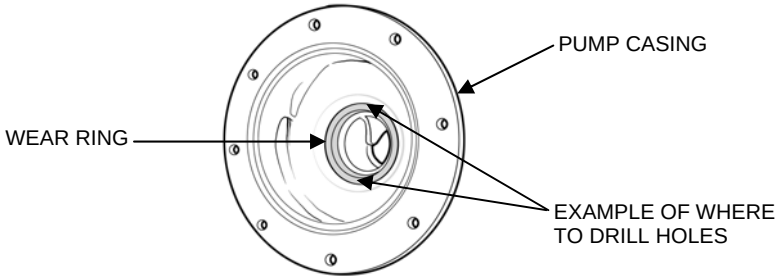

Figure 16. Wear Ring Removal.

6. Reinstall the pump casing as follows (see Figure 15):
    a. Install a new casing gasket on the shoulder of the pump cover.
    b. Position the pump casing so that the pump discharge points toward you when the motor is on your left and the pump is on your right.
    c. Place the new pump casing onto the pump cover, apply sealing compound (WP 0079, Table 1, item 35) to the eight cap screws and secure the pump casing with the screws.
    d. Tighten the cap screws uniformly.
7. Reconnect the electric motor cable to the P-3 skid junction box.
8. Place the MF Feed Pump back into service and inspect it for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0051 00**
UNIT MAINTENANCE PROCEDURES
MICRO-FILTRATION SYSTEM

Waste Out Rupture Disk RD-401 Repair:

Parts:
Rupture disk (BII and TM 10-4610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the rupture disk in Waste Out Rupture Disk RD-401 assembly as follows (see Figure 17):

WARNING

High velocity discharge hazard. The blow back step of the automatic MF backwash operation results in a sudden and very high velocity surge in the waste outlet hoses. The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing waste out rupture disk RD-401. Failure to observe this warning can result in injury.

1. Remove the rupture disk from rupture disk assembly RD-401 as follows:
   a. Note the position of the vent pipe for the position it needs to be in when reinstalled.
   b. While holding the vent pipe, unthread the nut from the inlet connection.
   c. Carefully lift the vent pipe and nut off of the inlet connection. The outlet connection will come out with the vent pipe and nut.
   d. Lift the rupture disk off of the inlet connection.

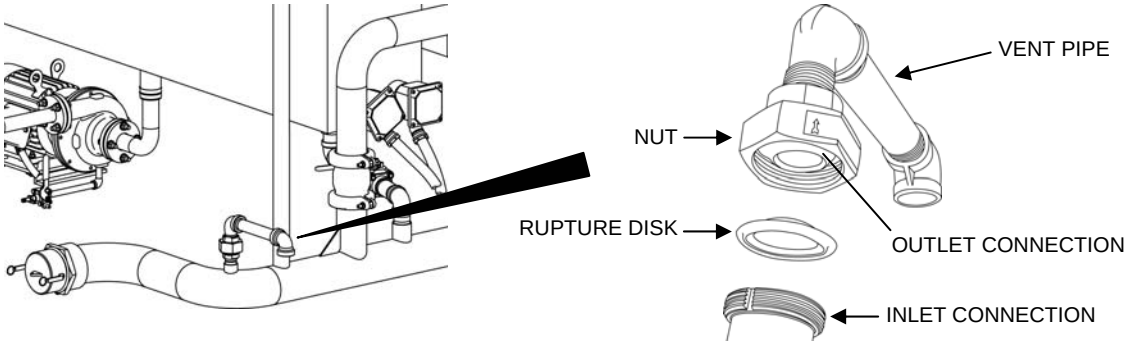

Figure 17. RD-401 Rupture Disk Replacement.

2. Install the new rupture disk as follows:
   a. Insert a new rupture disk in the inlet connection with the dome side of the disk facing up.
   b. Position the outlet connection, nut and vent pipe onto the rupture disk.
   c. Thread the nut onto the inlet connection, position the vent pipe as it was before it was removed, and tighten the nut.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0052 00**
UNIT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

THIS SECTION COVERS:
Replace, Repair, Service

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Torque wrench (minimum 0-250 in.-lbs)
Drill and drill bits
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One or two as required
Equipment Condition
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source

GENERAL:

This work package contains information and instructions for replacing, repairing, and servicing components in the Reverse Osmosis (RO) System. The procedures in this work package include:

- RO Feed Tank Strainer S-3 Replacement
- RO Feed Tank Heaters H-1 and H-2 Replacement
- RO Feed Pump P-4 Pump/ Motor Assembly Replacement
- RO Feed Pump P-4 Drain Valve V-211 Replacement
- RO Feed Pump P-4 Electric Motor Replacement
- Inline RO Strainer S-4 Replacement
- HP Pump Relief Valve RV-301 and RO Feed Relief Valve RV-302 Replacement
- RO Product Flow Three-Way Valves V-501 through V-510 Replacement
- Product Relief Valve RV-501 Replacement
- Product Vacuum Breaker VB-501 Replacement
- Product Check Valve V-512 Replacement
- Main and Auxiliary Pressure Control Valves HCV-401 and HCV-401A Replacement
- Pressure Recovery Turbocharger PRT-1 Replacement
- Turbocharger Feed Drain Valve V-303 and Reject Drain Valve V-410 Replacement
- Reject Backflow Check Valve V-411 Replacement
- Waste Out Hose and Adaptor A-09 Replacement
- Waste Out Rupture Disk RD-401 Repair
- RO Feed Tank Cover Hinge Repair
- RO Feed Pump P-4 Repair
- Pressure Recovery Turbocharger PRT-1 Repair

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0052 00**
UNIT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

Refer to WP 0053 for maintenance procedures for RO System High Pressure Pumps P-5 and P-6.

Refer to WP 0062 for maintenance procedures for the following RO System control instruments:
- RO feed tank level transmitter LT-201
- RO feed tank temperature indicator TI-202
- RO feed temperature transmitter TT-201
- RO feed pressure transmitter PT-201
- RO feed pressure indicator PI-202
- HP pump lubricant re-circulation flow indicators FI-202 and FI-203
- HP pump discharge pressure indicator PI-301
- RO feed pressure transmitter PT-302
- RO feed pressure indicator PI-304
- Product output pressure indicator PI-501
- Conductivity elements CE-501A and CE-501B
- Conductivity indicating transmitter CIT-501
- Product flow element FE-501
- Product flow transmitter FT-501
- Reject pressure indicator PI-401
- RO reject flow element FE-401
- RO reject flow transmitter FT-401

Refer to WP 0066 for maintenance procedures for the following Reverse Osmosis System valves and piping connectors:
- RO Feed Tank Auxiliary Drain Ball Valve V-210
- HP Pump Inlet Butterfly Valve V-212
- HP Pump Inlet Drain Ball Valve V-213
- HP Pump Case Drain Ball Valve V-214
- HP Pump Outlet Drain Ball Valve V-302
- Feed Piping Drain Ball Valve V-304
- RO Feed Tank Drain to Waste Ball Valve V-412
- Product Utility Ball Valve V-511
- Pipe Couplings
- Sanitary Clamps
- Grooved Couplings

REPLACE

RO FEED TANK PUMP INLET STRAINER S-3 REPLACEMENT:

Parts (TM 10-4610-309-24P):
Pump Inlet Strainer S-3
RO Feed Tank Cover Gasket
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0052 00**
UNIT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

Replace RO Feed Tank Pump Inlet Strainer S-3 as follows (see Figure 1):

CAUTION

Do not allow the screws or washers to fall into the RO feed tank. Pump inlet strainer S-3 will not prevent this mounting hardware from entering the pump. Failure to observe this caution can result in severe damage to and the failure of the RO feed pump if the hardware is sucked into the pump.

1. Remove the six screws and flat washers from the middle feed tank hatch cover.
2. Lift off the hatch cover.
3. Inspect the hatch cover gasket for damage or deterioration and replace if needed.
4. Lift the strainer out of the RO feed tank.
5. Unclip the chain from the strainer and clip it to the new strainer.
6. Lower and position the new strainer over the strainer guide at the bottom of the tank.
7. Place the hatch cover gasket and hatch cover on the RO feed tank.
8. Secure the hatch cover to the tank using the six screws and flat washers.

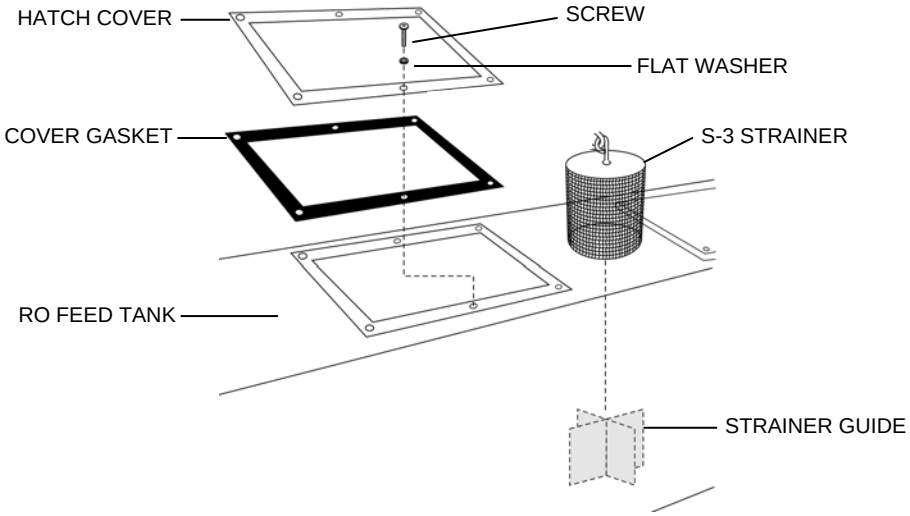

Figure 1. RO Feed Tank Pump Inlet Strainer S-3 Replacement.

RO Feed Tank Heaters H-1 and H-2 Replacement:

Parts (TM 10-4610-309-24P):
Heater Element
Materials:
Tape, Antiseizing (BII) (WP 0079, Table 1, item 43, 44)
Sealing Compound (WP 0079, Table 1, item 35)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace either of the RO Feed Tank Heaters H-1 or H-2 as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing an RO Feed Tank Heater. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

1. Remove an RO feed tank heater from the tank as follows (see Figure 2):
   a. Make sure the TWPS is in Standby Shutdown With Drain-Down.
   b. Remove the four screws from the heater cap on the heater terminal box and remove the cap.
   c. Tag and disconnect the three phase wires and the one ground wire from the heater terminals.
   d. Unscrew the lock nut inside the terminal box from the 45-degree box connector.
   e. Pull the connector and conduit as an assembly out of the terminal box. Retain the packing/retainer.
   f. Unscrew the heater from the tank heater coupling.
   g. Pull the heater element out the tank.

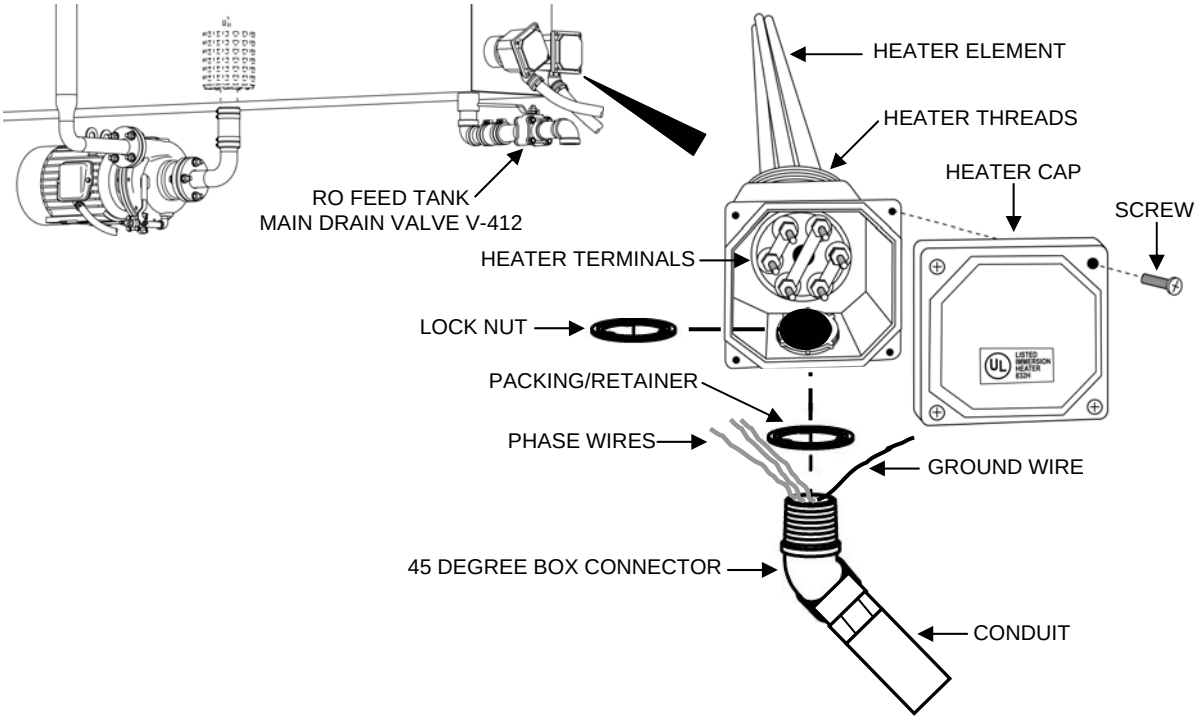

Figure 2. RO Feed Tank Heater Replacement.

2. Install an RO feed tank heater as follows:
    a. Apply sealing compound to the heater threads.
    b. Insert the new heater element into the tank and thread it all the way into the tank heater coupling.
    c. Make sure the packing/retainer is over the threads of the 45 degree box connector.
    d. Insert the 45-degree box connector, with the conduit attached, through the hole in the bottom of the terminal box.
    e. Thread the lock nut onto the box connector inside the terminal box and tighten to secure the connector to the box.
    f. Connect the heater cable wires to the heater terminals in accordance with the wire tags.
    g. Secure the heater cap onto the heater using the four screws.

RO Feed Pump P-4 Pump/Motor Assembly Replacement:

Parts (TM 10-4610-309-24P):
RO Feed Pump P-4 pump/motor assembly
Gasket, inlet flange
Gasket, outlet flange
Materials:
Clean, dry rags
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace RO Feed Pump P-4 Pump/Motor Assembly as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing the RO feed pump. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

1. Remove the RO Feed Pump P-4 Assembly from the TWPS skid as follows (see Figure 3):
    a. Make sure the TWPS is in Standby Shutdown With Drain-Down.
    b. Remove the terminal box cover from the pump motor (2 cap screws).
    c. Tag and disconnect the pump power cable wires and the motor wires (7 wires).
    d. Remove the power cable lock nut from the box connector.
    e. Pull the box connector and power cable as an assembly out of the terminal box.
    f. Open RO Feed Pump Drain Valve V-211. Once drained, remove the P-4 drain tubing.
    g. Remove the four cap screws, eight flat washers, and four lock nuts that connect the pump inlet flange to the RO feed tank discharge pipe flange. Push the pipe back and remove the gasket. Inspect the gasket and replace if necessary.
    h. Remove the four cap screws, eight flat washers, and four lock nuts that connect the pump outlet flange to the RO feed pump discharge pipe flange.

i. Remove the four cap screws, four lock washers, and four flat washers that connect the pump assembly base plate to the TWPS skid. Move the pump slightly and remove the outlet flange gasket. Inspect the gasket and replace if necessary.

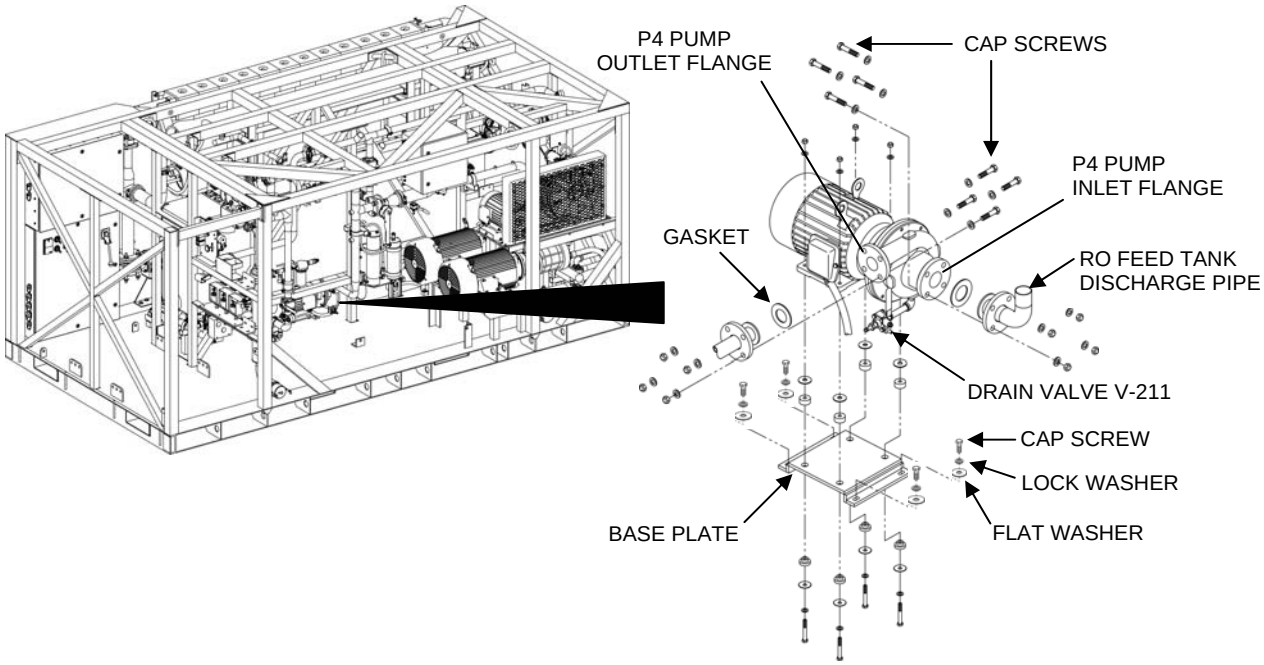

Figure 3. RO Feed Pump P4 Assembly Removal.

WARNING

Two person lift. Two people are required to move the pump assembly. Slide the pump toward the front of the skid. If it is necessary to move the assembly to another location to work on it, lift with your legs, not your back. Failure to observe this warning can result in back injury.

j. Slide the pump assembly toward the operator control station. Turn the pump and withdraw it motor-end first from under the tank.

2. Install the new RO Feed Pump P-4 Assembly onto the TWPS skid as follows (see Figure 3):
   a. Strip the junction box wires back.
   b. Slide the pump assembly into the clear space to the left of the pump mounting position under the RO Feed Tank. Slide roughly into place to match the piping flanges.
   c. Align the pump inlet flange with the RO Feed Tank discharge pipe. Insert the gasket. Install the four cap screws and eight flat washers. Loosely install the four lock nuts.
   d. Align the pump sufficiently to loosely install the four base plate cap screws, four lock washers, and four flat washers.
   e. Align the pump outlet flange with the RO Feed Pump discharge pipe. Insert the gasket. Install the four cap screws and eight flat washers. Loosely install the four lock nuts.
   f. Tighten the base plate cap screws.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0052 00**
UNIT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

NOTE
Be sure the gasket is positioned in the center as the cap screws are tightened.

g. Tighten the pump outlet flange nuts and cap screws.
h. Tighten the pump inlet flange nuts and cap screws.
i. Feed the tagged pump power cable wires and box connector through the bottom of the pump terminal box.
j. Screw the lock nut onto the box connector to secure the power cable to the box.
k. Reconnect the tagged pump power cable wires to the tagged motor wires.
l. Secure the terminal box cover gasket and cover to the pump motor terminal box using the two cap screws.

3. Place the pump back into service and inspect it for leaks.

RO Feed Pump P-4 Drain Valve V-211 Replacement:

Parts (TM 10-4610-309-24P):
RO Feed Pump P-4 Drain Valve
Material:
Tape, antiseizing (WP 0079, Table 1, item 43)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace RO Feed Pump P-4 Manual Drain Valve V-211 as follows (see Figure 4).

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing the RO feed pump. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

1. Make sure the TWPS is in Standby Shutdown With Drain-Down.
2. Remove the pump/motor assembly from the TWPS skid. Refer to **REPLACE** and **RO Feed Pump P-4 Pump/ Motor Assembly Replacement**.
3. Remove the drain hose from the drain valve.
4. Unscrew the drain valve from the street elbow. Discard the valve.
5. Clean off any tape residue remaining on the threads of the street elbow pipes.
6. Wrap antiseizing tape on the elbow pipe threads and screw the street elbow into the pump casing. Make sure the elbow, drain valve, and hose are facing in the same direction as the pump discharge flange.
7. Attach the drain hose to the valve outlet.
8. Install the RO Feed Pump P-4 Assembly onto the TWPS skid. Refer to **REPLACE** and **RO Feed Pump P-4 Pump/ Motor Assembly Replacement**.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0052 00**
UNIT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

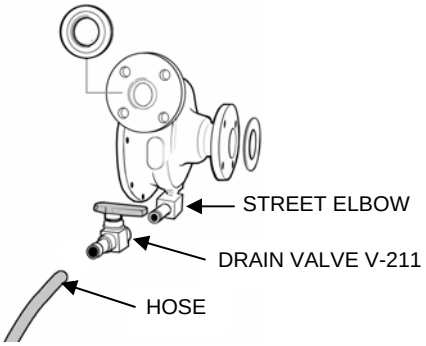

Figure 4. RO Feed Pump P-4 Drain Valve V-211 Replacement.

RO Feed Pump P-4 Electric Motor Replacement:

Parts (TM 10-4610-309-24P):
RO Feed Pump P-4 Electric Motor Assembly
Materials:
Glycerin (BII) (WP 0079, Table 1, item 21)
Solvent (WP 0079, Table 1, item 19)
Clean, dry rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace the RO Feed Pump P-4 electric motor as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing the RO Feed Pump. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

1. Make sure the TWPS is in Standby Shutdown With Drain-Down.
2. Remove the pump/motor assembly from the TWPS skid. Refer to **REPLACE** and **RO Feed Pump P-4 Pump/ Motor Assembly Replacement**.
3. Remove the pump from the adapter. Refer to **REPAIR** and **RO Feed Pump P-4 Pump Repair**.
4. Remove the four cap screws that hold the adapter to the motor (see Figure 5).
5. Remove the adapter, slinger and splash plate.

WARNING

Two person lift. Two people are required to safely move the motor. Lift with your legs, not your back. Failure to observe this warning can result in back injury.

6. Remove the four bolts, eight spacers, eight washers, and four nuts that hold the motor to its base and remove the motor.

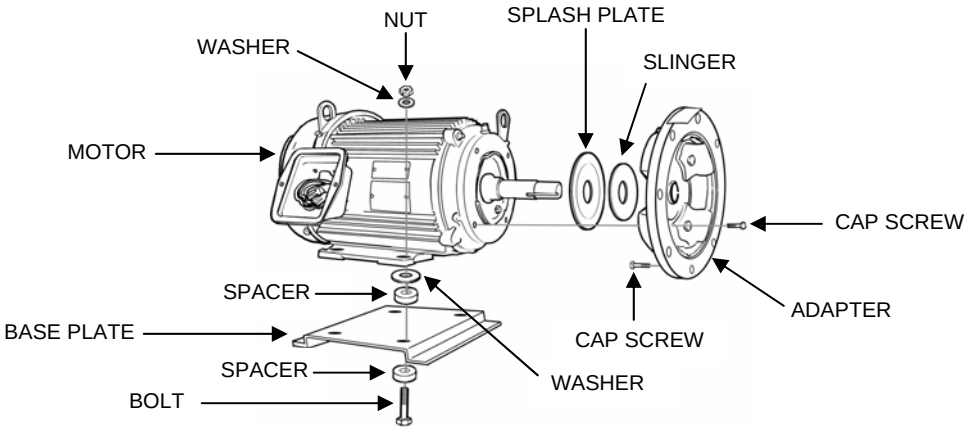

Figure 5. RO Feed Pump P4 Electric Motor Removal.

7. Secure the replacement motor to the motor base using the mounting hardware that was retained when the old pump motor was removed.
8. Install the splash plate and slinger on the motor drive shaft.
9. Attach the adapter to the replacement motor using the four cap screws.
10. Inspect the RO Feed Pump components, replace parts as needed, and install the pump onto the adapter. Refer to **REPAIR** and **RO Feed Pump P-4 Repair** in this work package.
11. Install the RO Feed Pump P-4 Assembly onto the TWPS skid. Refer to **REPLACE** and **RO Feed Pump P-4 Pump/ Motor Assembly Replacement**.
12. Place the RO Feed Pump back into service and inspect it for proper operation and leaks.

Inline RO Strainer S-4 Replacement:

Parts (TM 10-4610-309-24P):
Inline RO Strainer S-4 Body
Inline RO Strainer S-4 Mesh
4-in. Sanitary Clamp Gasket
2-in. Grooved Coupling Gasket
Material:
Tape, antiseizing (WP 0079, Table 1, item 43)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0052 00**
UNIT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

Replace inline RO Strainer S-4 as follows (see Figure 6):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing inline RO Strainer S-4. Failure to observe this warning can result in injury or damage to equipment.

1. Remove inline RO Strainer S-4 as follows:
    a. Close valve V-212 at the left of Strainer S-4.
    b. Open drain valve V-213 at the bottom of Strainer S-4.
    c. Remove the 2-in. grooved coupling at the right of Strainer S-4.
    d. Inspect the coupling gasket for damage or deterioration and replace if needed. Push the gasket back over the pipe end.
    e. Support Strainer S-4 and remove the 4-in. sanitary clamp at the left of Strainer S-4. Inspect the clamp gasket for damage and replace if necessary.
    f. Remove the strainer assembly.
    g. Remove and discard the strainer's interior mesh.
    h. Unscrew Drain Valve V-213 and its hose assembly from the strainer body.

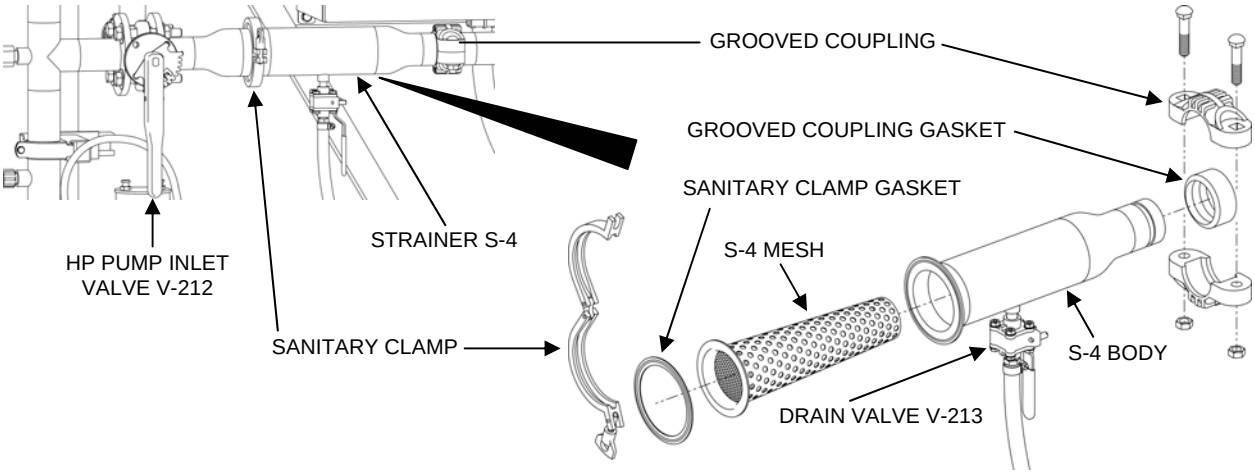

Figure 6. Inline RO Strainer S-4 Replacement.

2. Install Strainer S-4 as follows:
    a. Clean off any tape residue remaining on the threads of the drain valve.
    b. Wrap antiseizing tape on the drain valve pipe threads and screw the drain valve and hose assembly to the strainer drain port.
    c. Position the strainer mesh in the strainer body. Set the sanitary gasket in place on the strainer body flange.
    d. Set the strainer body in place. Be sure that the gasket is properly positioned and the strainer flange is centered.
    e. Install and partially tighten the sanitary clamp.

f. Push the grooved coupling gasket back into place. Install and partly tighten the coupling.
g. Tighten the sanitary clamp and then the grooved coupling.
h. Make sure Drain Valve V-213 is closed.
i. Open HP Pump Inlet Valve V-212.

HP Pump Relief Valve RV-301 and RO Feed Relief Valve RV-302 Replacement:

Parts (TM 10-4610-309-24P):
HP Pump Relief Valve RV-301
RO Feed Relief Valve RV-302
Material:
Tape, antiseizing (WP 0079, Table 1, item 43)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace HP Pump Relief Valve RV-301 or RO Feed Relief Valve RV-302 as follows (see Figure 7):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing Relief Valve RV-301 or RV-302. Failure to observe this warning can result in injury or damage to equipment.

1. Make sure the TWPS is in Standby Shutdown With Drain-Down.
2. Unthread the nipple, elbow, and the relief valve assembly from its pipe.
3. Remove the nipple and elbow from the relief valve.
4. Clean off any tape residue remaining on the threads of the nipple.
5. Wrap antiseizing tape on the nipple threads and screw the nipple and elbow assembly into the new relief valve.
6. Wrap antiseizing tape on the new valve threads and screw the valve assembly into the pipe.
7. Make sure that the open end of the elbow is positioned as shown in Figure 7.

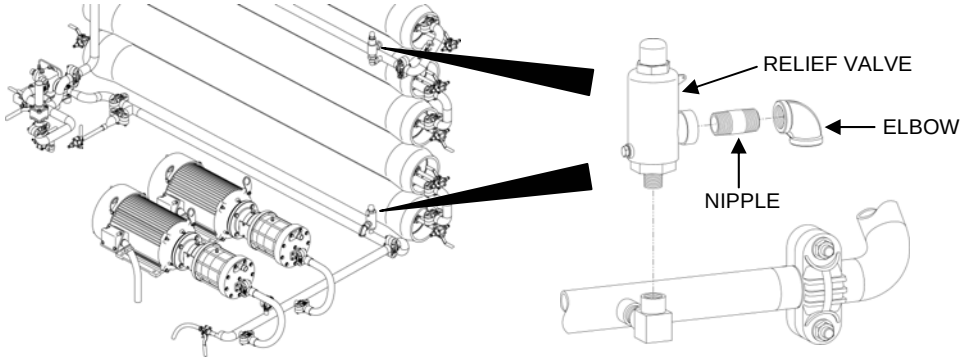

Figure 7. HP Pump Relief Valve RV-301 and RO Feed Relief Valve RV-302 Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0052 00**
UNIT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

RO Product Flow Three-Way Valves V-501 through V-510 Replacement:

Parts (TM 10-4610-309-24P):
RO Product Flow Three-Way Valve
Hose, ½" ID x ¾" OD, Black Reinforced PVC, Bulk
Material:
Tape, antiseizing (WP 0079, Table 1, item 43)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace any of the RO Product Flow Three-way Valves V-501 through V-510 as follows (see Figure 8):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing any of the RO Product Flow Three-Way Valves V-501 through V-510. Failure to observe this warning can result in injury or damage to equipment.

1. Remove the three-way valve as follows:
   a. Make sure the TWPS is in Standby Shutdown With Drain-Down.
   b. Loosen the hose clamps and remove the hoses from the sample and product outlet ports of the three-way valve. It may be necessary to cut the black product outlet hose to remove it from the hose barb.
   c. Unscrew the valve from the RO vessel product water outlet pipe.
   d. Unscrew the hose barbs from the sample and product outlet ports of the three-way valve.
   e. Discard the valve.

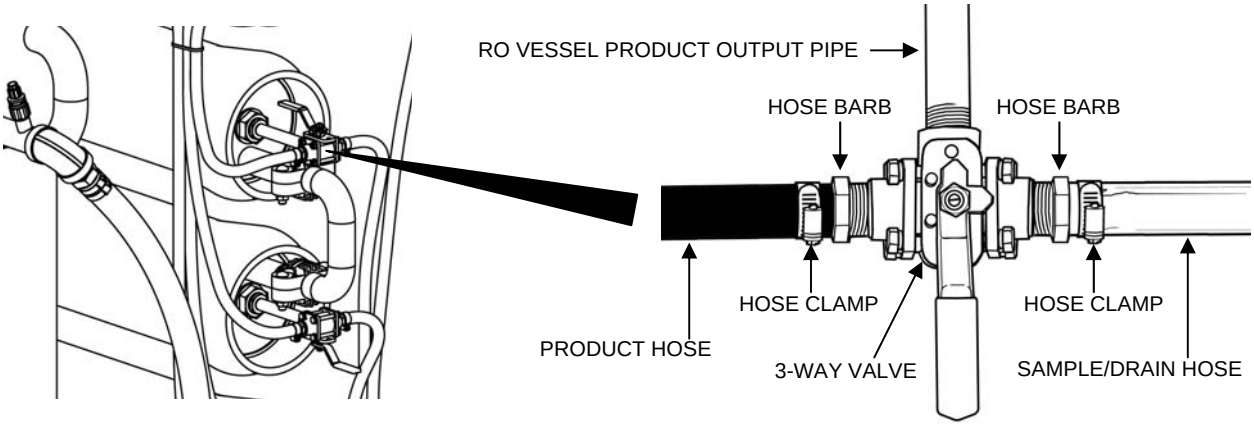

Figure 8. RO Product Three-Way Valve Replacement.

2. Install the new three-way valve as follows:

a. Clean off any tape residue remaining on the threads of the hose barbs and the RO vessel product water outlet pipe.
b. Wrap antiseizing tape on the threaded ends of the hose barbs and thread the hose barbs into the sample and product outlet ports of the new three-way valve.
c. Wrap antiseizing tape on the threads of the new three-way valve and thread the new three-way valve onto the RO vessel product outlet pipe.
d. Slide the hose clamp and hose over the end of the sample and product outlet barbs of the three-way valve. If the product hose is replaced, cut it to length such that it does not have a low point below the 3-way valve.
e. Tighten the hose clamp around the hoses and barbs.

Product Relief Valve RV-501 Replacement:

Parts (TM 10-4610-309-24P):
Product Relief Valve RV-501
Gasket
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace Product Relief Valve RV-501 as follows (see Figure 9):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing product Relief Valve RV-501. Failure to observe this warning can result in injury or damage to equipment.

1. Remove Product Relief Valve RV-501 as follows:
   a. Open Product Utility Valve V-511 to drain the product line. Then close the valve.
   b. Remove the sanitary clamp, gasket, and elbow pipe from the relief valve and fixed pipe.
   c. Inspect the gasket and replace if necessary.
   d. Remove and discard the relief valve.

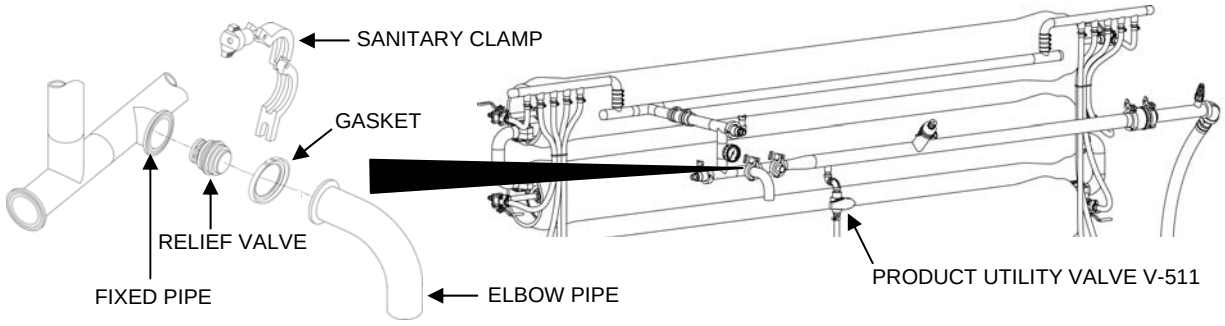

Figure 9. Product Relief Valve RV-501 Replacement.

2. Install the new product relief valve as follows:
    a. Position the new relief valve with the spring pointing upstream toward the fixed pipe and the disk pointing downstream toward the removable elbow pipe.
    b. Secure the fixed pipe, the new relief valve, the gasket, and the elbow pipe together using the sanitary clamp.

Product Vacuum Breaker VB-501 Replacement:

Parts (TM 10-4610-309-24P):
Product Vacuum Breaker VB-501
1-½ in. Sanitary Clamp Gasket
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace Product Vacuum Breaker VB-501 as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing Vacuum Breaker VB-501. Failure to observe this warning can result in injury or damage to equipment.

1. Remove Product Vacuum Breaker VB-501as follows (see Figure 10):
    a. Open Product Utility Valve V-511 to drain the product line, then close the valve.
    b. Remove the sanitary clamp that secures Product Vacuum Breaker VB-501 between the fixed pipe and the removable pipe.
    c. Remove the removable pipe.
    d. Discard the vacuum breaker.
    e. Inspect the sanitary clamp gasket for damage or deterioration and replace if needed.

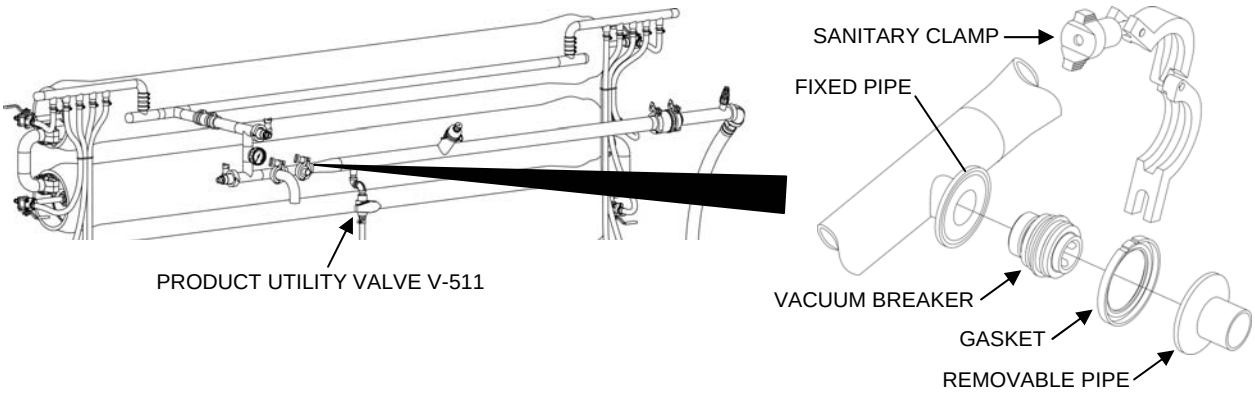

Figure 10. Product Vacuum Breaker VB-501 Replacement.

2. Install the new vacuum breaker as follows:
    a. Position the new vacuum breaker with the disk pointing upstream toward the fixed pipe and the spring pointing downstream toward the removable pipe.
    b. Secure the new vacuum breaker, the fixed pipe, the gasket, and the removable pipe together using the sanitary clamp.

Product Check Valve V-512 Replacement:

Parts (TM 10-4610-309-24P):
Product Check Valve V-512
1-½ in. Sanitary Clamp Gasket
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace Product Check Valve V-512 as follows (see Figure 11):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing Check Valve V-512. Failure to observe this warning can result in injury or damage to equipment.

1. Remove Product Check Valve V-512 as follows:
    a. Open Product Utility Valve V-511 to drain the product line.
    b. Loosen the pipe clamp holding the product pipe downstream of the check valve (not shown in Figure).
    c. Remove the sanitary clamps on both sides of Product Check Valve V-512.
    d. Slide the pipe section toward the outlet to gain clearance and remove the check valve.
    e. Inspect the 1-½ in. diameter sanitary clamp gaskets for damage or deterioration and replace if needed.

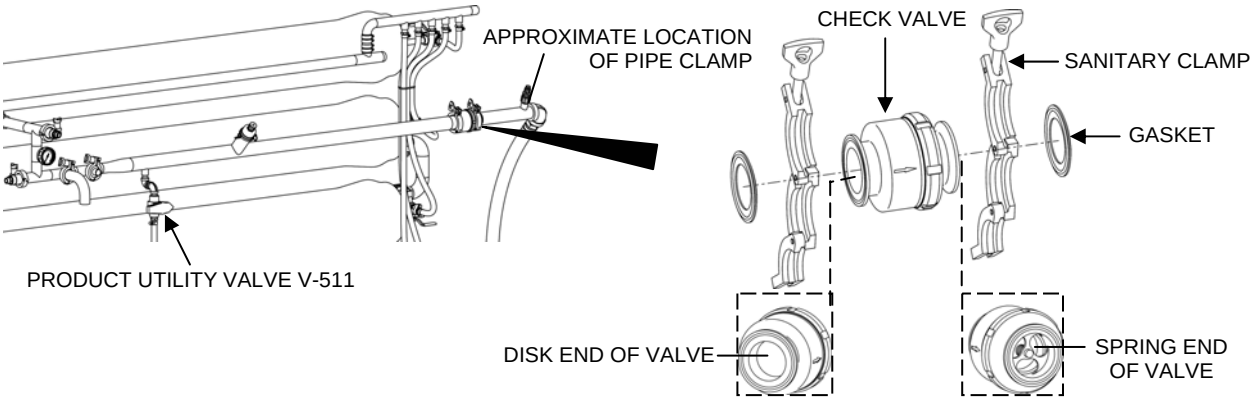

Figure 11. Product Check Valve V-512 Replacement.

2. Install the new product check valve as follows:
    a. Position the new product check valve in-line with the disk pointing upstream toward Product Vacuum Breaker VB-501 and with the check valve spring pointing downstream toward the chemical injection point and discharge end of the product line.
    b. Be sure the gasket is in place between the valve and the upstream pipe flange. Install the sanitary clamp and tighten.
    c. Be sure the gasket is in place between the valve and the downstream pipe section. Push the pipe section up to the check valve. Install the sanitary clamp and tighten.
    d. Re-tighten the pipe clamp.

Main and Auxiliary Pressure Control Valves HCV-401 and HCV-401A Replacement:

Parts (TM 10-4610-309-24P):
Main Pressure Control Valve HCV-401
Auxiliary Pressure Control Valve HCV-401A
Material:
Tape, antiseizing (WP 0079, Table 1, item 43)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace Main Pressure Control Valve HCV-401 or Auxiliary Pressure Control Valve HCV-401A as follows (see Figure 12):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing Main Pressure Control Valve HCV-401 or Auxiliary Pressure Control Valve HCV-401A. Failure to observe this warning can result in injury or damage to equipment.

1. Remove Main Pressure Control Valve HCV-401 or Auxiliary Pressure Control Valve HCV-401A as follows:
    a. Make sure the TWPS is in Standby Shutdown With Drain-Down.
    b. Loosen and remove the hose clamp and hose from the outlet side of the pressure control valve.
    c. Unscrew the valve from the threaded inlet pipe at the inlet side of the valve.
    d. Unscrew the threaded outlet pipe from the outlet side of the valve.
    e. Discard the valve.
2. Install the new valve as follows:
    a. Clean off any tape residue remaining on the threaded end of both the valve inlet and outlet pipes.

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NOTE

Make sure to thread the outlet pipe into the outlet port of the pressure control valve. An arrow on the side of the Main Pressure Control Valve HCV-401 points to the outlet port of the valve. With the valve open, the valve handle of Auxiliary Pressure Control Valve HCV-401A points to the outlet port of the valve.

b. Wrap antiseizing tape on the outlet pipe threads and screw the outlet pipe into the outlet port of the new pressure control valve.
c. Wrap antiseizing tape on the inlet pipe threads and thread the new pressure control valve onto the inlet pipe.
d. Install the hose clamp and outlet hose over the end of the outlet pipe and tighten the clamp.

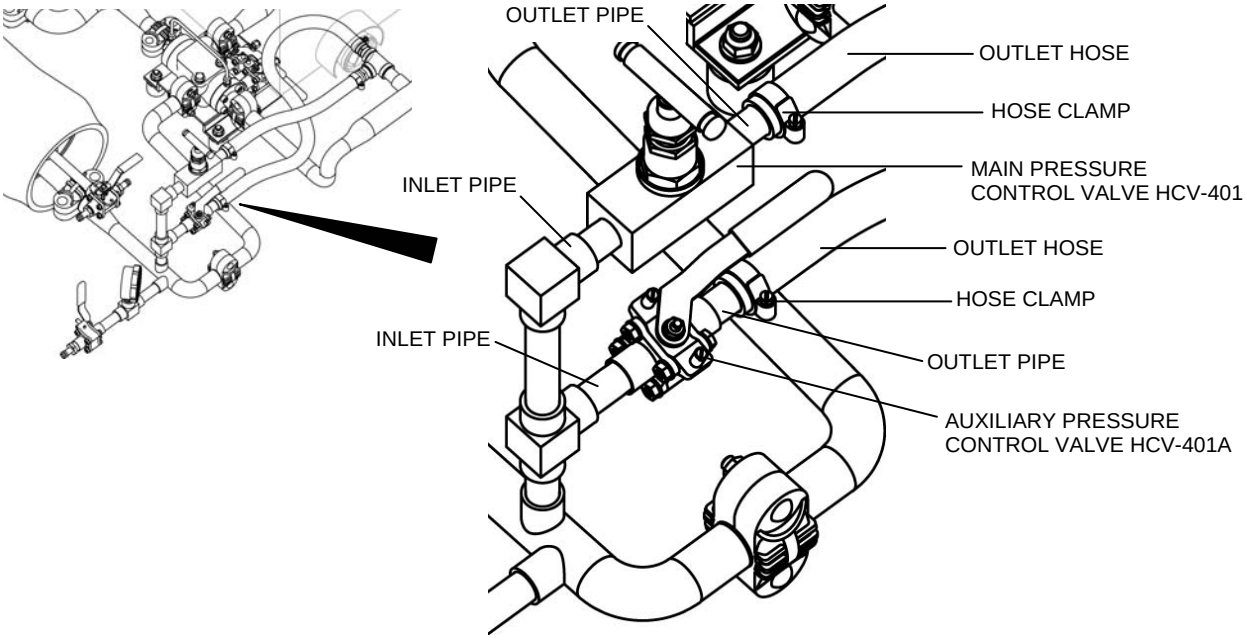

Figure 12. Main Pressure Control Valve HCV-401 Replacement.

Pressure Recovery Turbocharger PRT-1 Replacement:

Parts (TM 10-4610-309-24P):
Pressure Recovery Turbocharger
1-in. grooved coupling gasket
Material:
Corrosion preventive compound (WP 0079, Table 1, item 17)
Glycerin (WP 0079, Table 1, item 21)
Tape, antiseizing (WP 0079, Table 1, item 43
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

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Replace Pressure Recovery Turbocharger PRT-1 as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing Pressure Recovery Turbocharger PRT-1. Failure to observe this warning can result in injury or damage to equipment.

1. Remove Pressure Recovery Turbocharger PRT-1 from the TWPS as follows (see Figure 13):
   a. Make sure the TWPS is in Standby Shutdown With Drain-Down.
   b. Open the turbocharger reject drain valve V-410.
   c. Open the turbocharger feed drain valve V-303.
   d. Remove the four grooved couplings that secure the inlet and outlet connections of the turbocharger to the RO feed and reject inlet and outlet pipes. Push the gaskets back onto the pipe ends.
   e. Remove the second grooved coupling from the “S” shaped pipe between the RO vessel #5 reject outlet and the turbocharger. Remove the pipe and lay aside.
   f. Remove the two turbocharger plastic drain tubes (see Figure 14).
   g. Remove the four lock nuts and flat washers from the threaded studs that secure the turbocharger base plate to the TWPS floor.
   h. Remove the turbocharger valve bracket and set aside (see Figure 14).
   i. Lift the turbocharger assembly off of the studs and remove it from the TWPS.

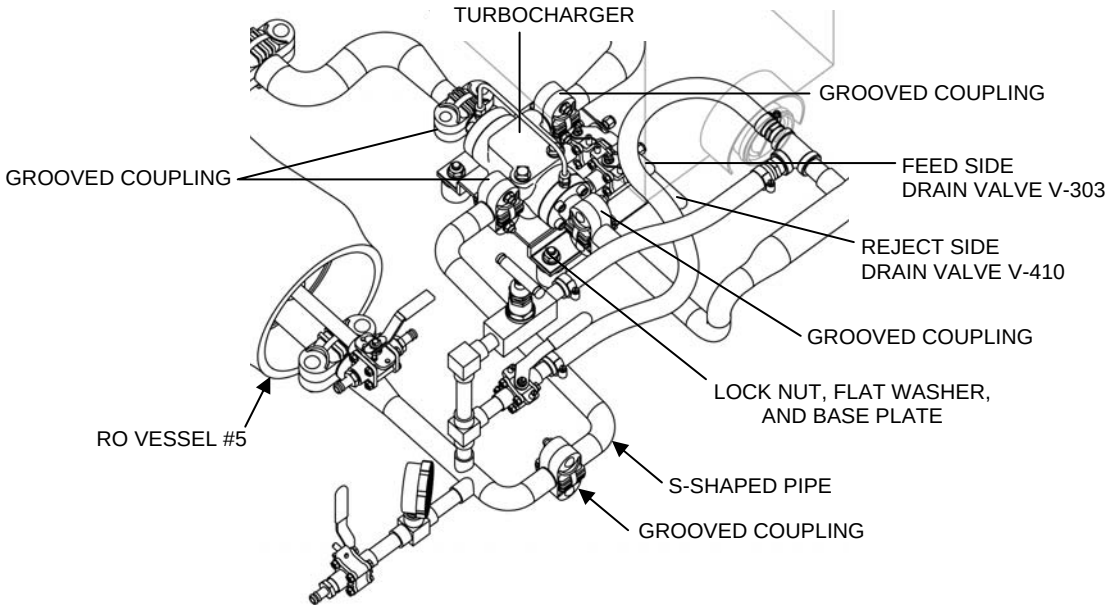

Figure 13. Removal of Pressure Recovery Turbocharger PRT-1 from the TWPS.

2. Remove Pressure Recovery Turbocharger PRT-1 from its base plate as follows (see Figure 14):
   a. Unscrew the drain tube nuts from the elbow fittings under the turbocharger.
   b. Set drain valves V-410 and V-303 (with their metal drain tubes still attached) aside.
   c. Unscrew the two elbow fittings from the bottom of the turbocharger.
   d. Remove the four cap screws, four lock washers, and four flat washers that secure the base plate to the bottom of the turbocharger and remove the turbocharger.
   e. Unscrew the two straight fittings from the bottom of the turbocharger.

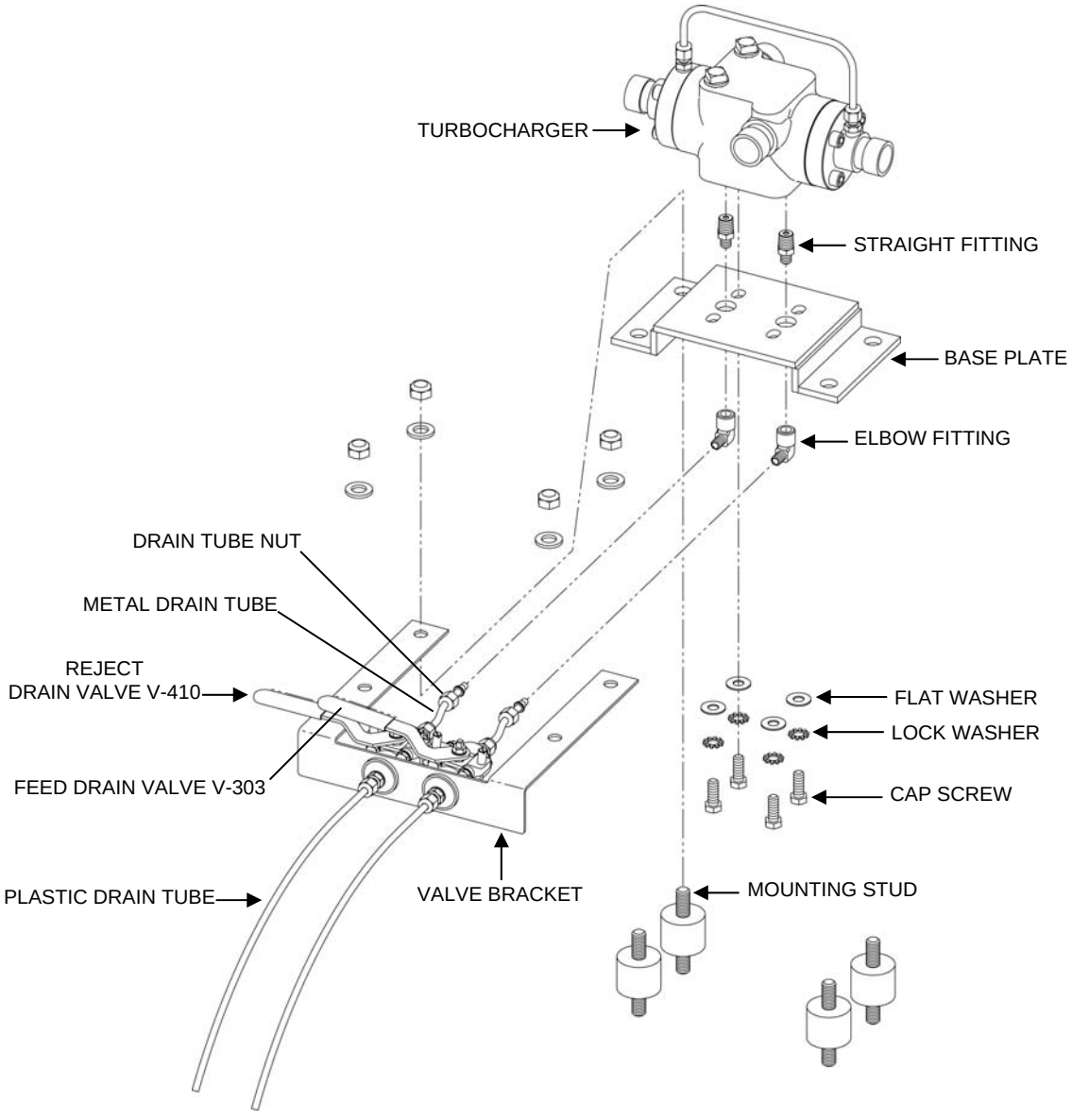

Figure 14. Removal of Pressure Recovery Turbocharger PRT-1 from Its Base Plate.

3. Install the new turbocharger to the base plate as follows (see Figure 14):
    a. Clean the external threads of the straight and elbow fittings.
    b. Wrap antiseizing tape on the threads at both ends of the straight fittings and screw them into the bottom of the turbocharger.
    c. Secure the base plate to the turbocharger using the four caps crews, four lock washers, and four flat washers.
    d. Wrap antiseizing tape on the threads of the elbow fittings and screw the elbow fittings into the straight fittings at the bottom of the turbocharger. Make sure the elbow fittings point out to the front of the turbocharger.
    e. Move the drain valves into place on the base plate and screw the drain tube nuts onto the elbow fittings under the turbocharger.
4. Install the turbocharger assembly onto the TWPS as follows (see Figure 13):
    a. Inspect the four 1-in. diameter grooved coupling gaskets for damage or deterioration and replace if needed. Lubricate with glycerin and slide the gaskets over the RO feed and reject inlet and outlet pipes.

WARNING

The turbocharger feed and reject inlet and outlet pipes must be installed to the correct system feed and reject inlet and outlet pipes. Failure to observe this warning can result in injury or damage to equipment.

    b. Apply corrosion preventive compound to the turbocharger mounting studs that are still threaded into the TWPS floor (see Figure 14).
    c. Set the turbocharger in place so that the holes in the base plate fit over the studs. Make sure the valves are facing the front of the TWPS.
    d. Set the valve bracket into place.
    e. Secure the valve bracket and base plate to the studs with the four flat washers and four lock nuts. Tighten evenly.
    f. Reconnect the “S” shaped reject out pipe to the RO vessel #5 reject out pipe.
    g. Reposition the grooved coupling gaskets to fit over the ends of the turbocharger inlet and outlet pipes and their matching RO feed and reject inlet and outlet lines.
    h. Secure the turbocharger inlet and outlet pipes to the RO feed and reject inlet and outlet lines using the grooved couplings.
    i. Reconnect the two plastic drain tubes.
    j. Place system back into service and inspect for leaks.

Turbocharger Feed Drain Valve V-303 and Reject Drain Valve V-410 Replacement:

Parts (TM 10-4610-309-24P):
    Turbocharger Feed Drain Valve V-303
    Turbocharger Reject Drain Valve V-410
Material:
    Tape, antiseizing (WP 0079, Table 1, item 43
Equipment Condition:
    TWPS in Standby Shutdown With Drain-Down
    Army: TWPS main breaker off
    Marine Corps: TWPS disconnected from power source

Replace Turbocharger Feed Drain Valve V-303 or Reject Drain Valve V-410 as follows (see Figure 15):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing Pressure Recovery Turbocharger PRT-1 or the Turbocharger Feed and Reject Drain Valves V-303 and V-410. Failure to observe this warning can result in injury or damage to equipment.

1. Make sure the TWPS is in Standby Shutdown With Drain-Down.
2. Remove the turbocharger from the TWPS. Refer to **REPLACE** and **Pressure Recovery Turbocharger PRT-1**.
3. Remove the drain valve as follows:
   a. Unscrew the drain tube nut from the front of the valve and remove the plastic drain tube.
   b. Unscrew the drain tube nut from the back of the valve and remove the valve from the metal drain tube.
   c. Discard the valve.

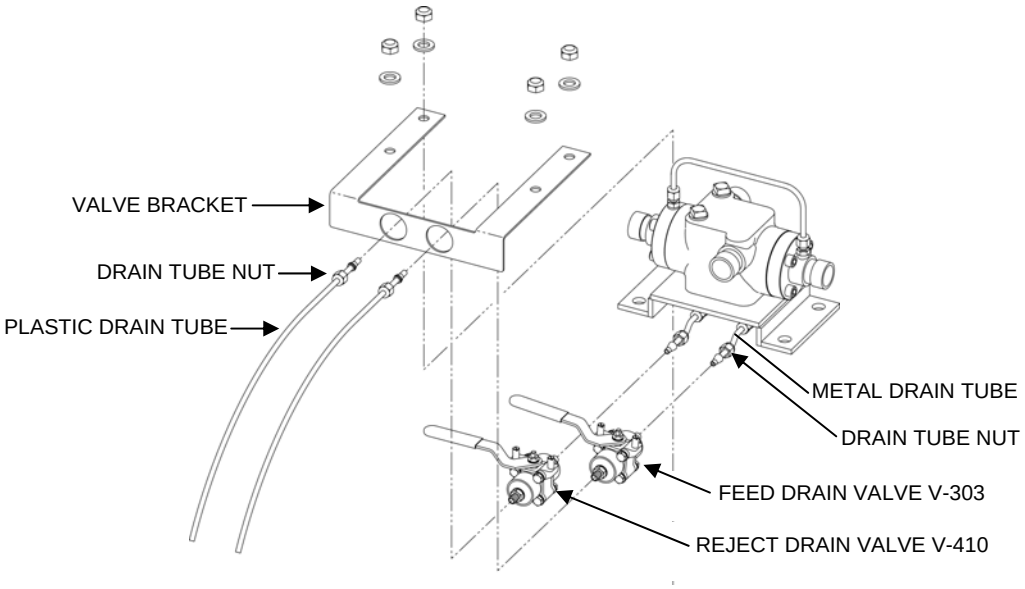

Figure 15. Turbocharger Feed or Reject Drain Valve V-303 / V-410 Replacement.

4. Install the new drain valve as follows:
   a. Wrap antiseizing tape on the valve inlet and outlet threads.
   b. Note the proper orientation of the valve (see Figure 15).
   c. Screw the drain tube nut on the metal drain tube onto the inlet of the valve.
   d. Fit the valve outlet through the opening in the front of the valve bracket and screw the drain tube nut on the plastic drain tube onto the outlet of the valve.
5. Install the turbocharger assembly onto the TWPS. Refer to **REPLACE** and **Pressure Recovery Turbocharger PRT-1**.

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Reject Backflow Check Valve V-411 Replacement:

Parts (TM 10-4610-309-24P):
Reject Backflow Check Valve V-411
1-½ in. Grooved Coupling Gasket
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Replace Reject Backflow Check Valve V-411 as follows (see Figure 16):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing Reject Backflow Check Valve V-411. Failure to observe this warning can result in injury or damage to equipment.

1. Remove the grooved couplings from both ends of Reject Backflow Check Valve V-411. Slide the gaskets back over the pipe ends.
2. Remove Reject Backflow Check Valve V-411.
3. Inspect the 1-½ in. diameter grooved coupling gaskets for damage or deterioration and replace if needed.
4. Position the new Reject Backflow Check Valve V-411 in the reject line so that the arrow on the side of the valve points downstream (to the right) and the hinge post is vertical.
5. Secure the ends of the Reject Backflow Check Valve V-411 to the reject line using the two grooved couplings.

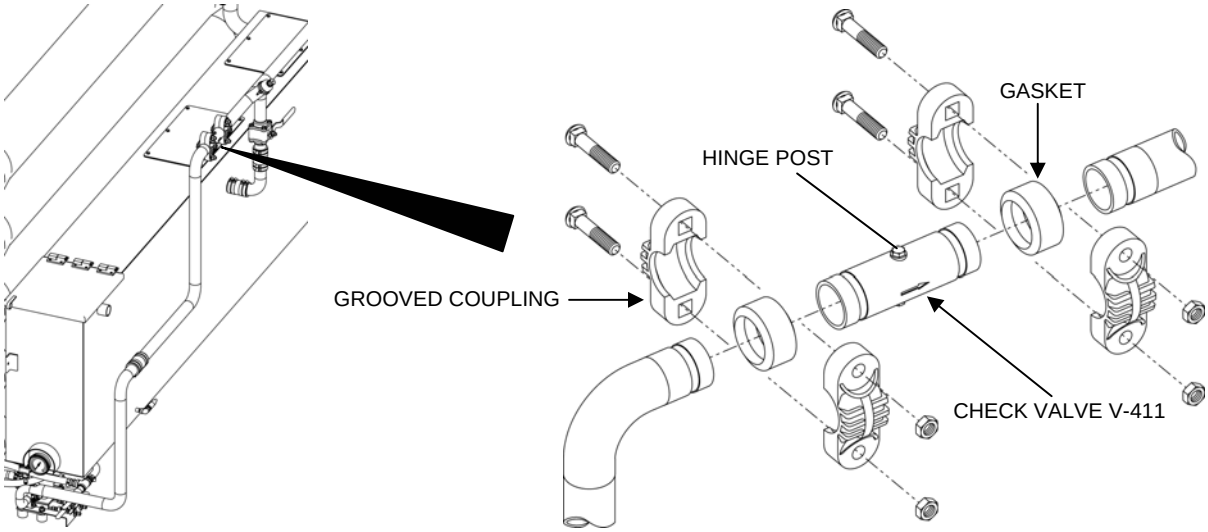

Figure 16. Reject Backflow Check Valve V-411 Replacement.

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Waste Out Hose and Adaptor A-09 Replacement:

Parts (TM 10-4610-309-24P):
- 4-in. x 5-ft. waste outlet suction hose
- 4-in. suction hose gasket
- Adaptor A-09
- Gasket, 4-in. adaptor
- Gasket, 6-in. adaptor
- 6-in. x 50-ft. waste outlet discharge hose

Equipment Condition:
- TWPS in Standby Shutdown Without Draining Down
- Army TWPS: TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Inspect and replace the waste outlet hoses, Adaptor A-09, and hose and adaptor gaskets as follows (see Figure 17:

WARNING

High velocity discharge hazard. The blow back step of the automatic MF backwash operation results in a sudden and very high velocity surge in the waste outlet hoses. The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing reject hose or adaptor A-09. Failure to observe this warning can result in injury.

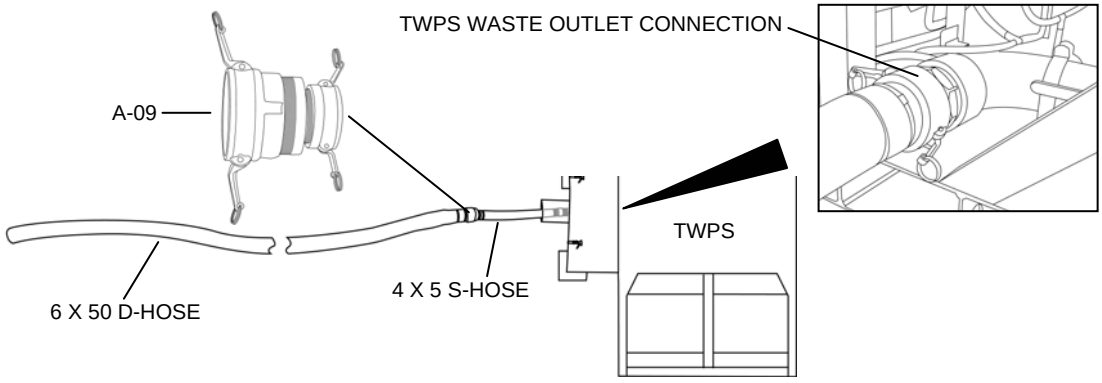

Figure 17. Waste Outlet Hoses and Adaptor A-09.

1. Inspect the 4-in. by 5-ft. waste outlet suction hose for leaks, cracks or other damage.
2. Replace the entire hose assembly if damage is found.
3. Inspect adaptor A-09 for leaks, cracks, or other damage.
4. Replace adaptor A-09 if damage is found.
5. Inspect the 6-in. by 50-ft. waste outlet discharge hose for leaks, cracks or other damage.
6. Replace the entire hose assembly if damage is found.
7. Check the female ends of the 4 x 5 hose and adaptor A-09 for missing or damaged gaskets.
8. If a gasket is missing or damaged, install a new gasket in the female end of the hose or adaptor.

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REPAIR

Waste Out Rupture Disk RD-401 Repair:

Parts:
Rupture disk (BII and TM 10-4610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the rupture disk in Waste Out Rupture Disk RD-401 assembly as follows (see Figure 18):

WARNING

High velocity discharge hazard. The blow back step of the automatic MF backwash operation results in a sudden and very high velocity surge in the waste outlet hoses. The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing waste out rupture disk RD-401. Failure to observe this warning can result in injury.

1. Remove the rupture disk from rupture disk assembly RD-401 as follows:
   a. Note the position of the vent pipe for the position it needs to be in when reinstalled.
   b. While holding the vent pipe, unthread the nut from the inlet connection.
   c. Carefully lift the vent pipe and nut off of the inlet connection. The outlet connection will come out with the vent pipe and nut.
   d. Lift the rupture disk off of the inlet connection.

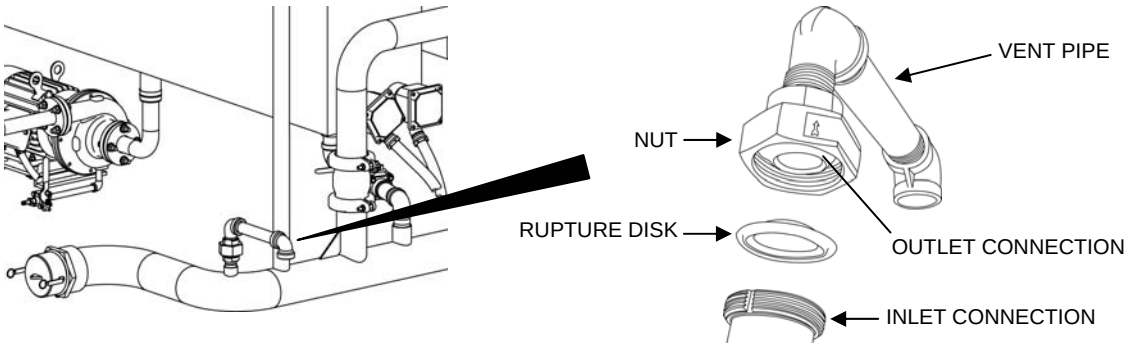

Figure 18. RD-401 Rupture Disk Replacement.

2. Install the new rupture disk as follows:
   a. Insert a new rupture disk in the inlet connection with the dome side of the disk facing up.
   b. Position the outlet connection, nut and vent pipe onto the rupture disk.
   c. Thread the nut onto the inlet connection, position the vent pipe as it was before it was removed, and tighten the nut.

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RO Feed Tank Cover Hinge Repair:

Parts (TM 10-4610-309-24P):
Nylon Liftoff Hinge
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down

Replace a nylon liftoff hinge on the RO feed tank cover as follows (see Figure 19):

WARNING

High velocity discharge hazard. The blow back step of the automatic MF backwash operation results in a sudden and very high velocity surge in the RO feed tank. There is no risk of injury from this surge while working on the RO feed tank cover. However, the suddenness of the surge and the noise accompanying it may startle the worker into a reflexive reaction that could result in injury. Therefore, the TWPS must be in Shutdown prior to working on the RO feed tank cover. Failure to observe this warning can result in injury.

CAUTION

Do not allow the screws, lock washers, or nuts to fall into the RO feed tank. Pump inlet strainer S-3 will not prevent this mounting hardware from entering the pump. Failure to observe this caution can result in severe damage to and the failure of the RO feed pump if the hardware is sucked into the pump.

1. Remove the four screws, lock washers, and nuts from the hinge to be replaced.
2. Lift off the hinge.
3. Place the new hinge on the RO feed tank and feed tank cover.
4. Secure the new hinge using the four screws, lock washers, and nuts.

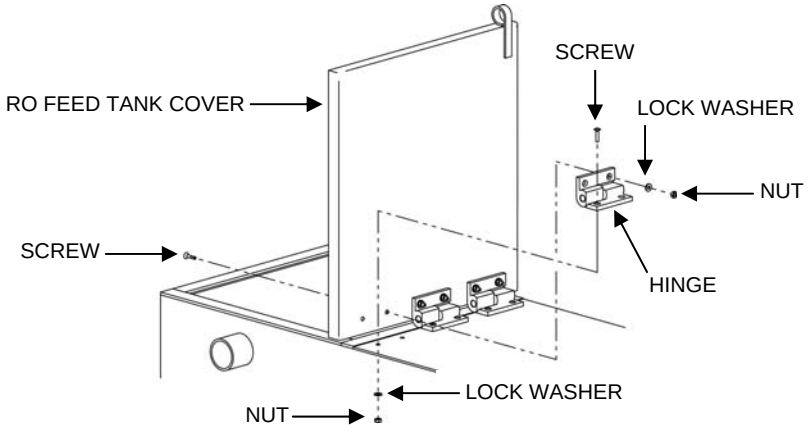

Figure 19. RO Feed Tank Cover Hinge Replacement.

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RO Feed Pump P-4 Repair:

Parts (TM 10-4610-309-24P):
- Seal Kit
- Shaft Sleeve
- Wear Ring

Materials:
- Solvent (WP 0079, Table 1, item 19)
- Glycerin (BII) (WP 0079, Table 1, item 21)
- Sealing compound (WP 0079, Table 1, item 35)
- Antiseizing tape (WP 0079, Table 1, item 43)
- Clean, dry rags (WP 0079, Table 1, item 33)

Equipment Condition:
- TWPS in Standby Shutdown With Drain-Down
- Army: Generator off and TWPS main breaker off
- Marine Corps: TWPS disconnected from power source

Repair RO Feed Pump P-4 (including inspecting and replacing the pump seal, shaft sleeve, and wear ring) as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to removing or installing the RO feed pump. Failure to observe this warning can result in injury or death from electrocution or damage to equipment.

1. Make sure the TWPS is in Standby Shutdown With Drain-Down.
2. Remove the pump/motor assembly from the TWPS skid. Refer to **REPLACE** and **RO Feed Pump P-4 Pump/ Motor Assembly Replacement**.
3. Remove the pump from the adapter as follows (see Figure 20):
    a. Remove the eight cap screws that hold the pump casing to the adapter and pull the casing off.
    b. Remove and discard the pump casing gasket.
    c. Unscrew the street elbow with the drain valve and hose from the pump drain port.

NOTE

It may be necessary to hold the impeller using a strap wrench or a pipe wrench to keep it from turning while loosening the screw with a socket wrench. If the screw is corroded onto the impeller, it may be necessary to apply corrosion preventive compound where the screw and impeller meet.

    d. Remove the impeller screw.
    e. Remove and discard the screw gasket.
    f. Carefully pry the impeller off of the shaft.
    g. Remove the spring.
    h. Remove the impeller key.
    i. Pull the shaft sleeve with the seal off the shaft.
    j. Lift the pump cover off the adapter. If required, carefully pry the cover off the adapter.

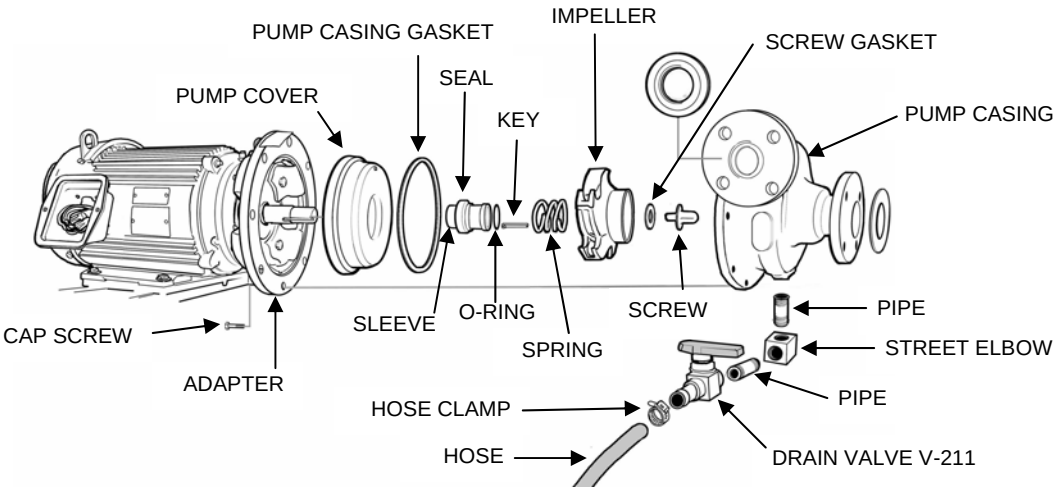

Figure 20. RO Feed Pump Removal.

4. Inspect the following parts for wear or damage:
    a. Seal on the shaft sleeve (do not remove the seal parts if not replacing).
    b. Stationary seat and stationary seat gasket in the pump cover (do not remove the stationary seat and seat gasket from the pump cover if not replacing them).
    c. Shaft sleeve.
    d. Wear ring.
5. If the seal kit (seal, stationary seat, seat gasket, and spring) and shaft sleeve need to be replaced, remove them as follows (see Figure 21):

NOTE

If the seal sticks tightly to the drive sleeve, it may be necessary to bathe it in oil to loosen the adhesive, or you may have to cut the seal away with a knife.

    a. Twist and slide the seal off the drive sleeve.
    b. Pry the stationary seat and seat gasket out of the bore of the pump cover.

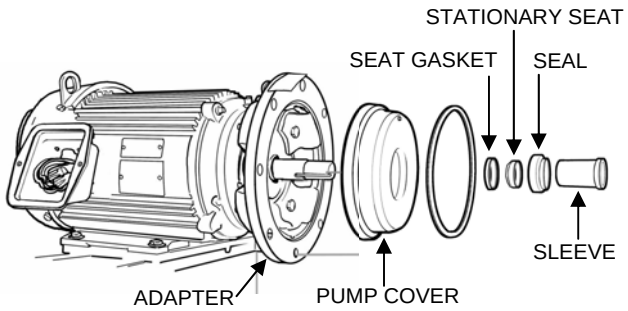

Figure 21. Seal Kit Component Removal.

6. Install a new seal kit (seal, stationary seat, seat gasket, and spring) and shaft sleeve as follows (see Figure 22):
    a. Clean the sleeve, pump cover bore, and pump shaft thoroughly with solvent, and dry with a clean cloth.

NOTE

Do not use grease to lubricate the sleeve and mechanical seal parts. Grease will prevent the seal from setting and result in leakage around the shaft.

Once the seal is placed onto the sleeve, the rest of the assembly must be completed without delay to ensure that the seal sets properly.

    b. Lightly lubricate the bore of the new pump cover with glycerin.
    c. Press the stationary seat gasket and then the stationary seat into the bore so they are seated firmly and squarely.
    d. Lightly lubricate the new seal with glycerin and slide it onto the new sleeve with the carbon side facing the small end of the sleeve. Complete the rest of the assembly without delay.
    e. Slide the new pump cover with the stationary seat over the shaft. Avoid bumping the seat as you slide it over the shaft.
    f. Position the pump cover so that the internal bypass hole in the cover is between the 1 and 2 o'clock position.
    g. Tap the cover with a rubber mallet if necessary to seat the cover securely.
    h. Insert the new sleeve O-ring into the I.D. of the sleeve if it is not already in place.
    i. Lubricate the I.D. of the sleeve and the O.D. (outer diameter) of the shaft with glycerin.
    j. Slide the sleeve with the seal onto the shaft with the small end of the sleeve going onto the shaft first. Push the sleeve all the way onto the shaft.
    k. Align the shaft and sleeve keyways.
    l. Position the key with the thick end of the key toward the motor and the flat back of the key against the motor shaft.
    m. Insert the key in the keyway.
    n. Discard the seal spring retainer and place the new spring over the end of the sleeve and over the seal assembly.
    o. Slide the impeller onto the shaft over the key.
    p. Place sealant on the impeller screw threads.
    q. Place the impeller screw gasket onto the impeller.
    r. Push down on the impeller and thread the impeller screw into the end of the shaft.
    s. Tighten the impeller screw.
    t. Check the freedom of the rotating parts by hand-rotating the impeller. If the impeller rubs against the pump cover, try tapping the cover down again with the rubber mallet to seat the cover on the adapter.

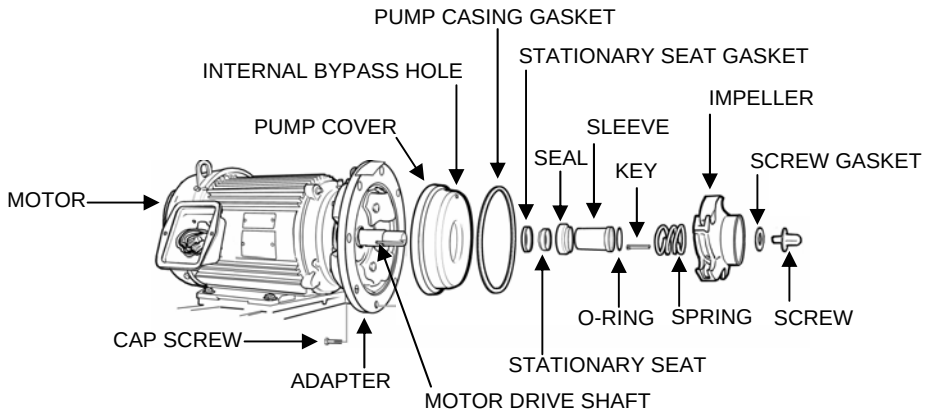

Figure 22. RO Feed Pump Installation.

7. If the wear ring is damaged, replace it as follows (see Figure 23):
    a. Drill a hole through the wear ring in two places opposite each other. Be careful not to damage the pump casing.
    b. Crack the remaining ring wall and remove the wear ring.
    c. Make sure the surfaces of the new wear ring and the pump casing where the ring is to be installed are free of burrs. Remove any burrs with a fine emery cloth.
    d. Press the new wear ring into place.
    e. Evenly drive the ring into place.

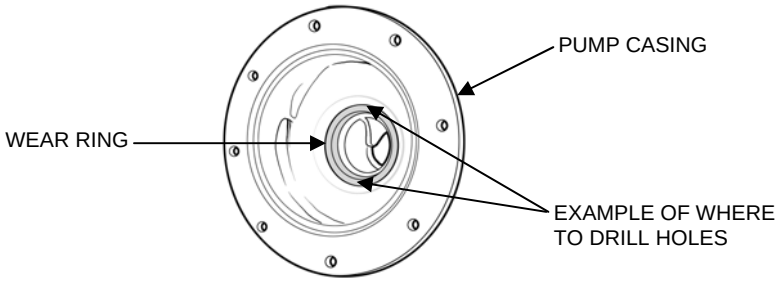

Figure 23. Wear Ring Removal.

8. Reinstall the pump casing as follows:
    a. Install a new pump casing gasket on the shoulder of the pump cover.
    b. Position the pump casing so that the pump discharge flange points toward you when the motor is on your left and the pump is on your right.
    c. Place the new pump casing onto the pump cover and secure with the eight cap screws.
    d. Tighten the cap screws uniformly.
    e. Clean off any tape residue remaining on the threads of the street elbow pipes.
    f. Wrap antiseizing tape on the elbow pipe threads and screw the street elbow into the pump casing. Make sure the elbow, drain valve, and hose are facing in the same direction as the pump discharge flange.

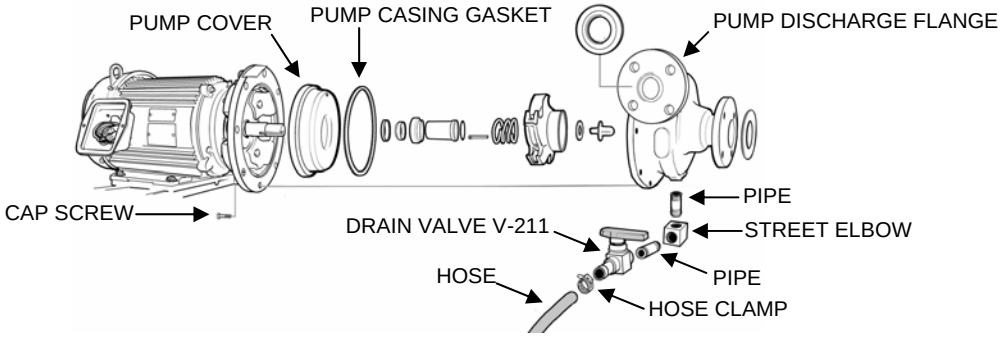

Figure 24. Pump Installation.

9. Install the RO Feed Pump P-4 Assembly onto the TWPS skid. Refer to **REPLACE** and **RO Feed Pump P-4 Pump/ Motor Assembly Replacement**.
10. Place the MF Feed Pump back into service and inspect it for leaks.

Pressure Recovery Turbocharger PRT-1 Repair:

Parts (TM 10-4610-309-24P):
Kit, turbocharger repair
Materials:
Glycerin (BII) (WP 0079, Table 1, item 14)
Clean, dry rags (WP 0079, Table 1, item 23)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source

Turbocharger repair consists of disassembling and inspecting the unit, and replacing worn or damaged parts. Repair the turbocharger as follows:

1. Make sure the TWPS is in Standby Shutdown With Drain-Down.
2. Remove the turbocharger from the TWPS and from its base plate. Refer to **REPLACE** and **Pressure Recovery Turbocharger PRT-1**.
3. Disassemble the turbocharger as follows (see Figure 25):
   a. Remove the thrust line assembly and straight adapters.
   b. Remove the pump and turbine end caps (4 cap screws).
   c. Remove and discard the cap O-rings.

NOTE

It may be necessary to remove the plug as indicated in Figure 25 and insert a thin screwdriver or other tool into the hole to keep the impeller from turning while you remove the retaining screw.

   d. Remove the pump impeller retaining screw and washer.
   e. Remove the pump impeller and impeller key by gently tapping on the end of the threaded turbine impeller shaft.
   f. Remove the turbine impeller/shaft assembly.

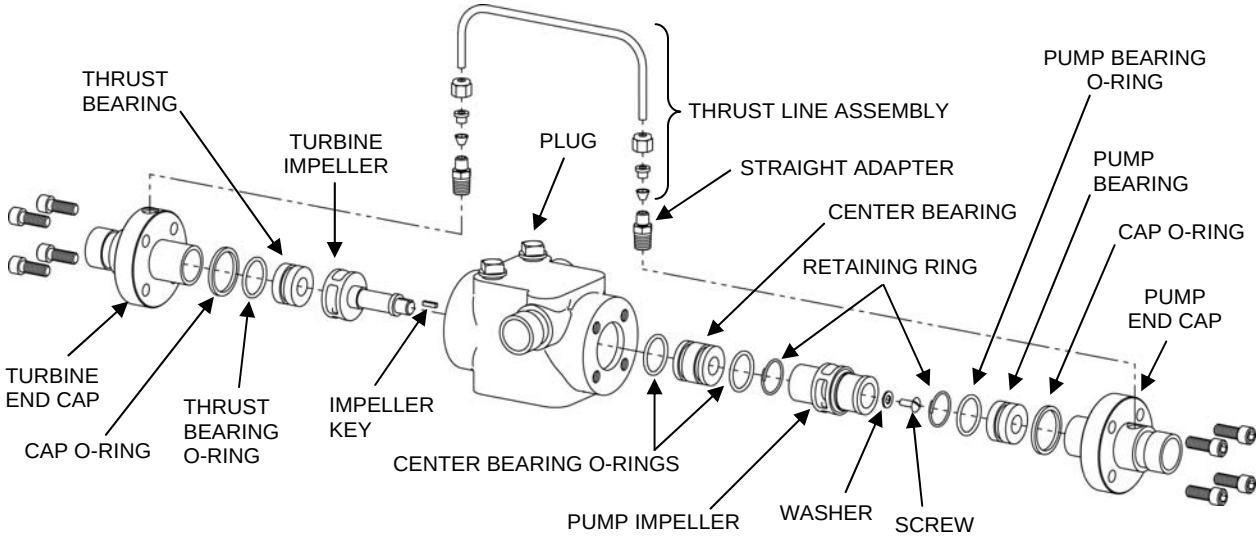

Figure 25. Pressure Recovery Turbocharger PRT-1.

NOTE
Light scratches are normal and not a reason to replace the components.

4. Inspect the bearing surfaces of the turbine impeller/shaft assembly for grooves or ridges. If you find grooves or ridges, or excessive wear of the impeller, replace the impeller/shaft assembly.

CAUTION

Attempting to remove the bearings may result in damage to the bearings. Do not remove the bearings unless you intend to replace them.

5. Inspect the pump bearing, center bearing, and turbine thrust bearing for cracks, grooves, or ridges. Replace any damaged bearings as described in the following steps.
6. If needed, replace the pump bearing as follows (see Figure 25):
    a. Place the pump end cap with the bearing side facing up.
    b. Remove the pump bearing retaining ring.
    c. Pry out the bearing. Discard the bearing and O-ring.
    d. Clean the bearing bore with a clean rag.
    e. Place a new O-ring into the groove on the new bearing. Lubricate the O-ring and bearing bore in the end cap with glycerin.
    f. Insert the bearing into the bearing bore until it is fully seated, making sure the O-ring is not pinched.
    g. Install the bearing retaining ring.
7. If needed, replace the center bearing as follows (see Figure Figure 25):
    a. Place the turbocharger casing horizontally on a clean surface.
    b. Remove the center bearing retaining ring.
    c. Gently tap the center bearing toward the pump end of the casing until it is free of the bearing bore. Discard the bearing and the two O-rings.

d. Clean the bearing bore with a clean rag.
e. Place two new O-rings into the grooves on the new bearing. Lubricate the O-rings and bearing bore with glycerin.
f. Gently insert the bearing into the bore until it is fully seated, making sure the O-rings are not pinched.
g. Install the bearing retaining ring.

8. If needed, replace the thrust bearing as follows (see Figure 25):
   a. Place the turbine end cap on a clean surface with the bearing side facing down. Support the cap on small blocks placed around the edge of the bearing bore so the bearing is free to drop out of the bore.
   b. Tap around the edge of the thrust bearing until it drops out of the bore. Discard the bearing and O-ring.
   c. Clean the bearing bore with a clean rag.
   d. Place a new O-ring into the groove on the new bearing. Lubricate the O-ring and bearing bore with glycerin.
   e. Making sure the small hole in the thrust bearing is lined up with the straight adapter at the top of the turbine end-cap bore. Gently insert the bearing into the bore until it is fully seated. Make sure the O-ring is not pinched.
9. Reassemble the turbocharger as follows (see Figure 25):
   a. Insert the turbine impeller/shaft assembly through the turbine end of the center bearing.

CAUTION

Make sure the washer is evenly seated in its counter-bore in the pump impeller. Improper seating can cause equipment damage from impeller misalignment or loosening of the screw.

NOTE

It may be necessary to insert a thin screwdriver or other tool into the turbocharger plug hole to keep the impeller from turning while you install the retaining screw.

   b. Install the impeller key, pump impeller, washer, and screw. Torque the screw to 72 in.-lbs.
   c. Install the plug if removed.
   d. Position the casing vertically with the pump end facing up.
   e. Slide a new O-ring onto the pump end cap.
   f. Carefully slide the end cap into the casing until it is fully seated, making sure the thrust bearing water supply tube connection is toward the top (label side) of the casing. Fasten the cap in place using the four cap screws. Torque to 240 in.-lbs.
   g. Position the casing vertically with the turbine end facing up.
   h. Slide a new O-ring onto the turbine end cap.
   i. Carefully slide the end cap into the casing until it is fully seated, making sure the thrust bearing water supply tube connection is toward the top (label side) of the casing. Fasten the cap in place using the four cap screws. Torque to 240 in.-lbs.
   j. Reinstall the thrust bearing water supply tube.
10. Reinstall the turbocharger on its base plate and then on the TWPS. Refer to **REPLACE** and **Pressure Recovery Turbocharger PRT-1**.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

THIS SECTION COVERS:
Replace, Repair

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS removed from service

GENERAL:

This work package contains information and instructions for replacing and repairing components of high pressure pump P-5 or P-6. The procedures in this work package include:

- High Pressure Pump Assembly Replacement
- High Pressure Pump or Motor Replacement
- 1000-Hour High Pressure Pump PMCS
- 2000-Hour High Pressure Pump PMCS
- High Pressure Pump Repair

REPLACE

High Pressure Pump Assembly Replacement:

Parts (TM 10-4610-309-24P):
High Pressure Pump Assembly
Self-Locking Nuts
Motor Terminal Box Cover Gasket
Materials:
Antiseizing compound (WP 0079, Table 1, item 2)
Clean, dry, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in standby shutdown (less than four hours) without draining-down.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

Replace high pressure pump assembly P-5 or P-6 as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the high-pressure pumps. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the high pressure pumps. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure that all items stored under HP pumps are removed.

1. Make sure that electrical power to the operator control panel has been shut down.
2. Drain the high pressure pumps and the piping to the pumps as follows (see Figure 1):
   a. Open High Pressure Pump Inlet Drain Valve V-214. Close when drained.
   b. Open High Pressure Pump Outlet Drain Valve V-301. Close when drained.
   c. Open High Pressure Pump Case Drain Valve V-215.
   d. Close all three valves when the piping and pumps finish draining.
3. Remove the high pressure pump assembly as follows (see Figure 1):

NOTE
The inner high pressure pump assembly P-6 is more easily removed if the outer pump assembly P-5 is removed first.

   a. Tag the inlet and outlet hoses.
   b. Remove the inlet and outlet hose grooved couplings.
   c. Disconnect the drain hoses from the pump case and the pump mounting flange.
   d. Remove the lubricant return hose from the pump.
   e. Remove the terminal box cover, four caps screws, four washers, and cover gasket.
   f. Tag and disconnect the electrical wiring from the pump motor.
   g. Remove the lock nut inside the terminal box and pull the power cable and box connector out of the box.

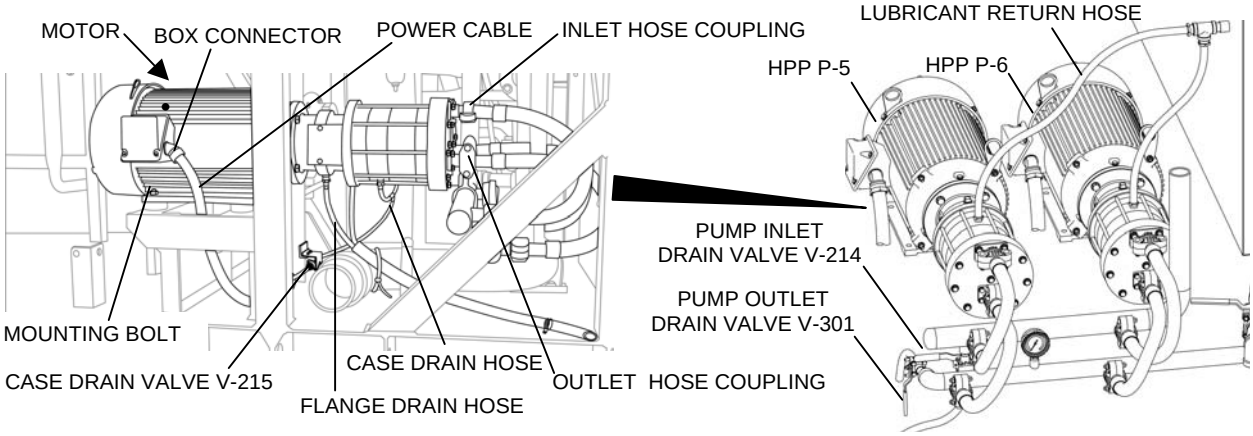

Figure 1. High Pressure Pump Assembly Removal.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

WARNING

An appropriate lifting device and two people are required to remove the high pressure pump assembly from its mounting. Do not attempt to lift by hand. Make sure that the pump assembly is properly supported before removing the bolts that secure the assembly to its mounting base. Failure to observe this warning can result in injury to personnel and damage to equipment.

h. Support the pump assembly using an appropriate lifting device.
i. Remove the four mounting bolts, four small washers, four large washers, and four self-locking nuts that secure the pump motor to its mounting pad.
j. Using the lifting device, remove the high pressure pump assembly from its mounting and move to a clean work area.

4. Install the high pressure pump assembly in the TWPS as follows (see Figure 1):

WARNING

An appropriate lifting device and two people are required to install the high pressure pump assembly onto its mounting. Do not attempt to lift by hand. Failure to observe this warning can result in injury to personnel and damage to equipment.

a. Using an appropriate lifting device, move the high-pressure pump assembly onto its mounting pad.
b. Secure the motor to its mounting pad using the four mounting bolts, four small washers, four large washers, and four self-locking nuts removed earlier.
c. Insert the power cable wires and box connector through the hole in the terminal box and secure the connector to the box using the lock nut.
d. Connect the electrical wiring to the motor.
e. Inspect the motor terminal box cover gasket and replace if necessary.
f. Secure the terminal box cover gasket and cover to the box using the four cap screws and washers removed earlier.
g. Connect the pump case drain hose to the pump.
h. Connect the pump flange drain hose to the pump mounting flange.
i. Connect the lubricant return hose to the pump.
j. Connect the inlet and outlet hoses to the proper ports of the pump using the grooved couplings.

5. Perform the Start-Up After a Short Term or Standby Shutdown Without Draining procedures described in WP 0015.
6. Check for leaks and proper high pressure pump operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

High Pressure Pump or Motor Replacement:

Parts (TM 10-4610-309-24P):
- High Pressure Pump
- High Pressure Pump Motor
- Self-Locking Nuts

Materials:
- Corrosion preventive compound (WP 0079, Table 1, item 17)
- Clean, dry, lint-free rags (WP 0079, Table 1, item 33)

Equipment Condition:
- TWPS in standby shutdown (less than four hours) without draining-down.

Replace a High Pressure Pump or Motor as follows:

1. Remove the high pressure pump assembly from the TWPS as described in this WP under the headings **High Pressure Pump Assembly Replacement**.
2. Remove the HP Pump from its motor as follows:

CAUTION

Do not turn the high-pressure pump by hand for any reason. Failure to observe this caution may result in serious damage to the pump.

   a. Remove the four bolts and four lock washers that secure the high-pressure pump mounting flange to the motor.
   b. Move the pump back and away from the motor coupling and lay it on a clean work surface.

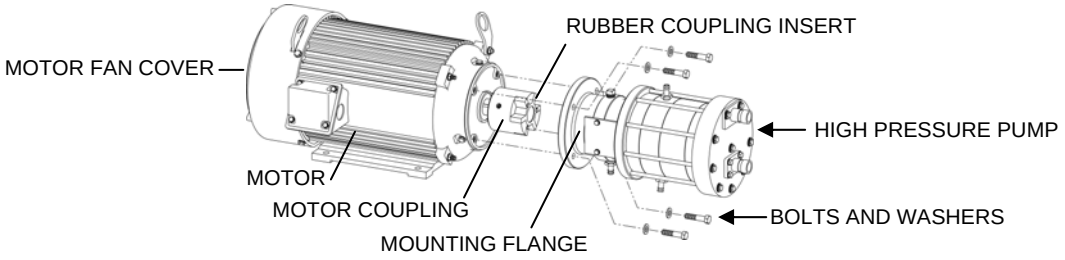

Figure 2. Removing the High Pressure Pump from Its Motor.

3. If replacing the motor, perform the following steps:
   a. Loosen the set screw on the motor coupling and remove the coupling from the shaft.
   b. Remove the motor shaft key.
   c. Apply antiseize compound to the new motor shaft, the coupling, the coupling set screw, and the shaft key.
   d. Install the shaft key and coupling on the motor shaft, but do **NOT** tighten the setscrew.
   e. Clean the pump using clean, lint-free rags.
   f. Inspect the pump for corrosion, especially around the inlet and outlet connections where the grooved couplings mount.
   g. Inspect the grooved coupling gasket and replace if necessary.

4. If replacing the pump, perform the following steps:
    a. Remove the cover plate from the pump mounting flange (see Figure 3).
    b. Loosen the set screw on the pump coupling and remove the coupling from the shaft.
    c. Remove the pump shaft key.

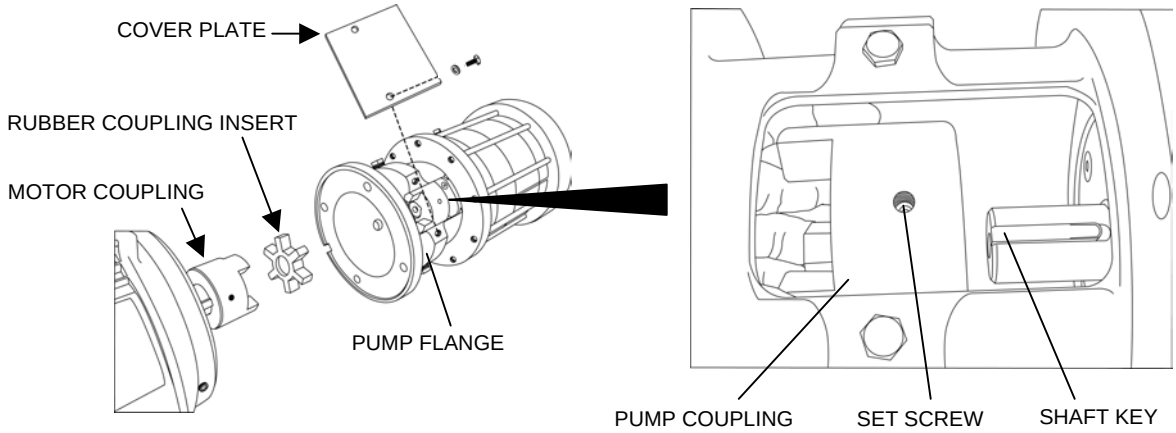

Figure 3. High Pressure Pump Coupling Removal

    d. Clean and inspect the motor for corrosion and damage.

CAUTION

Do NOT turn the high-pressure <u>pump</u> shaft by hand for any reason. Turn the <u>motor</u> shaft if it is necessary to align the pump and motor couplings. Failure to observe this caution may result in serious damage to the pump.

    e. Apply antiseize compound to the pump shaft, the pump coupling, the coupling set screw, and the shaft key.
    f. Install the shaft key and coupling on the pump shaft, but do **NOT** tighten the setscrew.
5. Install the high-pressure pump on the motor as follows (see Figure 3):
    a. Align the motor coupling and rubber coupling insert with the pump coupling as follows:
        1) Remove the four motor fan cover screws and the motor fan cover (see Figure 2).
        2) Turn the fan by hand to rotate and align the motor coupling.
        3) Do **NOT** turn the pump shaft.
    b. Fit the motor coupling and pump coupling together and the pump flange up to the motor.
    c. Secure the flange to the motor using the 4 bolts and 4 lock washers removed earlier.
    d. Do **NOT** tighten the pump coupling set screw at this time. It will be tightened later.
    e. Install the motor fan cover and secure with the 4 screws removed earlier.
6. Install the high pressure pump assembly onto the TWPS as described in this WP under the headings **High Pressure Pump Assembly Replacement**.
7. Before tightening the set screw(s) on the pump coupling, perform the following:
    a. Perform an initial startup as described in WP 0014 through starting the RO feed pumps. (Starting the RO feed pump pressurizes the inlet and outlet of the high-pressure pump and properly position the cam inside the high-pressure pump.)

b. After both RO feed pumps have started, perform a standby shutdown including deenergizing the Power Distribution Panel (WP 0017).
c. Set the gap between the pump and motor coupling jaws to 0.030 in. and tighten the setscrew.
d. Do not pinch or compress the rubber coupling insert.
e. Install the pump coupling cover plate.

8. Perform the Start-Up After a Short Term or Standby Shutdown without Draining procedures described in WP 0015.
9. Check for leaks and proper high pressure pump operation.

SERVICE

1000-Hour High Pressure Pump PMCS:

Parts (TM 10-4610-309-24P):
Piston Set
Disc Valve Set
O-Ring Kit
Materials:
Glycerin (WP 0079, Table 1, item 21)
Clean, dry, lint-free rags (WP 0079, Table 1, item 33)
Tools:
Torque wrench (0-250 in.-lbs.)
Rubber or Plastic Face Hammer
Equipment Condition:
TWPS in standby shutdown (less than four hours) without draining-down.

Perform high pressure pump 1000-hour PMCS as follows:

1. Remove the high-pressure pump assembly. Refer to **High Pressure Pump Assembly Replacement.**
2. Remove the pump from its motor. Refer to **High Pressure Pump or Motor Replacement**.
3. Disassemble the high pressure pump as follows:

CAUTION

Do not rotate the high-pressure pump shaft by hand. Rinse all parts as they are removed. Do not scratch or soil any bearing surfaces, metal or plastic. To simplify your work, keep the pump mounted to the flange and work on the pump in the vertical position. Work on the pump in a clean area. Note the orientation of all parts relative to the flange and the motor.

Do not attempt to pry the coupling off the pump shaft. If the coupling does not easily slide off the shaft, remove the coupling using an appropriate tool such as a puller. Failure to observe these cautions may result in serious damage to the pump.

a. Remove the 2 pump mounting flange cover screws and the cover.

b. Loosen the pump coupling set screw and remove the coupling from the pump shaft (see Figure 3).

NOTE
Keep the rubber coupling insert with the motor.

c. Leave the pump attached to the mounting flange.
d. Stand the high-pressure pump up on its mounting flange (see Figure 4).
e. Scribe a pencil line down along all segments of the pump and the flange for alignment.
f. Remove the 9 bolts, 9 lock washers, and 9 flat washers around the outer edge of the top of the High Pressure Pump (HPP) manifold.
g. Remove the center hex bolt, lock washer, and flat washer on the top of HPP the manifold.
h. Remove the manifold.

NOTE
Be sure to keep the three O-rings with the manifold.

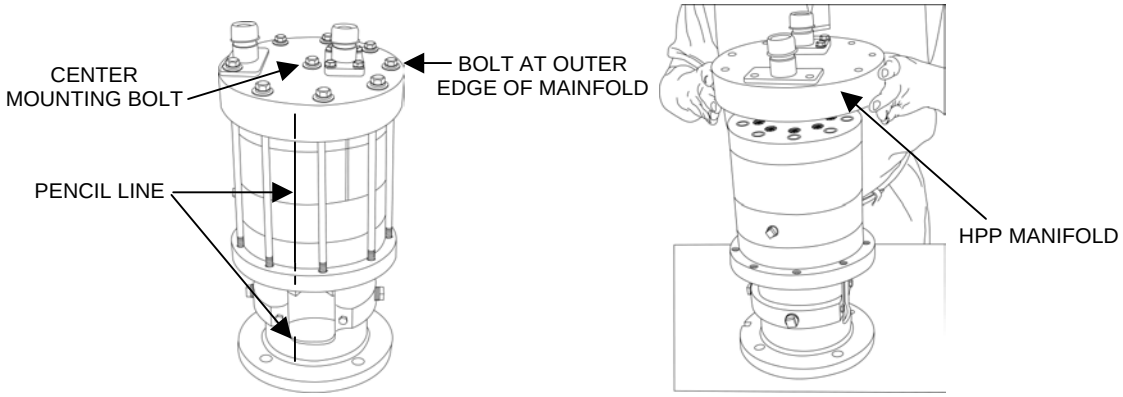

Figure 4. High Pressure Pump Manifold Removal.

i. Remove the valve housing (see Figure 5).

NOTE
If alignment pins cause resistance, gently tap the housing free.

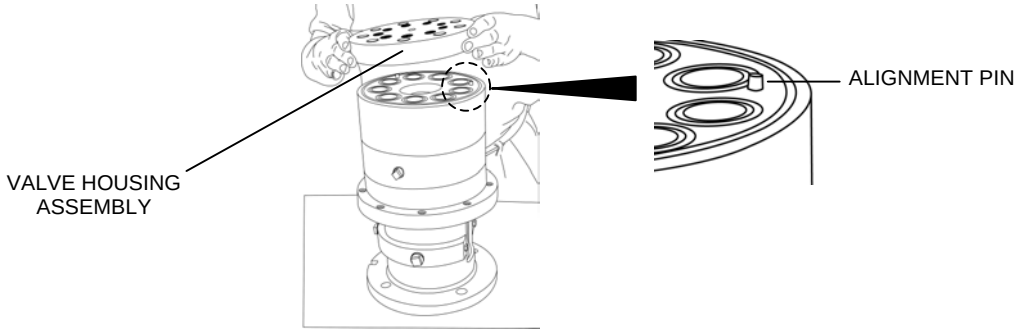

Figure 5. High Pressure Pump Valve Housing Removal.

j. Remove the body (see Figure 6).

NOTE

The body may require gentle tapping upward with a rubber mallet to dislodge it from the cam spacer.

k. Remove the pistons from the piston body.

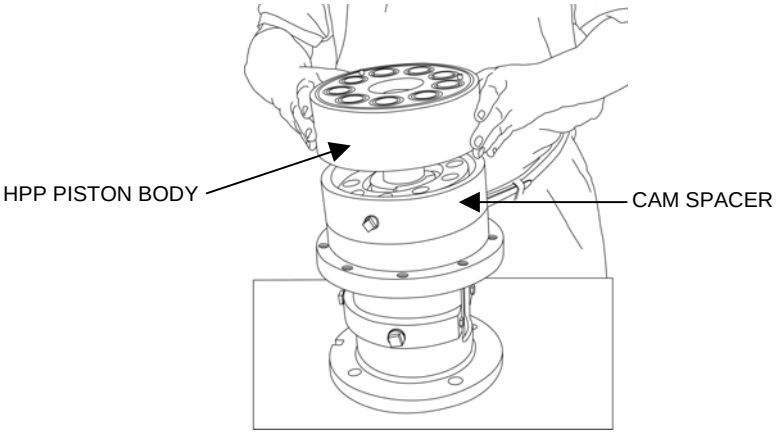

Figure 6. Piston Body Removal.

NOTE

The face of the piston cluster that bears on the cam must be kept clean and free of scratches. Do not place the cam side down; place the cup side downward on the work surface.

l. Remove the piston cluster. Set on the work surface **cam** side up (see Figure 7).

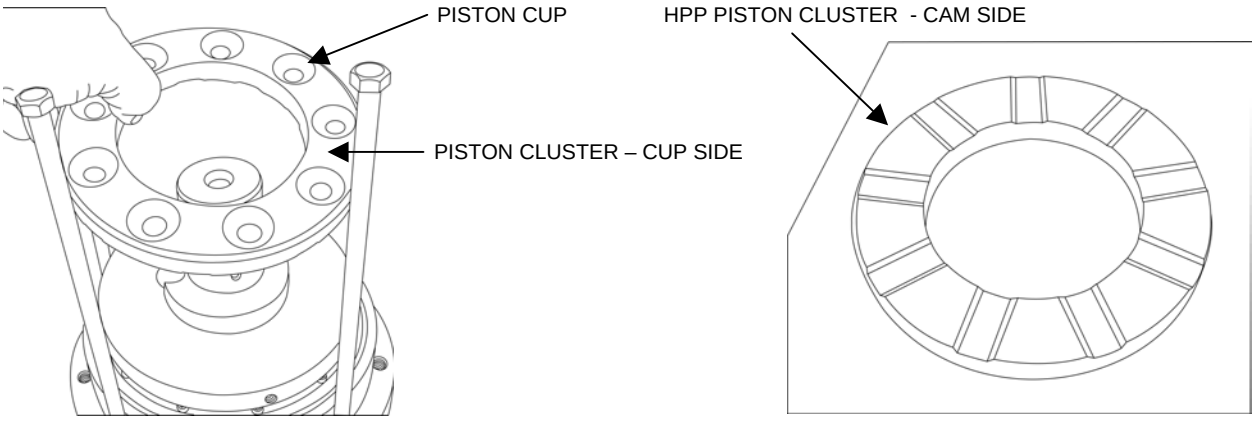

Figure 7. Piston Cluster Removal.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

NOTE

If the previous steps were performed as the initial steps of the 2000 hour PMCS, return to and continue with step 4 of the 2000 hour PMCS procedure. If the previous steps were performed as the initial steps of the 1000 hour PMCS, continue with step 4 below.

4. Inspect and (if necessary) replace the piston cluster:

NOTE

The piston cluster supports the downward force of the pistons on the rotating cam surface. During the break-in process, the piston cluster is polished-in to match the cam surface. The piston cluster must be replaced if damage and/or wear are discovered.

Damaged bearings may cause damage to the cam surface. Inspect and replace the piston cluster and cam assembly as needed. It is critical during reassembly that the pistons line up properly with the piston cluster.

a. Inspect the piston cluster for wearing and cracking, and replace if necessary.
b. Carefully clean and rinse the piston cluster with fresh water before installing in the pump.
c. Add a drop of glycerin to the piston cluster cup and cam surfaces (see Figure 7).
d. Install the piston cluster onto the camshaft cup side up (see Figure 8).
e. Reinstall the cam spacer making sure to line up the pencil scribe marks.

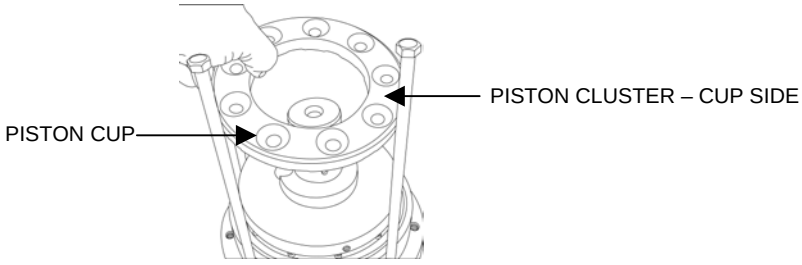

Figure 8. Piston Cluster Installation.

5. Inspect and (if necessary) replace the body (see Figure 9).

NOTE

Inside the pump body are removable, corrosion-resistant, metal cylinder liners. These cylinder liners may need replacement if excessive corrosion and/or wear occur. In addition, a body-bearing supports the camshaft. If the body-bearing is damaged or excessively worn, the bearing will need to be replaced.

a. Inspect the cylinder liners for corrosion. Replace the cylinder liners if needed.

NOTE

Corrosion inside the cylinder liner will cause wear and premature seal and/or piston failure. If abrasives have entered the pump or corrosion has occurred, scoring may be evident.

b. Carefully wipe off any superficial rust/dirt prior to reassembly.
c. Remove and replace O-rings.
d. Inspect the body bearing for wear or damage. If damaged, replace the body bearing. Refer to **High Pressure Pump Repair.**

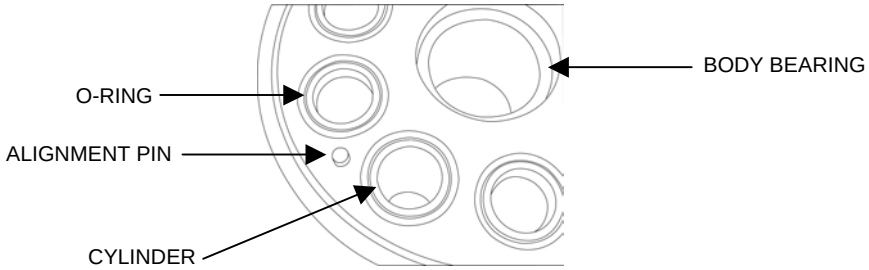

Figure 9. Piston Body Inspection.

6. Discard the old piston assemblies and install the new piston assemblies from the kit except for two, one from each side into the body.
   a. Replace old O-rings on the piston body. Use a little glycerin to hold the O-rings in place.
   b. Apply glycerin to the body bearing and install the piston body on the cam spacer making sure to line up the pencil scribe marks (see Figure 10).

NOTE
Make sure that the pistons line up with the cups in the piston cluster.

   c. Install the last two pistons.
   d. Push all the pistons down into the piston cluster as far as they will go.

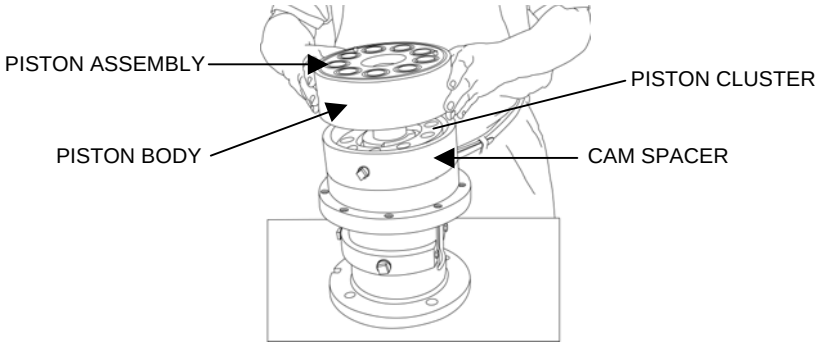

Figure 10. Piston Body Assembly Installation.

CAUTION

Once the pistons are set into the cluster do NOT turn the high-pressure pump shaft (cam shaft) for any reason. Failure to observe this caution may result in serious damage to the pump when it is started up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

NOTE

The valve housing contains pairs of disk check valves above each piston to rectify the flow through the pump. The failure of a valve will drastically affect the performance of the pump.

The disk check valves can be easily removed from the valve housing by inserting a narrow rod through the holes in the bottom of the valve housing and pushing the valves out the top of the housing.

7. Remove and discard the old disk check valves from the valve housing (see Figure 11).

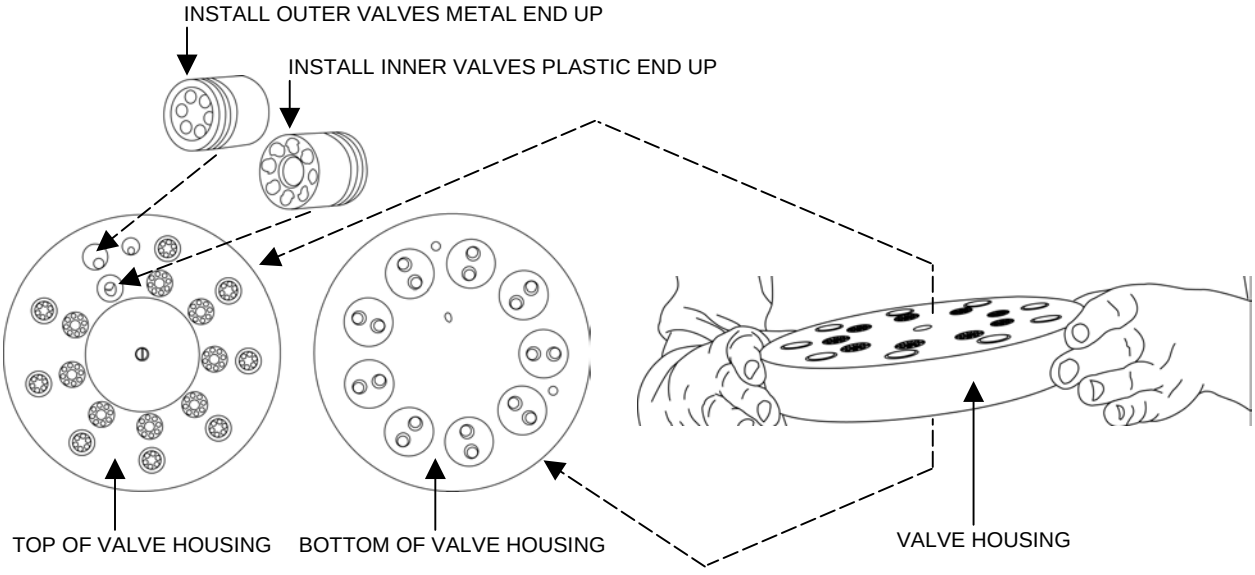

Figure 11. Disk Check Valve Replacement.

8. Inspect the valve housing for any cracks, de-lamination or damage. Replace the valve housing assembly if any de-lamination or obvious damage is visible.
9. Install new pairs of valves into the valve housing from the kit as follows (see Figure 12):

NOTE

If a valve does not easily push in flush with the valve housing, place a soft, flat material, such as a small, flat piece of wood over the valve and gently tap the wood until the valve is fully inserted and the top is flush with the surface of the valve housing. Do not tap directly on the valve.

a. Install the outer valves into the holes plastic end first so that the metal end of the valve faces up.
b. Install the inner valves into the holes metal end first so that the plastic end of the valve faces up.
c. Make sure that the top surface of the valves is flush with the surface of the valve housing.

10. Mount the valve housing onto the piston body (see Figure 12).

NOTE
Alignment pins on the piston body help align the valve housing to the body.

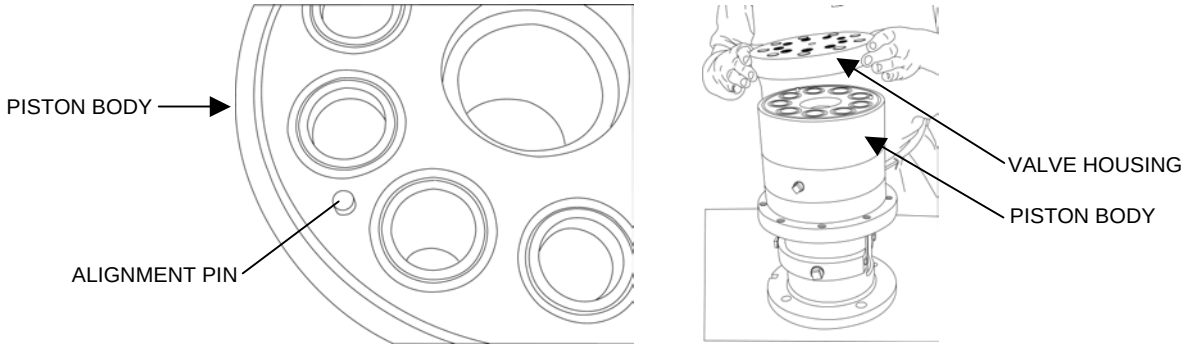

Figure 12. Valve Housing Assembly Installation.

11. Inspect and (if necessary) replace the manifold (see Figure 13).

NOTE
The manifold permits fluid transfer from the inlet port to the valves and again from the valves to the outlet port. The inner of the two manifold channels carries high-pressure fluid to the outlet port from the check valves. The outer channel carries low-pressure fluid from the inlet port to the check valves.

a. Inspect all ports, fittings, and threads for deterioration or damage.
b. Remove and discard O-rings.
c. Inspect all O-ring grooves for scratches, deterioration, or signs of leakage.
d. Inspect the manifold channels. If any de-lamination or structural cracks are present on the manifold's channels (annular grooves), O-ring grooves, or ports, the manifold must be replaced.
e. Inspect inlet and outlet nipples for damage, wear, or corrosion. Replace as needed.
f. Install new O-rings.

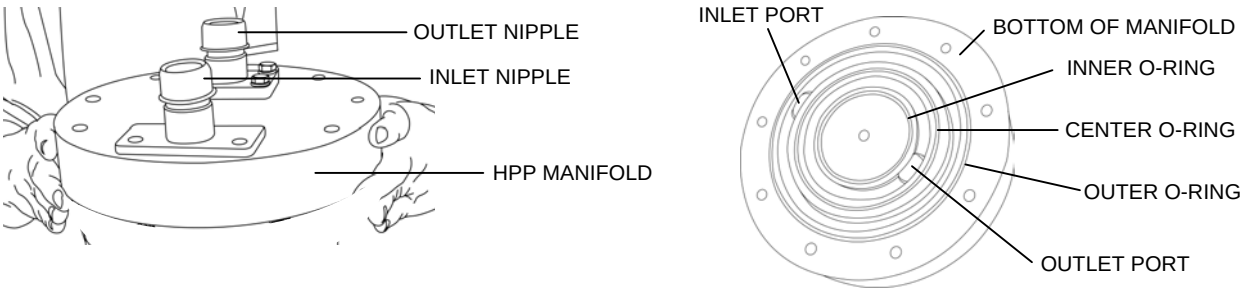

Figure 13. HPP Manifold Inspection.

12. Install the manifold to the top of the valve housing (see Figure 14).

NOTE
Make sure that the manifold is centered and lined up with the pencil scribe marks.

a. Install and torque the center mounting bolt, lock washer, and flat washer to 150 in.-lbs.
b. Install the 9 bolts, 9lock washers, and 9 flat washers at the outer diameter of the manifold. Torque the bolts to 150 in.-lbs. in the sequence shown in Figure 14.

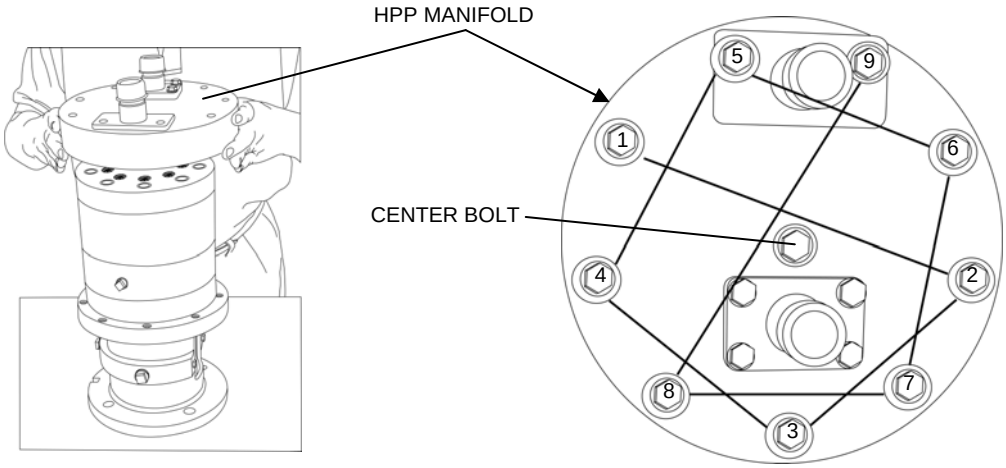

Figure 14. HPP Manifold Installation and Bolt Torque Sequence.

13. Install the high-pressure pump onto the motor. Refer to **High Pressure Pump or Motor Replacement**.
14. Install the high-pressure pump assembly onto the TWPS. Refer to **High Pressure Pump Assembly Replacement**.
15. Perform the Start-Up After a Short Term or Standby Shutdown Without Draining procedures described in WP 0015.
16. Check for leaks and proper high pressure pump operation.

2000 Hour High-Pressure Pump PMCS:

Parts (TM 10-4610-309-24P):
Piston Cluster (Cluster Plate)
Shaft Seal Assembly
Materials:
Glycerin (BII) (WP 0079, Table 1, item 21)
Clean, dry lint free rags (WP 0079, Table 1, item 33)
Tools:
Torque wrench (0-250 in.-lbs.)
Rubber or Plastic Face Hammer
Equipment Condition:
TWPS in standby shutdown (less than four hours) without draining-down.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

The 2000 Hour PMCS procedures include the performance of the 1000 hour PMCS and the following additional Items: replacement of the high pressure pump piston cluster and shaft seal assembly.

Perform high-pressure pump 2000-hour PMCS as follows:

1. Remove the high-pressure pump assembly. Refer to **High Pressure Pump Assembly Replacement.**
2. Remove the pump from its motor. Refer to **High Pressure Pump or Motor Replacement**.
3. Disassemble the high-pressure pump. Refer to **SERVICE** and **1000-Hour High Pressure Pump PMCS**.

NOTE

Do not rotate the high-pressure pump shaft by hand. Rinse all parts as they are removed. Do not scratch or soil any bearing surfaces, metal or plastic. To simplify your work, keep the pump mounted to the flange and work on the pump in the vertical position. Work on the pump in a clean area. Note the orientation of all parts relative to the flange and the motor.

To remove the cam spacer, it may be necessary to gently tap the spacer upwards with a rubber mallet to free it from the bearing plate. Take care not to cut or nick the O-ring or the alignment lip.

4. Continue disassembling the pump as follows:
   a. Remove the cam spacer (see Figure 15):

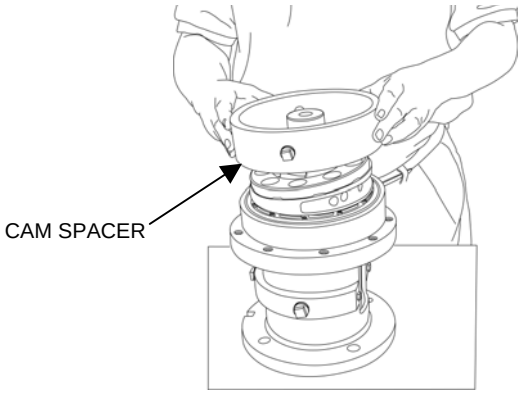

Figure 15. High Pressure Pump Spacer Removal.

b. Carefully wipe the lower exposed cam shaft free of dirt, rust grease, etc. (see Figure 16).
c. Remove the HPP cam.

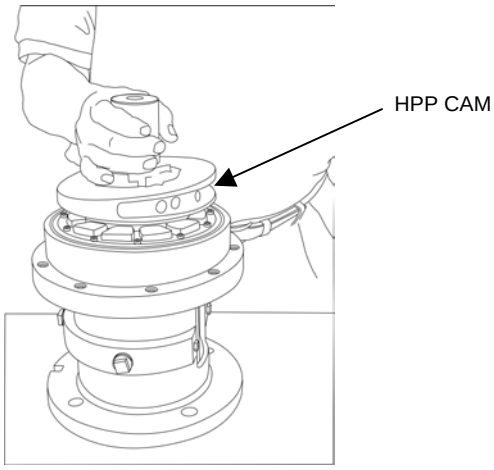

Figure 16. HPP Cam Removal.

d. Inspect the thrust bearing. If the bearing pads are severely scored, grab opposing hex head screws on the thrust bearing with pliers or similar tools. Lift and remove the thrust bearing from the bearing plate, then discard the thrust bearing (see Figure 17).

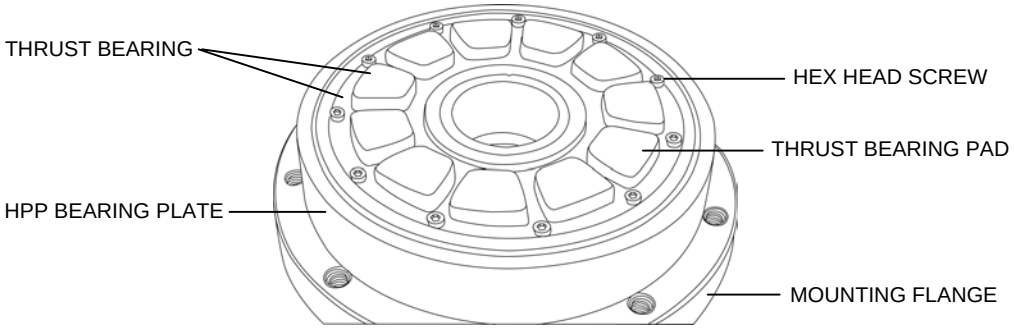

Figure 17. High Pressure Pump Thrust Bearing Removal.

e. Mark the position of the bearing plate to the mounting flange for reassembly and lift the bearing plate off the flange. (If the bearing plate does not easily lift out, place a block of wood into the bottom of the pump flange and tap with a rubber mallet to pop the bearing plate off.)

f. Turn the bearing plate over and remove the shaft seal assembly from the bearing plate by removing the allen head screws (see Figure 18).
g. Inspect the bearing plate as follows:
    1) Remove and discard the O-rings.
    2) Inspect the bearing plate and all threads for damage or de-lamination.
    3) Inspect the shaft bearing for signs of wear or damage. If damaged, replace the bearing plate bearing. Refer to **High Pressure Pump Repair.**

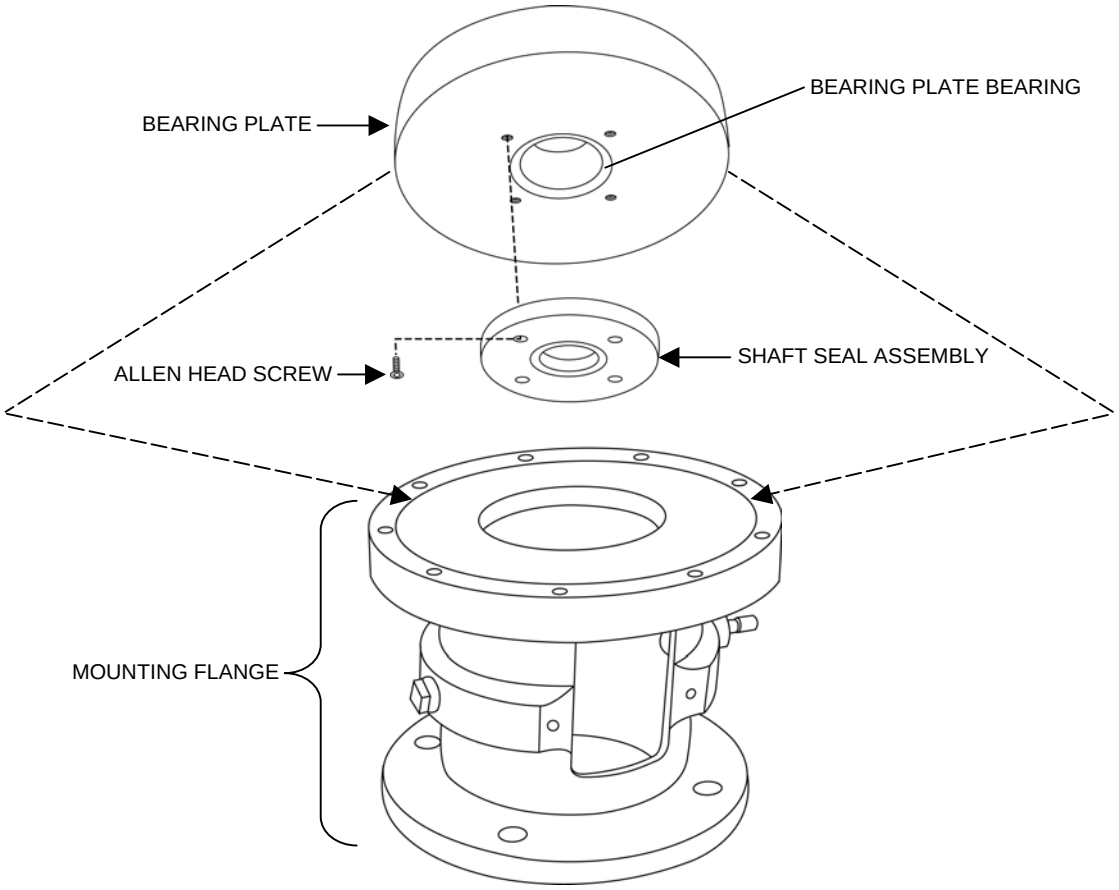

Figure 18. HPP Shaft Seal and Mounting Flange Removal and Installation.

5. Assemble the pump components as follows:
    a. Install the new shaft seal assembly onto the bearing plate using the allen head screws (see Figure 18). Tighten the screws evenly in an alternating cross pattern. Torque to 5.0 ft-lbs.
    b. Set the bearing plate onto the mounting flange so that the shaft seal assembly fits into the opening at the top of the mounting flange (see Figure 18).

c. If replacing the thrust bearing, clean the new thrust bearing in fresh water and install it in the bearing plate (see Figure 19).

NOTE

Ensure that the counter bore hole or flat side of the thrust bearing engages the alignment pin (protruding from the groove in the plate). The thrust bearing should lie flat against the bottom of the groove in the bearing plate.

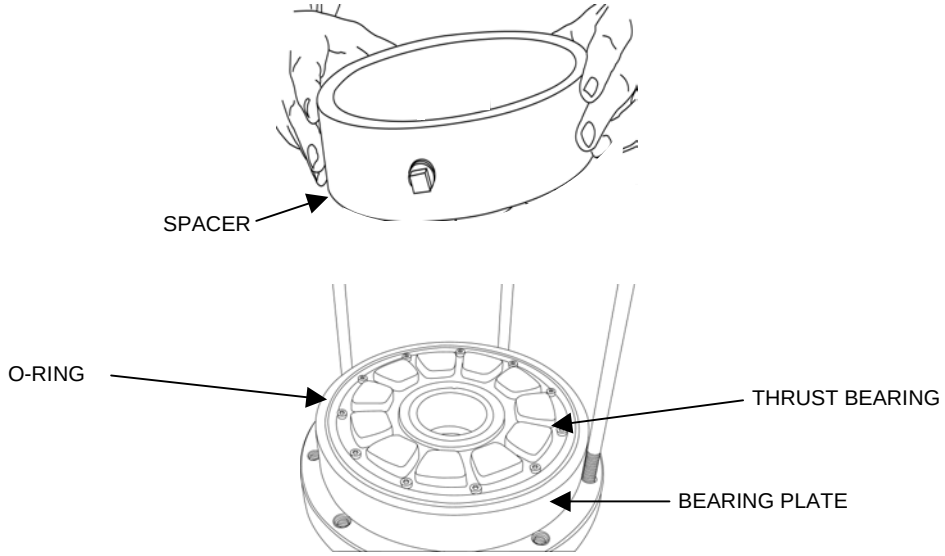

Figure 19. Thrust Bearing and Spacer Installation.

NOTE

Make sure a new O-ring is mounted between the spacer and the bearing plate.

d. Install the spacer onto the bearing plate (see Figure 19).
e. Lubricate all bearing surfaces with glycerin before assembly.
f. Inspect and (if necessary) replace the cam as follows (see Figure 20):

NOTE

The corrosion-resistant cam upper and lower surfaces and shafts run against bearings lubricated by the pumped fluid and are highly polished. For the pump to operate properly, the cam upper and lower surfaces and shaft surfaces must be free from scratches, nicks, or dents. Use caution when handling the cam so as not to scratch or damage any of the bearing surfaces. Some light scoring or wear on these surfaces is acceptable.

1) Inspect for scoring or corrosion on both the upper angled and lower flat cam surfaces and on the shafts. Replace as needed.
2) Check the journal bearing surfaces on both ends of the cam. Replace the cam if the surfaces have been scored or corroded.

3) Clean and rinse the cam thoroughly with fresh water before reinstalling.
4) Inspect the keyway and remove any dirt, sharp edges, or nicks that could damage the shaft seal at installation.

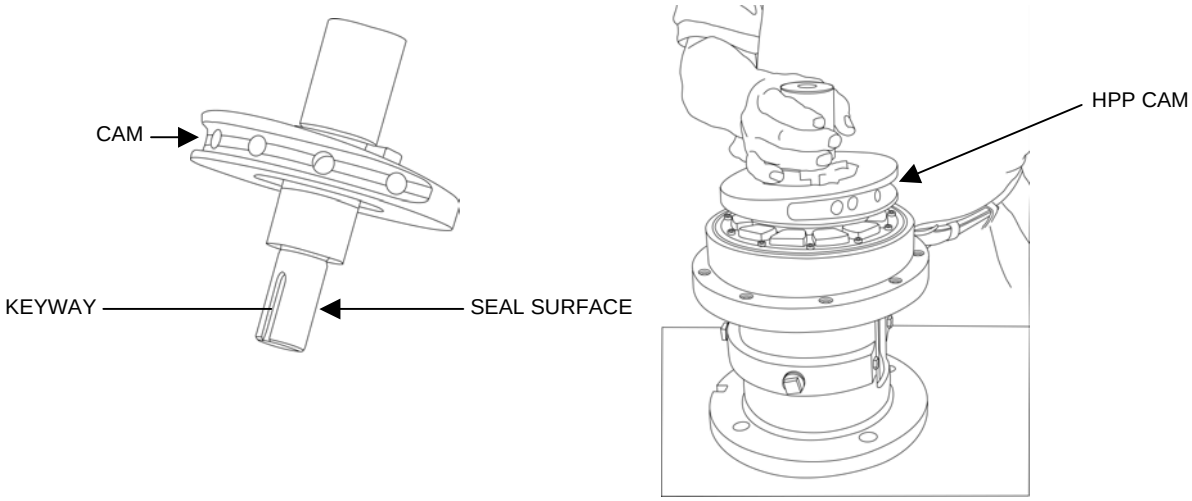

Figure 20. HPP Cam Inspection and Installation.

g. Install the cam as follows (see Figure 20):
1) Carefully rinse the cam with clean fresh water.
2) Apply glycerin to the cam seal surface.

CAUTION

Care is required when installing the cam to prevent damage to the shaft seal. Do not pierce or damage the shaft seal in any way. Make sure the key way faces the opening in the flange when the cam is installed. Failure to observe this caution may result in damage to the shaft seal causing it to leak during operation.

3) Slide the camshaft through the bearing plate and the shaft seal.

6. Perform the 1000-Hour PMCS procedures. Refer to **SERVICE** and **1000-Hour High Pressure Pump PMCS**.
7. Install the high-pressure pump onto the motor. Refer to **High Pressure Pump or Motor Replacement**.
8. Install the high-pressure pump assembly onto the TWPS. Refer to **High Pressure Pump Assembly Replacement**.

CAUTION

Failure to follow the break-in procedure listed below may cause premature failure of the cam, thrust cluster, or tilt pad bearings or it may result in excessive power consumption by the pump.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0053 00**
UNIT MAINTENANCE PROCEDURES
HIGH PRESSURE PUMPS

NOTE

The thrust bearing assembly of the pump is broken in during factory assembly. The bearing assembly consists of the cam and thrust bearing. If either of these components is replaced during service or repair, the bearing assembly must again be "Broken In".

9. If either or both the CAM or THRUST BEARING were replaced, perform the thrust bearing break-in procedures as follows:
    a. Perform the Start-Up After a Short Term or Standby Shutdown Without Draining procedures described in WP 0015.
    b. Operate the high pressure pump at zero psig discharge pressure for 30 minutes.
    c. Raise the discharge pressure in 100-psig increments, operating the pump at each incremental pressure increase for 30 minutes, until the maximum discharge pressure is attained.
10. Check for leaks and proper high pressure pump operation.

High Pressure Pump Repair:

Parts (TM 10-4610-309-24P):
- Thrust Bearing
- Piston Cluster
- Piston Set
- Disc Valve Set

Materials:
- Corrosion preventive compound (WP 0079, Table 1, item 17)
- Glycerin (WP 0079, Table 1, item 21)
- Clean, dry, lint free rags (WP 0079, Table 1, item 33)

Tools:
- Cylinder liner removal tool, FMC P502704
- Bearing removal/installation tool, FMC P502677
- Torque wrench
- Rubber or plastic faced hammer

When an internal malfunction occurs with the high pressure pump, it should be disassembled and all internal parts inspected and replaced as required. The parts kit used for the 2000 hour PMCS contains most parts required to repair the pump with the exception of the bearings and section assemblies.

NOTE

Rinse all parts with fresh water as they are removed. Do not scratch or soil any bearing surfaces, metal or plastic. To simplify your work, keep the pump mounted on the flange and work on the pump in the vertical position. Work on the pump in a clean area. Note the orientation of all parts relative to the flange and the motor.

Remove and disassemble the pump as follows:

1. Remove the high-pressure pump assembly. Refer to **High Pressure Pump Assembly Replacement.**
2. Remove the pump from its motor. Refer to **High Pressure Pump or Motor Replacement**.

3. Inspect the data logs to see when the last PMCS was performed on the pump.
4. Disassemble the high-pressure pump. Refer to **SERVICE** and **2000-Hour High Pressure Pump PMCS**.

Inspect and repair the pump as follows:

1. Replace the shaft seal assembly.

NOTE

The shaft seal is pressed and glued into the shaft seal retainer and cannot be separately replaced.

The shaft seal assembly must be installed onto the bearing plate before the bearing plate is reinstalled onto the mounting flange.

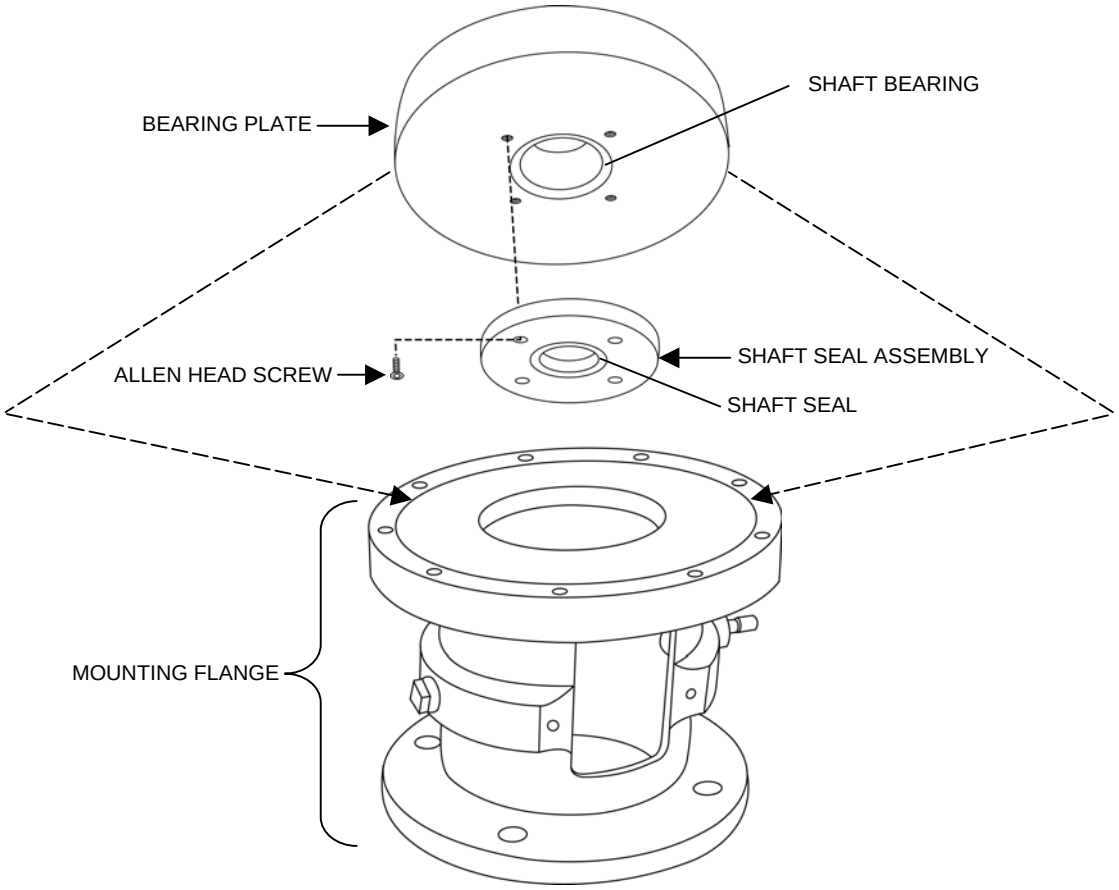

Figure 21. High Pressure Pump Shaft Seal Removal

a. Carefully clean the cam shaft.
b. Check the cam shaft seal surface for grooves, nicks, or burrs, which might damage the shaft seal (see Figure 22).

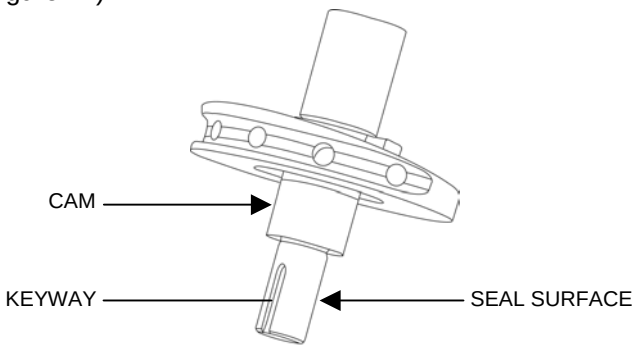

Figure 22. Cam Cleaning and Inspection.

2. Inspect and (if necessary) replace the bearing plate.

NOTE

To support the camshaft, a precision bearing was installed in the bearing plate at the factory. If the bearing plate is damaged or worn, the bearing plate should be replaced.

a. Remove and discard the O-rings. Inspect the bearing plate and all threads for damage, delamination, etc.
b. Inspect the bearing for signs of wear or damage. Check if the bearing plate bearing is within the (2.010 in.) requirement. If outside the requirement, replace bearing (see Figure 23).
c. To replace the bearing, press it out and press the new one in using the FMC P502677 bearing removal and installation tool.
d. The new bearing should be pressed in from the cam side of the bearing plate. Once installed, the bearing should be flush with the cam side of the bearing plate.

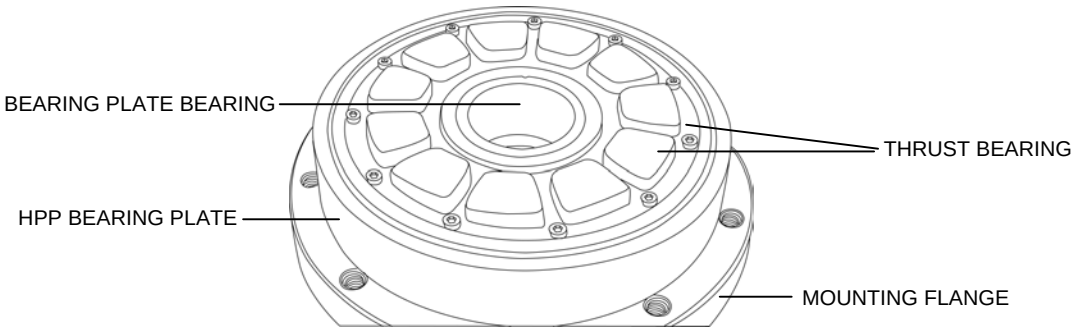

Figure 23. Bearing Plate Bearing Inspection.

3. Remove the bearing plate bearing using the FMC P502677 bearing removal and installation tool as follows (see Figure 24):
    a. Place the bearing plate on its side on a flat surface that will not scratch or damage the part. (The worn bearing will be pressed out towards the cam side of the bearing plate.)
    b. Insert the pilot plug into the worn bearing so the shoulder on the pilot plug stops against the bearing.
    c. Insert the tension rod through the pilot plug so that the nut of the tension rod is against the shoulder end of the pilot plug.
    d. Place the “adapter can” over the tension rod on the cam side of the bearing plate; slide the adapter can down the tension rod until it rests on the bearing plate.
    e. Screw the speedball handle onto the tension rod until it contacts the adapter can.
    f. Continue to rotate the speedball handle clockwise until the worn bearing is pulled from the bearing plate.

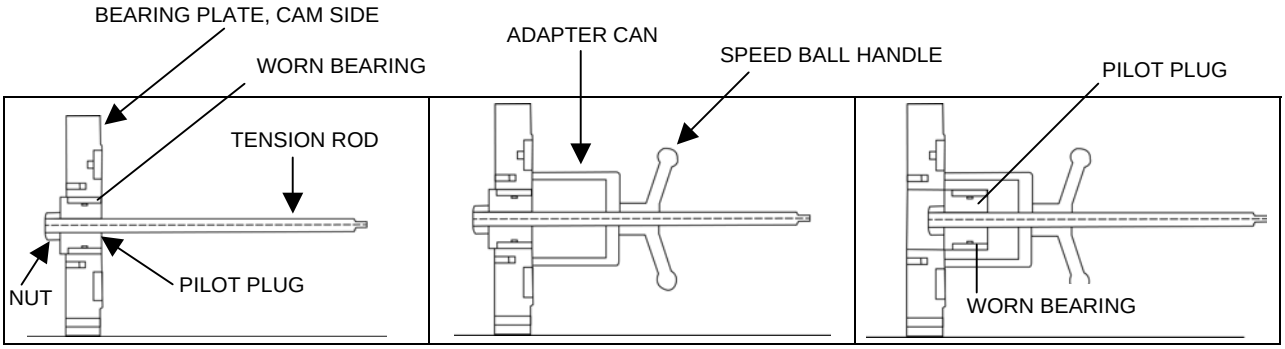

Figure 24. Bearing Plate Bearing Removal.

4. Install the new body bearing using the FMC P502677 bearing removal and installation tool as follows (see Figure 25):

CAUTION

Do not use silicone grease on the inside diameter of the bearing or on the cam outside diameter. The grease will cause rapid failure of the pressed-in body bearing.

    a. Visually inspect the bearing housing bore for any defects and wipe clean of debris.

NOTE

Before installation, submerge the new bearing in clean, fresh water. Water is the only lubricant that can be used.

    b. Install the reaction plate on the tension rod until it contacts the nut of the tension rod.
    c. Insert the pilot plug into the new bearing. The shoulder on the pilot plug needs to stop against the bearing.
    d. Insert the tension rod reaction plate assembly at the opposite end of the new bearing, through the new bearing and the hole in the pilot plug. Take care not to damage the new bearing while the tension rod is inserted.

e. Lubricate the bearing bore with a small amount of clean, fresh water before installing the bearing.
f. Insert the threaded end of the tension rod through the cam side of the bearing plate.

NOTE

The shoulder of the pilot plug enters the bearing bore before the bearing makes contact with the bearing plate.

g. Place the adapter can over the tension rod on the opposite side of the part. Slide the adapter can down the tension rod until it rests on the bearing housing.
h. Screw the speedball handle onto the tension rod until the speedball handle contacts the adapter can.
i. Continue to rotate the speedball handle clockwise until the reaction plate stops against the cam side of the bearing plate.
j. Remove the tool from the new bearing.

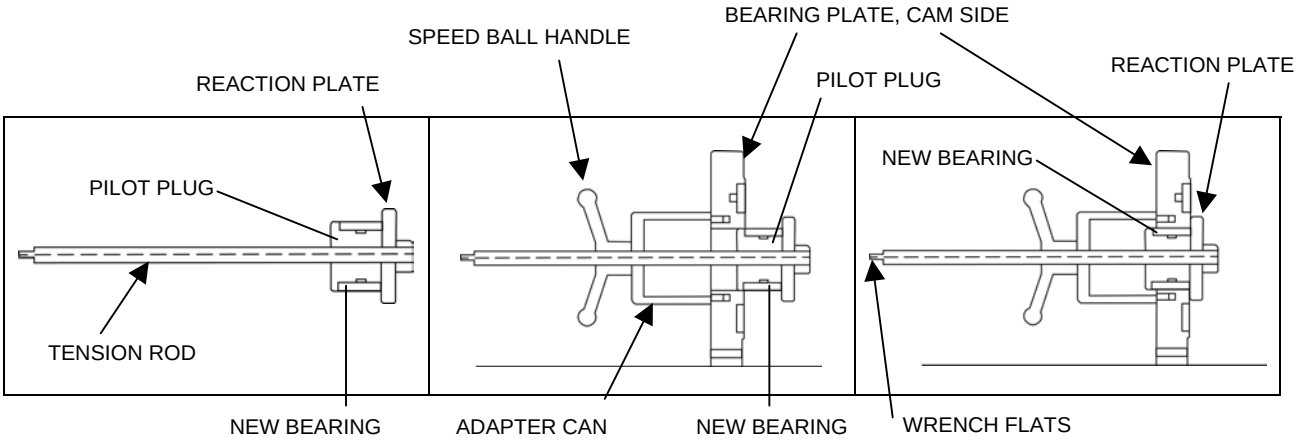

Figure 25. Bearing Plate Bearing Installation.

5. Carefully clean and rinse all components before reinstalling in the pump.
6. Install the new shaft seal assembly onto the bearing plate using the allen head screws (see Figure 21). Tighten the screws evenly in an alternating cross pattern. Torque to 60 in.-lbs.
7. Set the bearing plate onto the mounting flange so that the shaft seal assembly fits into the opening at the top of the mounting flange (see Figure 21).
8. Install the bearing plate on the mounting flange (see Figure 26).

NOTE

Make sure that the counter bore hole or flat side of the thrust bearing engages the alignment pin (protruding from the groove in the plate). The thrust bearing should lie flat against the bottom of the groove in the bearing plate.

9. Install a clean thrust bearing.

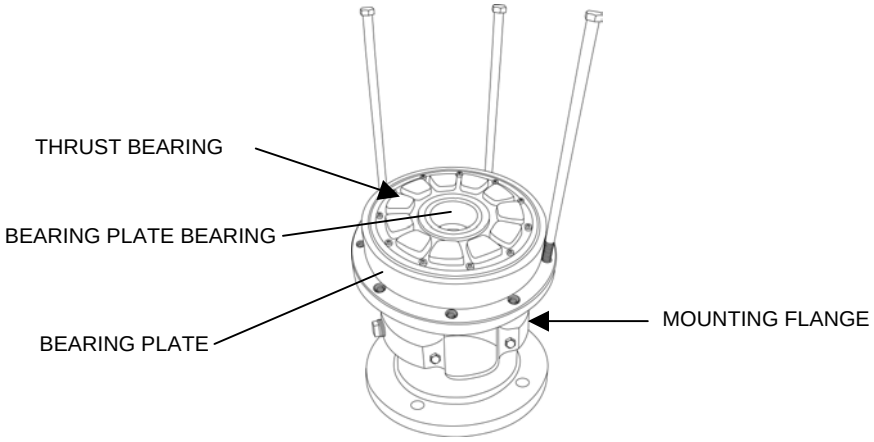

Figure 26. Bearing Plate and Thrust Bearing Setup.

10. Inspect and (if necessary) replace the cam as follows (see Figure 27):

NOTE

The corrosion-resistant cam upper and lower surfaces and shaft run against bearings lubricated by the pumped fluid and are highly polished. For the pump to operate properly, the cam upper and lower faces and shaft surfaces must be free from scratches, nicks, or dents. Use caution when handling the cam so as not to scratch or damage any of the bearing surfaces. Some light scoring or wear on these surfaces is acceptable.

a. Inspect for scoring or corrosion on both the upper angled and lower flat cam surfaces and on the shafts. Replace as needed.
b. Check the journal bearing surfaces on both ends of the cam. Replace the cam if the surfaces have been scored or corroded.
c. Clean and rinse the cam thoroughly with fresh water before reinstalling.
d. Inspect the keyway and remove any dirt, sharp edges, or nicks that could damage the shaft seal at installation.

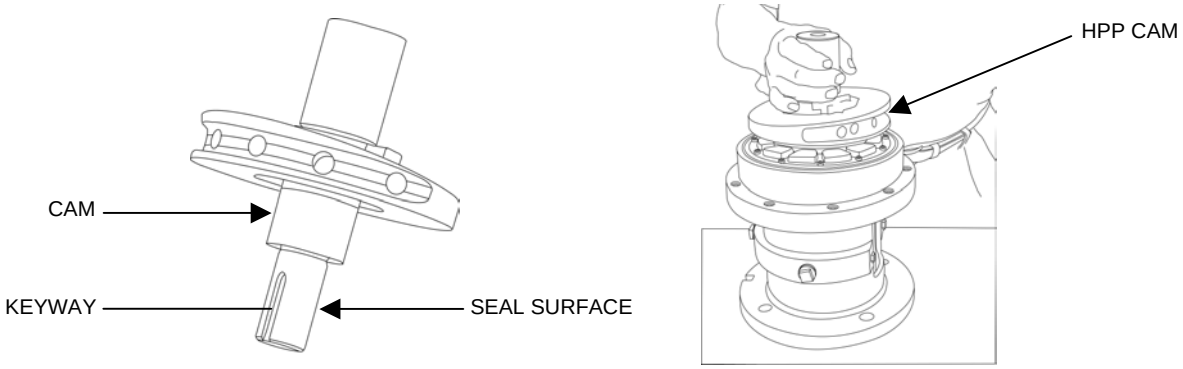

Figure 27. HPP Cam Inspection and Installation.

11. Lubricate the bearing plate bearing surface with glycerin.
12. Install the cam as follows (see Figure 27):
    a. Carefully rinse the cam with fresh water.

NOTE
Do not pierce or damage the shaft seal in any way.

    b. Slide the clean camshaft through the bearing plate bearing and shaft seal.
13. Inspect and (if necessary) replace the piston cluster (see Figure 28).

NOTE
The piston cluster supports the downward force of the pistons on the rotating cam surface. During the break-in process, the piston cluster is polished-in to match the cam surface. The piston cluster must be replaced if damage and/or wear is discovered.

Damaged bearings may cause damage to the cam surface. Inspect and replace the piston cluster and cam assembly as needed.

It is critical during reassembly that the pistons line up properly with the piston cluster.

    a. Inspect the piston cluster cups and flat surfaces for wear and cracking. Replace if needed.
    b. Carefully clean and rinse the piston cluster with fresh water before installing in the pump.
    c. Add a drop of glycerin to each piston cluster cup and flat (bearing) surface.

NOTE
The piston cluster cups must face upwards. The position of the piston cluster relative to the pistons is critical and should be carefully maintained during the next two reassembly steps.

    d. Place the piston cluster onto the upper cam surface.

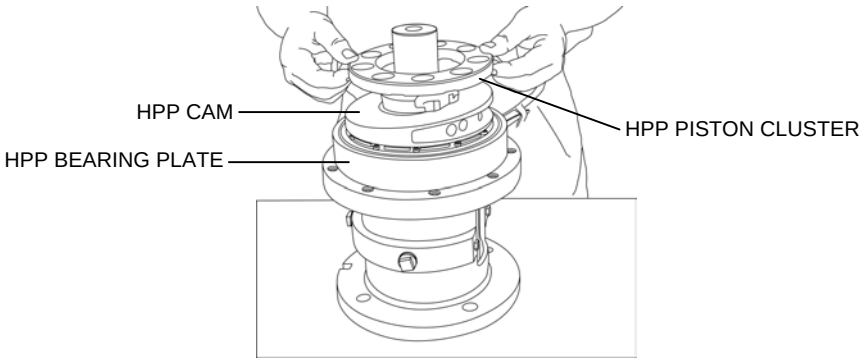

Figure 28. Piston Cluster Installation.

e. Install the spacer onto the bearing plate (see Figure 29).

NOTE
Be sure the O-ring is installed between the bearing plate and spacer outer edge.

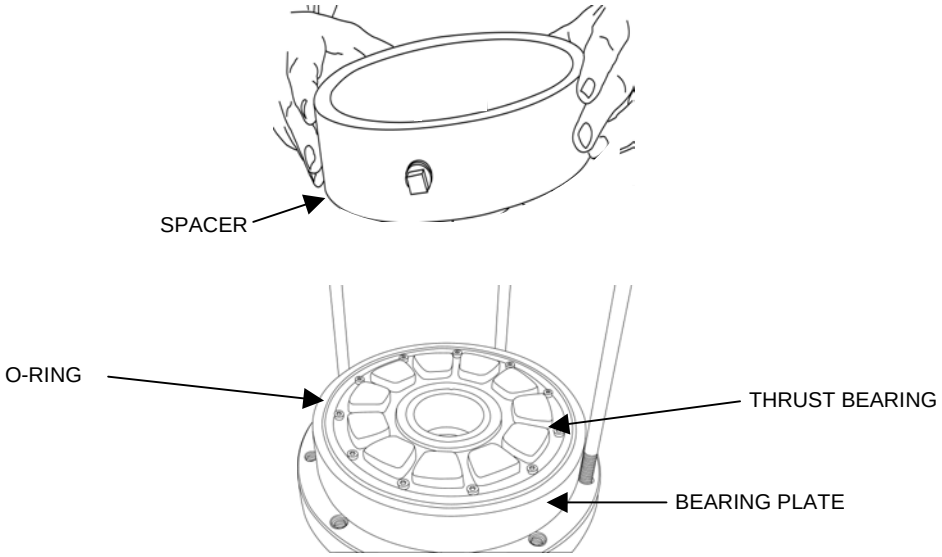

Figure 29. Thrust Bearing and Spacer Installation.

14. Inspect and (if necessary) replace the body (see Figure 30).

NOTE
Inside the pump body are removable, corrosion-resistant, metal cylinder liners. These cylinder liners may need replacement if excessive corrosion and/or wear occur. In addition, a body bearing supports the camshaft. If the body bearing is damaged or excessively worn, the bearing will need to be replaced.

a. With the pistons removed, inspect the cylinder liners for corrosion.

NOTE
Corrosion inside the cylinder liner will cause wear and premature seal and/or piston failure.

b. If abrasives have entered the pump or corrosion has occurred, scoring may be evident. Replace the liners if needed.
c. Remove the cylinder liner as follows (see Figure 30):
    1) Place the pump body on its side on a flat surface that will not scratch or damage the body.
    2) Insert the cylinder liner removal tool into the cam side of the cylinder liner.
    3) Strike the cylinder liner removal tool with a plastic or rubber hammer to drive the cylinder liner out for inspection or replacement.

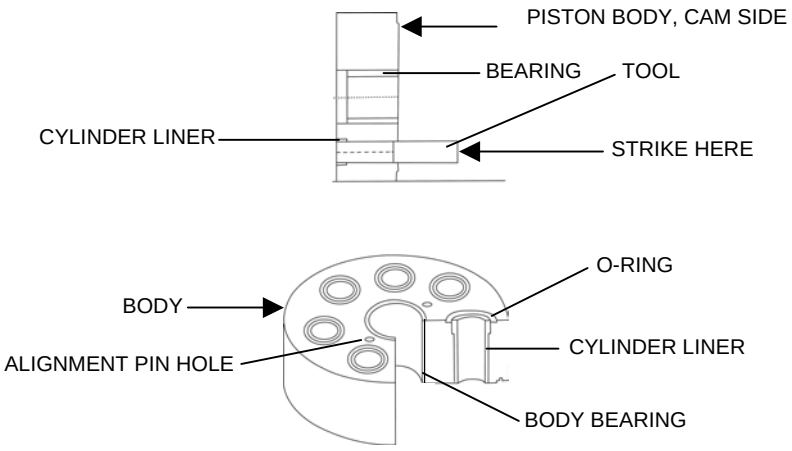

Figure 30. Piston Cylinder Liner Removal.

d. The alignment pins are press-fitted into the body to properly align it relative to the valve housing.
e. Remove any superficial rust/dirt prior to reassembly.
f. Remove and discard O-rings.
g. Inspect the body bearing for wear or damage. Check if the body bearing inner diameter is within the 2.010 in. requirement. If outside requirement, replace bearing.

15. Remove the body bearing using the FMC P502677 bearing removal and installation tool as follows (see Figure 31):
    a. Place the piston body on its side on a flat surface.

NOTE
The worn bearing will be pressed out toward the cam side of the piston body.

    b. Insert the pilot plug into the worn bearing with the pilot plug stopping on the bearing.
    c. Insert the tension rod through the pilot plug so that the nut of the tension rod contacts the shoulder of the pilot plug.
    d. Place the “adapter can” over the tension rod and slide it down the tension rod until it rests on the piston body.
    e. Screw the speedball handle onto the tension rod until the speedball handle contacts the adapter can.
    f. Continue to rotate the speedball handle clockwise until the bearing is pulled from the bearing housing.
    g. Remove the bearing tool from the old bearing.

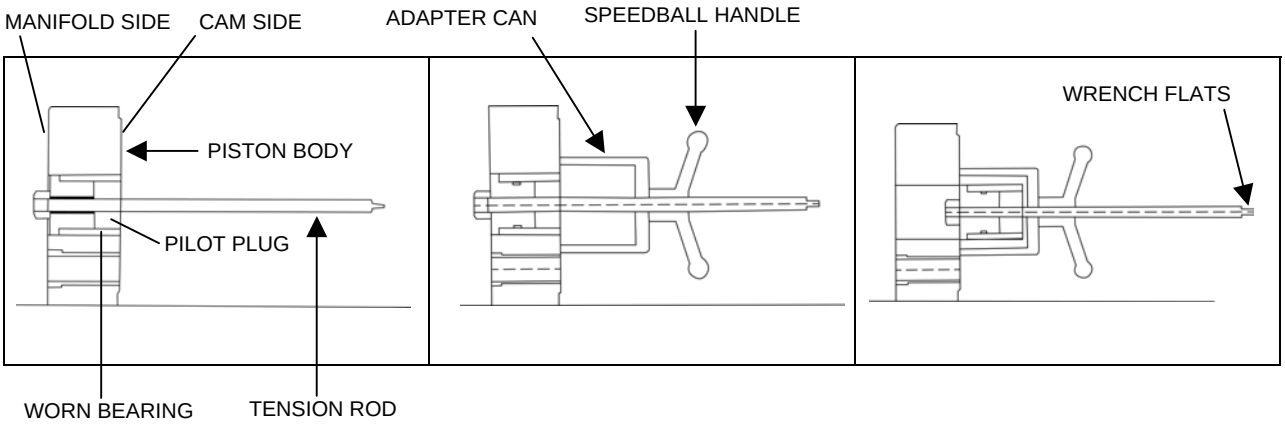

Figure 31. High Pressure Pump Body Bearing Removal.

16. Install the new body bearing using the FMC P502677 bearing removal and installation tool as follows (see Figure 32):

CAUTION

Do not use silicone grease on the inside diameter of the bearing or on the cam outside diameter. The silicon grease will cause rapid failure of the pressed-in body bearing.

a. Visually inspect the body bearing for any defects and wipe it clean of any debris.

NOTE

Before installation, submerge the new bearing in clean, fresh water. Water is the only lubricant that can be used.

b. Install the reaction plate on the tension rod until it is against the nut of the tension rod.
c. Insert the pilot plug into the new bearing. The shoulder on the pilot plug needs to stop against the bearing.
d. Insert the tension rod reaction plate assembly at the opposite end of the new bearing through the new bearing and the hole in the pilot plug.
e. Lubricate the bearing bore with a small amount of clean, fresh water before installing the bearing.
f. Insert the threaded end of the tension rod through the cam side of the piston body.

NOTE

The shoulder of the pilot plug enters the bearing bore before the bearing makes contact with the piston body.

g. Place the adapter can over the tension rod on the opposite side. Slide the adapter can down the tension rod until it rests on the piston body.
h. Screw the speedball handle onto the tension rod until the speedball handle contacts the adapter can.

i. Continue to rotate the speedball handle clockwise until the reaction plate stops against the cam side of the piston body.
j. Remove the tool from the new bearing.
k. Carefully clean and rinse all components with fresh water before reinstalling in the pump.

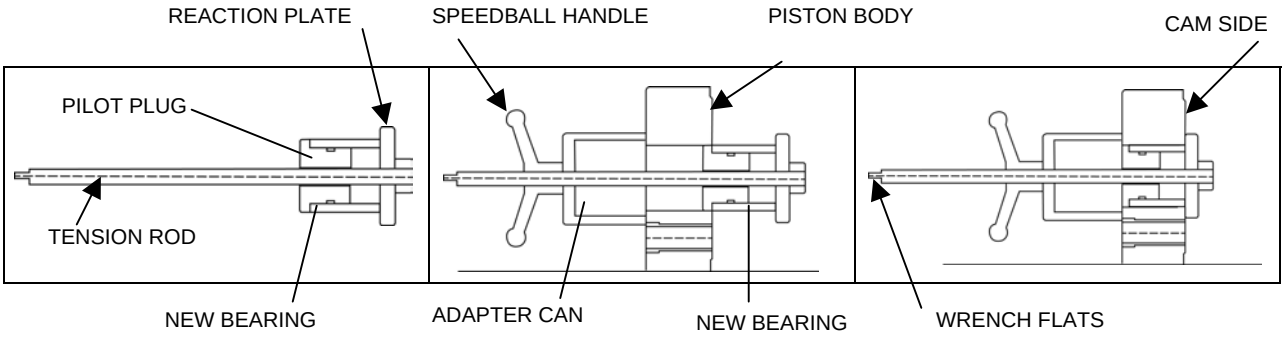

Figure 32. High Pressure Pump Body Bearing Installation.

NOTE
Make sure the key way is accessible through the pump shaft coupling cover plate.

17. Check for bad piston seals by performing the following water hold test:
    a. Place the pistons into the body and push them down into their cylinders.
    b. Hold the body up off the surface of the work area.
    c. Pour water into the top of the cylinders.
    d. If water flows through any of the cylinders and out the bottom, replace the piston in the cylinder with the leak.
    e. Repeat the test. If water still leaks through a cylinder, replace the cylinder as described earlier in this work package.
18. Install the body as follows:
    a. Make sure all cylinder liners and O-rings are installed into the body.
    b. Sighting through an the open cylinder liners, make sure the liners are aligned directly above the piston cluster cups.
    c. Place the body onto the spacer.
    d. Install the new O-ring between the spacer and the body outer area.

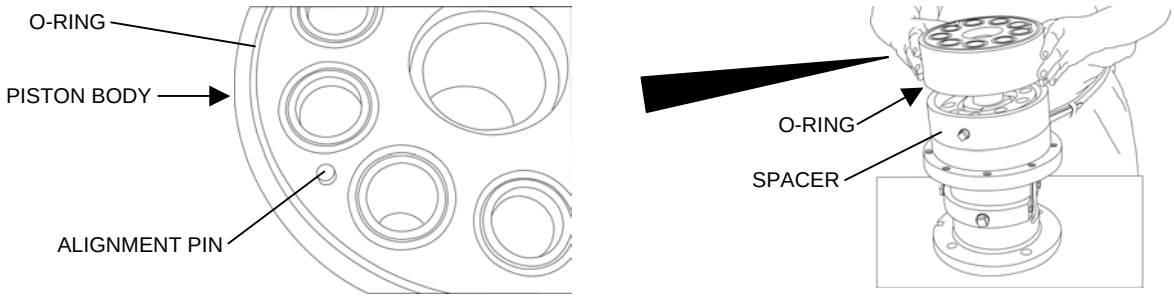

Figure 33. Piston Body Installation.

19. Inspect and (if necessary) replace the pistons as follows:

NOTE

The pistons are free-floating in the cylinder liners. They rely on positive feed pressure to push them downward during refill and are then pushed upward by the cam and piston cluster during the pump stroke. Each piston has specially designed low friction, high-pressure seal and wear sleeves installed onto them. If any one of the pistons needs replacement, the whole piston assembly should be replaced.

a. Inspect the spherical end of the pistons for damage. Damage may include flattening, discoloration or cracking. Replace the piston assembly if any of this damage is found.
b. Measure the length of the piston. If it is shorter than 2.969 in., discard and replace the piston assembly.
c. Inspect the piston wear rings and the pistons for scratching or scoring. Replace the assembly if needed.
d. Inspect the piston seals. If a seal is torn or otherwise deteriorated, replace the piston assembly.
e. Carefully clean and rinse all components with clean, fresh water before reinstalling into the pump.

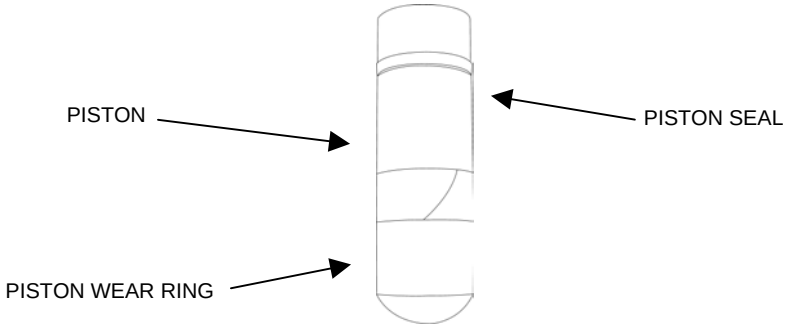

Figure 34. Piston Inspection.

CAUTION

Once the pistons are properly seated into the body, do not turn the cam shaft for any reason. Failure to observe this caution may result in serious damage to the pump.

NOTE

The ball end of the pistons goes down against the cups on the face of the piston cluster.

f. Install the pistons and push all pistons down through the body into the dimples in the piston cluster (see Figure 35).
g. Install the large O-ring on the outer edge of the piston body.

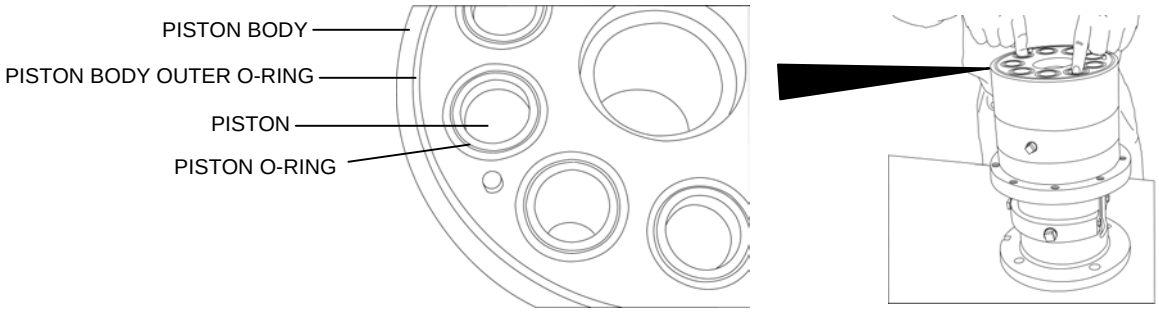

Figure 35. High Pressure Pump Piston Installation.

20. Inspect and (if necessary) replace the valve housing.
    a. Inspect the valve housing for any cracks, delamination or damage. Replace the valve-housing assembly if any delamination or obvious damage is visible.

NOTE

The valve housing contains pairs of disk check valves above each piston to rectify the flow through the pump. All valves must be properly seated and properly oriented. The failure of a valve will drastically affect the performance of the pump.

    b. The top surface of the valves should be flush with the surface of the valve housing.
    c. Inspect the exposed surfaces of the valves for damage and / or wear.
21. Check for bad valves by performing the following water hold test:
    a. Hold the valve housing up off the surface of the work area.
    b. Pour water only into the valves with the plastic ends.
    c. If water flows through any of the valves and out the bottom, replace the valve as described earlier in this work package in the 1000 hour PMCS.
    d. Flip the valve housing over and repeat the water hold test for the valves with the plastic ends showing on the other side of the housing.

NOTE

Alignment pins on the piston body help align the valve housing to the body.

22. Mount the valve housing onto the piston body (see Figure 36):

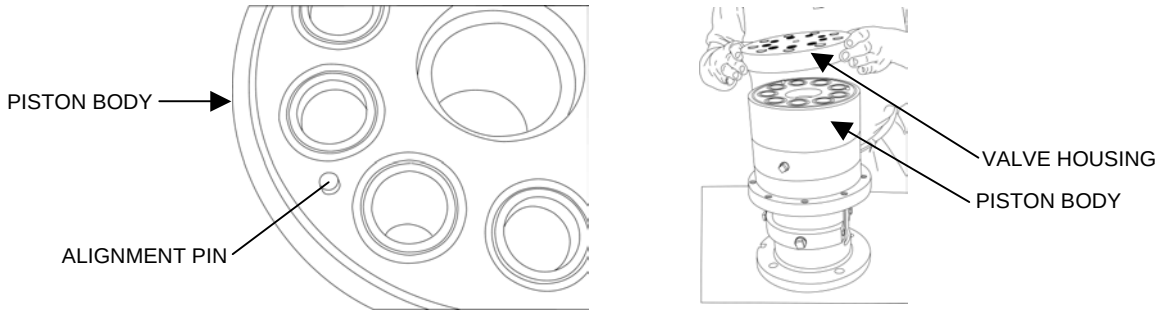

Figure 36. Valve Housing Installation.

23. Inspect and (if necessary) replace the manifold (see Figure 37).

NOTE

The manifold permits fluid transfer from the inlet port to the valves and again from the valves to the outlet port. The inner of the two manifold channels carries high-pressure fluid to the outlet port from the check valves. The outer channel carries low-pressure fluid from the inlet port to the check valves.

a. Inspect all ports, fittings, and threads for deterioration or damage.
b. Remove and discard all O-rings.
c. Inspect all O-ring grooves for scratches, deterioration, or signs of leakage.
d. Inspect the manifold channels. If any delamination or structural cracks are present on the manifold's channels (annular grooves), O-ring grooves, or ports, the manifold must be replaced.
e. Inspect inlet and outlet nipples for damage, wear, or corrosion. Replace as needed.
f. Install new O-rings.

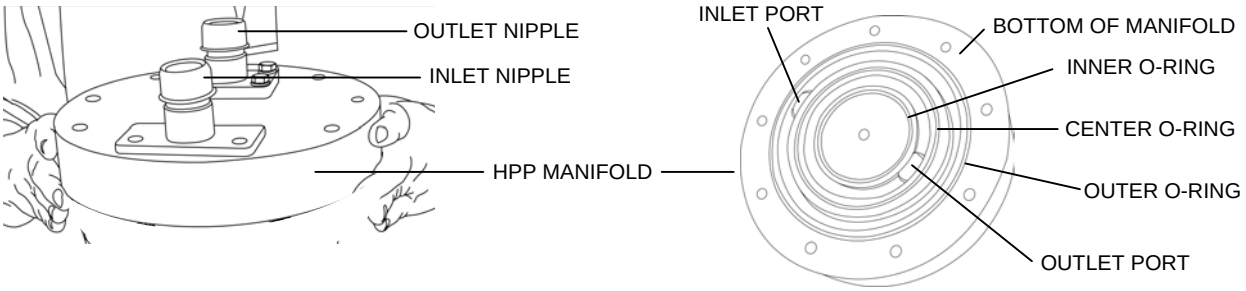

Figure 37. HPP Manifold Inspection.

24. Install the manifold as follows:

NOTE

Apply a little glycerin on the three O-rings on the bottom side of the manifold to hold them in place.

a. Install the manifold onto the valve housing (see Figure 38).

NOTE

It may be necessary to rotate the manifold to properly orient it to the tapped holes in the bearing plate.

b. Install and torque the center mounting bolt to 150 in.-lbs.
c. Install the bolts at the outer diameter of the manifold and torque them to 150 in. lbs. in the sequence shown in Figure 38.

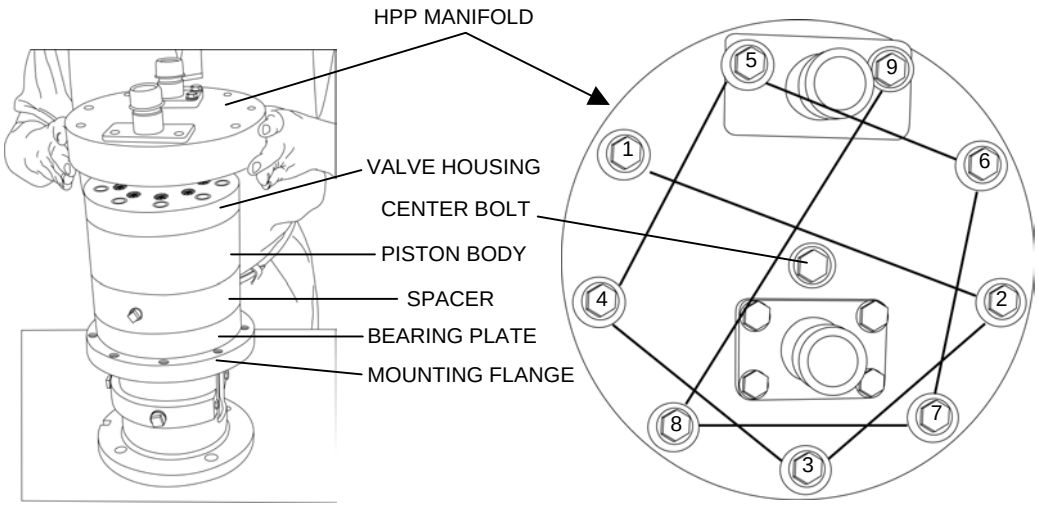

Figure 38. High Pressure Pump Manifold Installation.

CAUTION

Do not turn the pump shaft.

25. Install the pump shaft coupling key and set screw at the original position on the pump.
26. Install the high-pressure pump onto the motor. Refer to **High Pressure Pump or Motor Replacement**.
27. Install the high-pressure pump assembly onto the TWPS. Refer to **High Pressure Pump Assembly Replacement**.

CAUTION

Failure to follow the break-in procedure listed below may cause premature failure of the cam, thrust cluster, or tilt pad bearings or it may result in excessive power consumption by the pump.

NOTE

The thrust bearing assembly of the pump is broken in during factory assembly. The bearing assembly consists of the cam and thrust bearing. If either of these components is replaced during service or repair the bearing assembly must again be "Broken In".

28. If either or both the CAM or THRUST BEARING were replaced, perform the thrust bearing break-in procedures as follows:
    a. Perform the Start-Up After a Short Term or Standby Shutdown Without Draining procedures described in WP 0015.

b. Operate the high pressure pump at zero psig discharge pressure for 30 minutes.
c. Raise the discharge pressure in 100-psig increments, operating the pump at each incremental pressure increase for 30 minutes, until the maximum discharge pressure is attained.

29. Check for leaks and proper high pressure pump operation.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0054 00
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

THIS SECTION COVERS:
Replace, Service

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Wrench, Air Compressor Purification Chamber (BII)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS in Standby Shutdown Without Draining Down or With Drain-Down as required
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
High Pressure Air System or entire air system bled down as required

GENERAL:

This work package contains information and instructions for replacing and servicing components in the high pressure air system. The procedures covered in this work package include:

- High-Pressure Air System Bleed Down Procedures
- Entire Air System Bleed Down Procedures
- Oil/Water Coalescer CO1 Replacement
- Purification Filter Assembly AF2 Replacement
- Pressure Switch Assembly PSL/PSH-901 Replacement
- Air System Section 1 Assembly Replacement
- Pressure Maintaining Valve V-905 Replacement
- Low Pressure Air Check Valve V-906 Replacement
- Pressure Gauge PI-901 Replacement
- Air Receiver Tank R-1 Replacement
- Pressure Regulating Valve PRV-901 Replacement
- Pressure Gauge PI-902 Replacement
- Relief Valve RV-902 Replacement
- CO1 Oil Water Coalescer Sintered Metal Filter Service

All air system repair procedures in this work package, except for the pressure maintaining valve and gauge replacement and the pressure switch adjustment, will be performed off the TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

HIGH-PRESSURE AIR SYSTEM BLEED DOWN PROCEDURES:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on components in the TWPS high-pressure air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to performing maintenance on components in the TWPS high-pressure air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Bleed the high-pressure air system as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the high pressure air system as follows (see Figure 1 for valve location):
    a. Switch the Air Compressor control at the OCP to OFF.
    b. **Slowly** open High Pressure Air Vent Valve V-904 to bleed the air from the high-pressure system. Then close the valve.

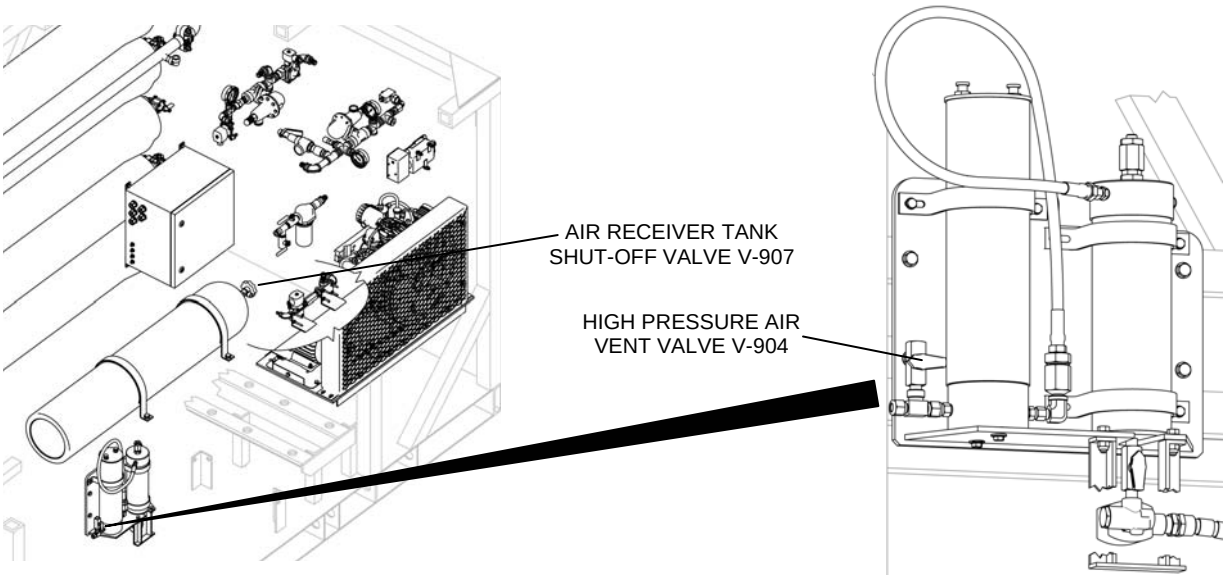

Figure 1. Valves for Bleeding the High Pressure Air System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

ENTIRE AIR SYSTEM BLEED DOWN PROCEDURES:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Bleed the entire air system as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the entire air system as follows (see Figure 2 for valve location):
    a. Stop the air compressor by switching the Air Compressor control at the OCP to OFF.
    b. Close Air Receiver Tank Shut-Off Valve V-907.
    c. Make sure that Low Pressure Air Shut Off Valve V-909 is open.
    d. **Slowly** open Low Pressure Air Vent Valve V-910 to bleed the air from the low pressure air system.
    e. **Slowly** open High Pressure Air Vent Valve V-904 to bleed the air from the high pressure air system.

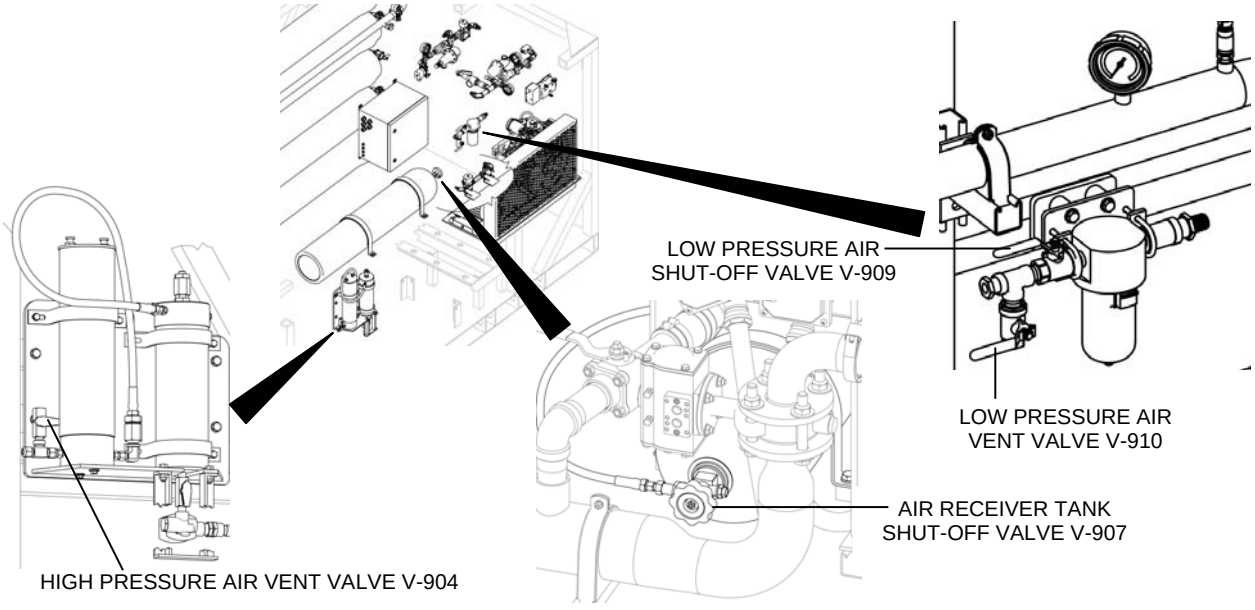

Figure 2. Valves for Bleeding the Entire Air System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

REPLACE

Oil/Water Coalescer CO1 Replacement:

Parts (TM 10-4610-309-24P):
Oil/Water Coalescer
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Clean, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
High Pressure Air System bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace oil/water coalescer CO1 as follows (see Figure 3):

1. Make sure the high-pressure air system has been bled down. Refer to **HIGH-PRESSURE AIR SYSTEM BLEED DOWN**.
2. Remove the CO1 oil/water coalescer as follows:
    a. Disconnect the hose connections from the coalescer.
    b. Remove the valve protector assembly by removing the 2 bolts, 4 washers, and 2 nuts.
    c. Disconnect the electrical plug to the solenoid assembly.
    d. Remove the two brackets and two gaskets that secure the coalescer to the mounting plate by removing the 2 cap screws, 2 star washers, and 2 flat washers.

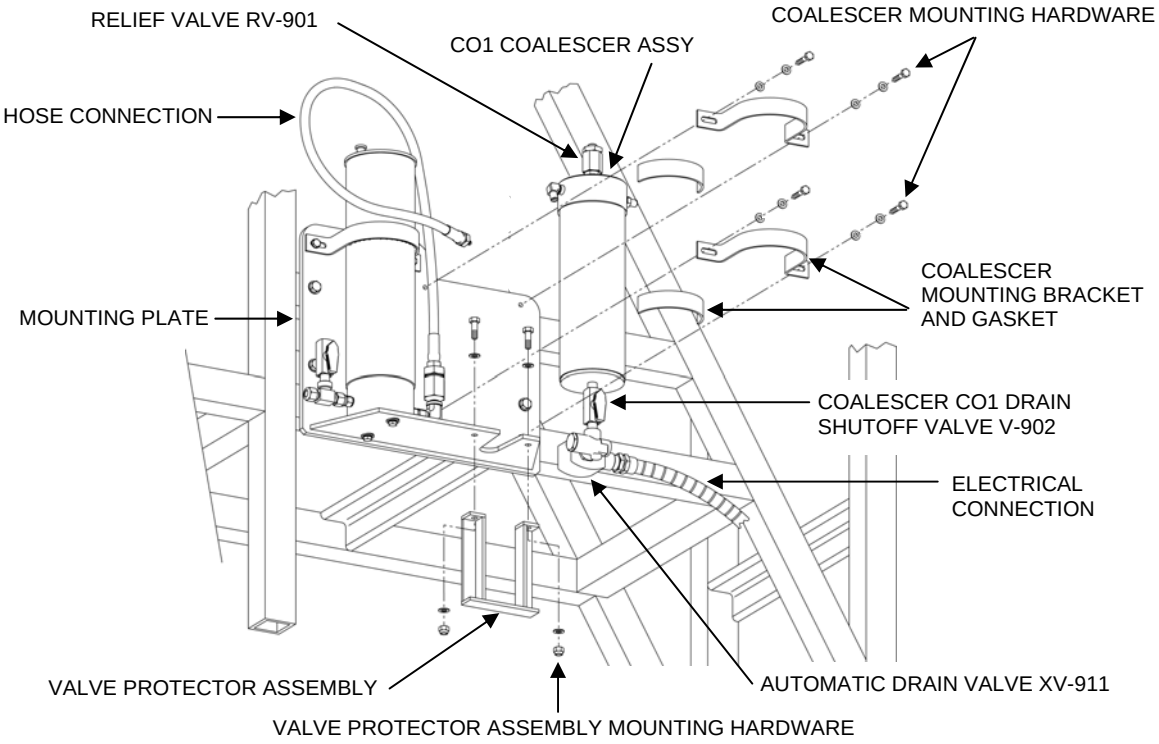

Figure 3. Oil/Water Coalescer CO1.

3. Place the old CO1 coalescer on a clean workbench and perform the following steps:
    a. Unscrew Coaleser CO1 Drain Shutoff Valve V-902 with piping from the coalescer.
    b. Remove the input, output and relief valve adapters from the old coalescer.
    c. Clean the three adapters and Coaleser CO1 Drain Shutoff Valve V-902.
    d. Apply antiseizing tape to the threads of the adapters and the vent valve.
    e. If Relief Valve RV-901 was removed, clean and install antiseizing tape to its threads and reinstall in its adapter.
    f. Install the adapter with the relief valve to the new coalescer.
    g. Install the two adapters onto the new oil/water coalescer.
4. Install the new oil/water CO1 coalescer as follows:
    a. Install Coaleser CO1 Drain Shutoff Valve V-902 with piping to the coalescer CO1.
    b. Secure the coalescer to the mounting plate with the 2 brackets, 2 gaskets, 2 cap screws, 2 star washers, and 2 flat washers.
    c. Install the valve protector assembly using the 2 bolts, 4 washers, and 2 nuts.
    d. Connect the hoses to the coalescer that were removed earlier.
5. Start the air compressor.
6. Check the new oil/water CO1 coalescer for leaks.
7. Check the automatic drain valve for proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

Purification Filter Assembly AF2 Replacement:

Parts (TM 10-4610-309-24P):
Purification Filter Assembly AF2
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Clean, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
High Pressure Air System bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Purification Filter Assembly AF2 as follows:

1. Make sure the high-pressure air system has been bled down. Refer to **HIGH-PRESSURE AIR SYSTEM BLEED DOWN**.
2. Remove Purification Filter Assembly AF2 as follows (see Figure 4):
    a. Disconnect the hose connection and Check Valve V-903 connection from the filter assembly.
    b. Remove the two bolts that secure the filter assembly to the bottom mounting plate.
    c. Remove the bracket while supporting Purification Filter Assembly AF2.
    d. Remove the purification filter assembly from the TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

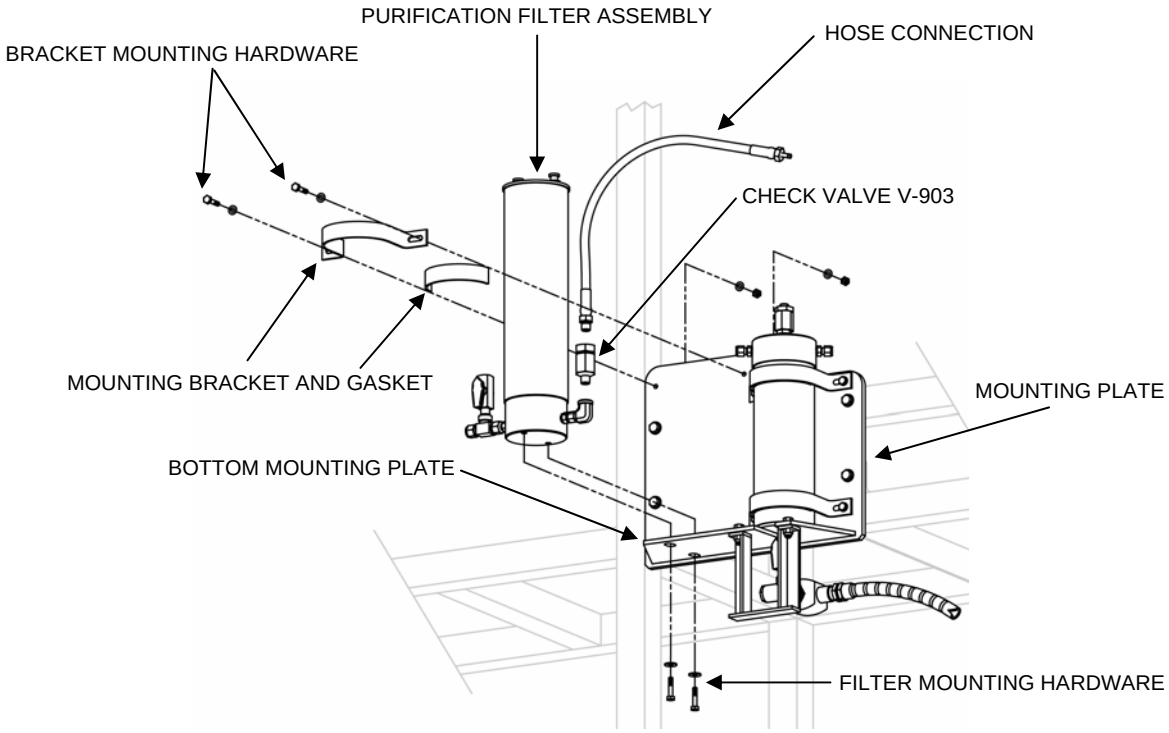

Figure 4. Purification Filter Assembly AF2.

3. Place the old AF2 purifier filter assembly on a clean workbench and perform the following steps:
    a. Remove the input and output adapters from the old filter assembly.
    b. Clean the two adapters.
    c. Apply antiseizing tape to the threads of the adapters.
    d. Install the two adapters into the new purification filter assembly.
4. Install the new purification filter assembly AF2 as follows:
    a. Install the two bolts that secure the filter assembly to the bottom mounting plate.
    b. Install the bracket that holds the purifier filter assembly in position.
    c. Reconnect the hose and Check Valve V-903 to the purifier assembly.
5. Check the new Purification Filter Assembly AF2 for leaks.

Pressure Switch Assembly PSL/PSH-901 Replacement:

Parts (TM 10-4610-309-24P):
Pressure Switch Assembly PSL/PSH-901
Materials:
Tape, antiseizing (WP 0079, Table 1, item 43,44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

Replace Pressure Switch Assembly PSL/PSH-901 as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the pressure switch assembly as follows (see Figure 5):
   a. Remove the terminal box cover and remove the two screws that secure the control wires.
   b. Unscrew the ring nut from the terminal box connection and pull the control wire out.
   c. Loosen the nut on the ferrule of the air hose compression fitting and remove the air hose.
   d. Remove the three bolts, six washers, and three nuts that secure the pressure switch assembly to the TWPS and remove the pressure switch assembly.
   e. Remove the elbow ferrule from the assembly.

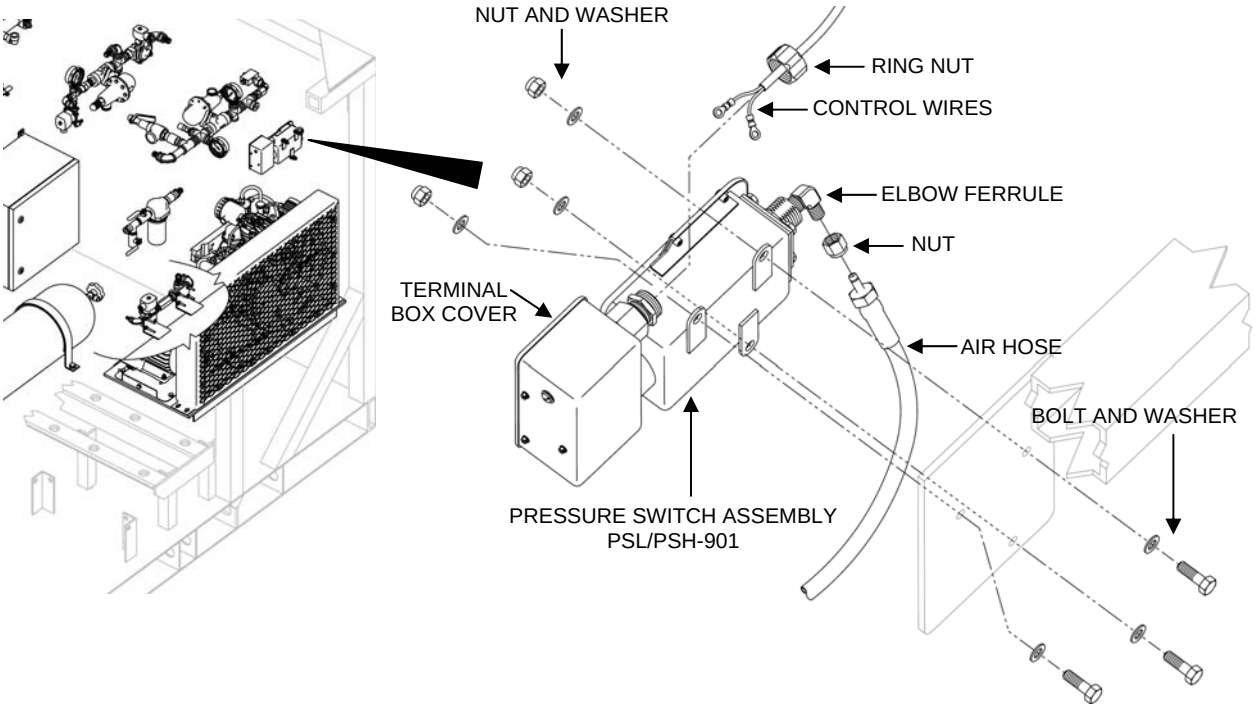

Figure 5. Pressure Switch Assembly PSL/PSH-901 Replacement.

3. Install the new pressure switch assembly as follows (see Figure 5):
    a. Clean the threads of the elbow ferrule and wrap antiseize tape around the threads.
    b. Screw the ferrule into the pressure switch assembly box.
    c. Secure the pressure switch assembly to the TWPS using the three bolts, six washers, and three nuts.
    d. Secure the air hose to the elbow ferrule on the pressure switch assembly box. Refer to WP 0066, **REPLACE** and **Compression Fitting Connected Hose Replacement**.
    e. Remove the new pressure switch assembly terminal box cover. Feed the control wires into the box. Secure the red wire with the upper terminal screw. Secure the black wire with the lower terminal screw.
    f. Screw the ring nut onto the terminal box connection
    g. Secure the pressure switch assembly terminal box cover to the box.

Air System Section 1 Assembly Replacement:

Parts (TM 10-4610-309-24P):
Air System Section 1 Assembly
Materials:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Personnel Required:
Two
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the Air System Section 1 assembly as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 1 assembly as follows (see Figure 6):
    a. Tag and disconnect the air supply hose from Pressure Maintaining Valve V-905.
    b. Tag and disconnect the hose from the Section 1 outlet that goes to the PSL/PSH-901 pressure switch.
    c. Tag and disconnect the hose from the Section 1 outlet that goes to Air Tank R-1.
    d. Tag and disconnect the hose from the Section 1 outlet that goes to Air System Section 3.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

CAUTION

Two people are required to safely remove the Air System Section 1 assembly from the TWPS. Failure to observe this warning may result in damage to equipment.

e. With another person holding the Air System Section 1 assembly, disconnect the 3 U-bolts, 6 flat washers, and 6 locking nuts that attach the assembly to the TWPS frame.
f. Remove the Section 1 assembly from the TWPS and place on a clean workbench.

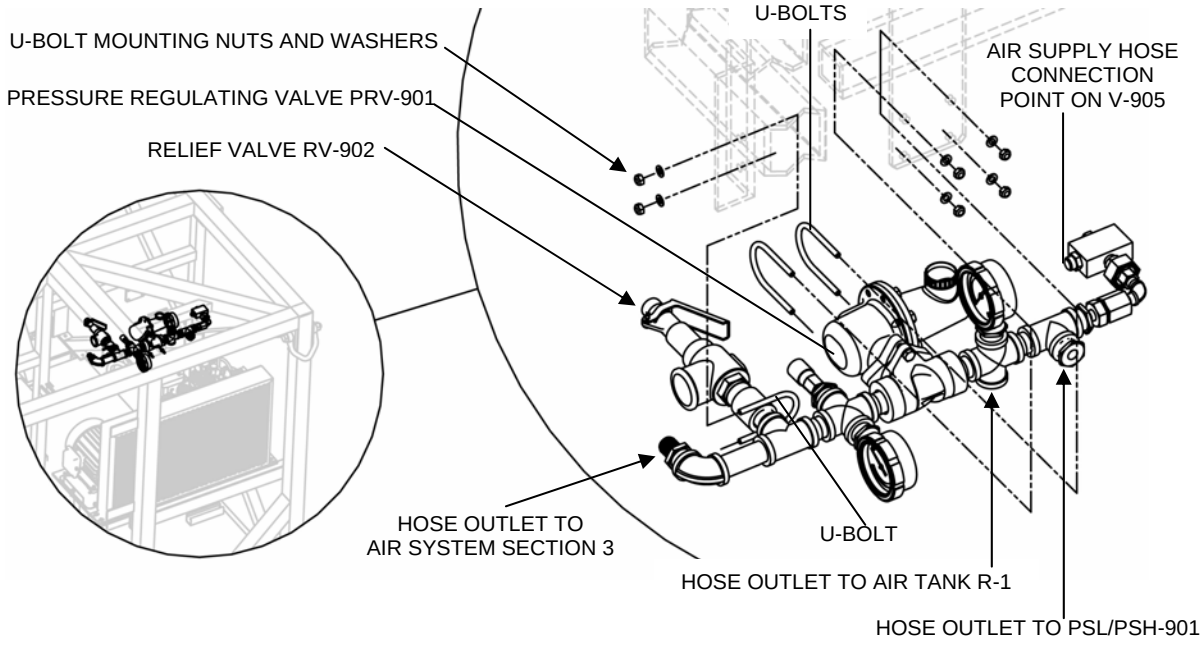

Figure 6. Air System Section 1 Assembly.

CAUTION

Two people are required to safely install the air system section 1 assembly to the TWPS. Failure to observe this warning may result in damage to equipment.

3. Install the new Air System Section 1 assembly onto the TWPS as follows (see Figure 6):
   a. With another person supporting the Air System Section 1 assembly, secure the assembly to the TWPS using the 3 U-bolts, 6 flat washers, and 6 locking nuts.
   b. Clean the hose connectors threads for the hoses that were disconnected from the old Air System Section 1. Wrap antiseizing tape on the cleaned threads.
   c. Connect the hose from Air System Section 3 to the Air System Section 1 assembly.
   d. Connect the hose from Air Receiver Tank R-1 to the Air System Section 1 assembly.
   e. Connect the hose from PSL/PSH-901 Pressure Switch assembly to the Air System Section 1 assembly.
   f. Connect the air supply hose to Pressure Maintaining Valve V-905.
4. Check the Air System Section 3 assembly for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

Pressure Maintaining Valve V-905 Replacement:

Parts (TM 10-4610-309-24P):
Pressure Maintaining Valve V-905
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Pressure Maintaining Valve V-905 as follows:

NOTE
Pressure-maintaining valve V-905 can be replaced without removing the air system section 1 assembly from the TWPS.

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove Pressure Maintaining Valve V-905 from the Air System Section 1 assembly as follows (see Figure 7):
   a. Tag and disconnect the air supply hose from Pressure Maintaining Valve V-905.
   b. Disconnect the pressure-maintaining valve from the assembly at the pipe union.

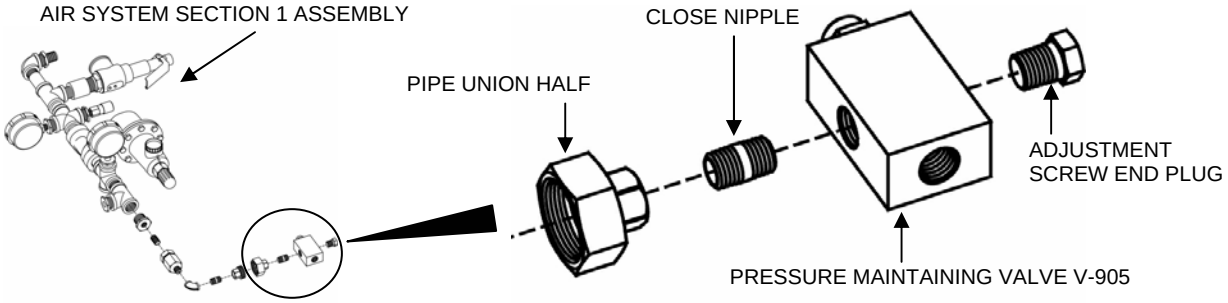

Figure 7. Pressure Maintaining Valve V-905.

3. Place the old pressure maintaining valve on a clean workbench and perform the following steps:
    a. Remove the close nipple and the half of the pipe union on the nipple from the valve. Separate the union half from the nipple.
    b. Clean both ends of the close nipple. Apply antiseizing tape to the threads at both ends.
    c. Thread the pipe union half onto the close nipple.
    d. Thread the close nipple with the union half into the output of the new pressure maintaining valve. Do not over-tighten.
    e. Clean the threaded end of the pipe union half that was left on the Section 1 assembly. Apply antiseizing tape to the threads.
4. Install the new pressure-maintaining valve on the Air System Section 1 assembly.
5. Make sure the position of Pressure Maintaining Valve V-905 matches Figure 6 (Air System Section 1 Assembly).
6. Check the new pressure-maintaining valve for leaks.

Low Pressure Air Check Valve V-906 Replacement:

Parts (TM 10-4610-309-24P):
Low-Pressure Air Check Valve V-906
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Clean, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Low-Pressure Air Check Valve V-906 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 1 assembly. Refer to **REPLACE** and **Air System Section 1 Assembly.**
3. Remove Low-Pressure Check Valve V-906 from the Air System Section 1 assembly as follows (see Figure 8):
    a. Disconnect Pressure-Maintaining Valve V-905 from the assembly at the pipe union.

b. Disconnect the ¼-in. 90-degree elbow from the ¼-in. close nipple that is connected to the check valve.

NOTE
Note the direction of flow for Check Valve V-906 before removing it.

c. Disconnect Low-Pressure Check Valve V-906 from the ¾-in. to ¼-in. reducing bushing.

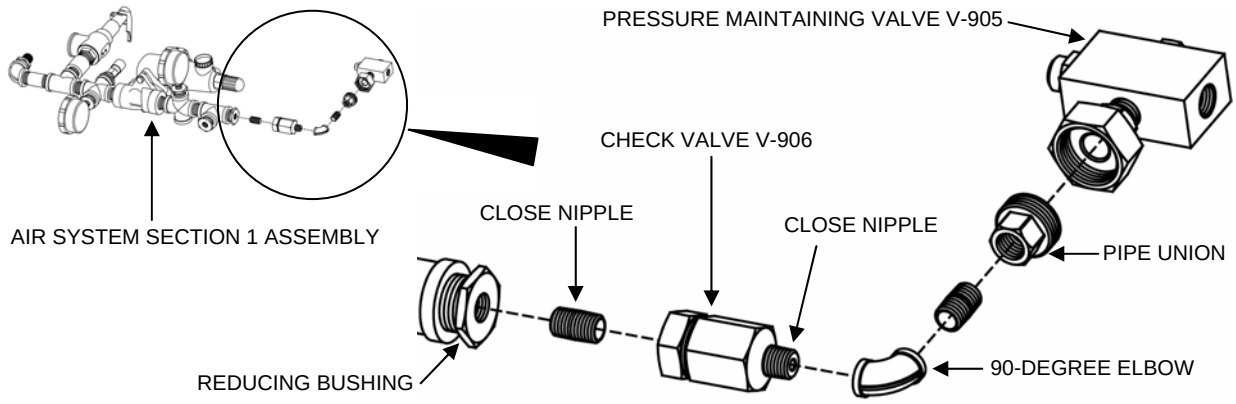

Figure 8. Low-Pressure Check Valve V-906.

4. Place the old Low-Pressure Check Valve V-906 on a clean workbench and perform the following:
   a. Remove the two close nipples from the Check Valve.
   b. Clean the two close nipples and apply antiseizing tape to one end of each.
   c. Thread the taped end of the pipe nipples into each end of the new Low-Pressure Check Valve V-906.
   d. Apply antiseizing tape to the other ends of the pipe nipples.
5. Install new Check Valve V-906 onto the Air System Section 1 assembly as follows (see Figure 8):

NOTE
Make sure the direction of flow for the Check Valve is correct. See Figure 8 for correct positioning of the Check Valve. Care must be taken not over-tighten. Loosening the connection once tightened could cause the connection to leak.

   a. Thread the check valve and close nipple into the ¾-in. to ¼-in. reducing bushing and tighten.
   b. Thread the ¼-in., 90-degree elbow onto the other close nipple on the check valve and tighten. Make sure that the position of the ¼-in., 90-degree elbow matches Figure 8.
   c. Clean the threads of the pipe union and apply antiseizing tape to the threads.
   d. Thread Pressure-Maintaining Valve V-905 onto the pipe union. Check the correct positioning of the pressure-maintaining valve.
6. Install the Air System Section 1 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 1 Assembly.**
7. Check the new Low-Pressure Check Valve V-906 for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

Pressure Gauge PI-901 Replacement:

Parts (TM 10-4610-309-24P):
Pressure Gauge PI-901
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Pressure Gauge PI-901 as follows:

NOTE
Pressure Gauge PI-901 can be replaced without removing the Air System Section 1 assembly from the TWPS.

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove Pressure Gauge PI-901 from its reducing bushing in the Air System Section 1 assembly (see Figure 9).

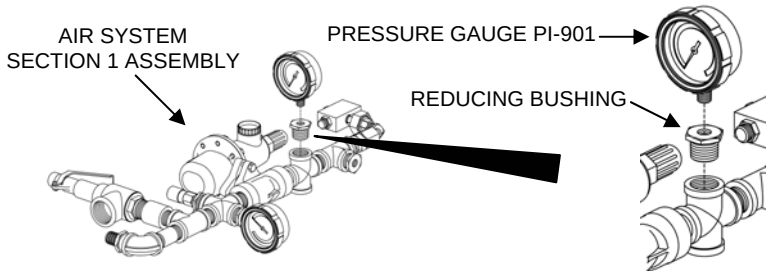

Figure 9. Pressure Gauge PI-901.

3. Clean and apply antiseizing tape to the threads of new Pressure Gauge PI-901.
4. Thread new Pressure Gauge PI-901 into its reducing bushing in the Air System Section 1 Assembly and tighten in the position shown in Figure 9.
5. Check new Pressure Gauge PI-901 for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

Air Receiver Tank R-1 Replacement Replacement:

Parts (TM 10-4610-309-24P):
Air Receiver Tank R-1
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Glycerin (WP 0079, Table 1, item 21)
Clean, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace air receiver tank R-1 as follows:

1. Make sure that the TWPS is in Standby Shutdown With Drain-Down.
2. Bleed the entire air system as follows (see Figure 10 for valve location):
    a. Stop the air compressor by switching the Air Compressor control at the OCP to OFF.
    b. Open Air Receiver Tank Shut-Off Valve V-907.
    c. Make sure that Low Pressure Air Shut Off Valve V-909 is open.
    d. **Slowly** open Low Pressure Air Vent Valve V-910 to bleed the air from the low pressure air system.
    e. **Slowly** open High Pressure Air Vent Valve V-904 to bleed the air from the high pressure air system.

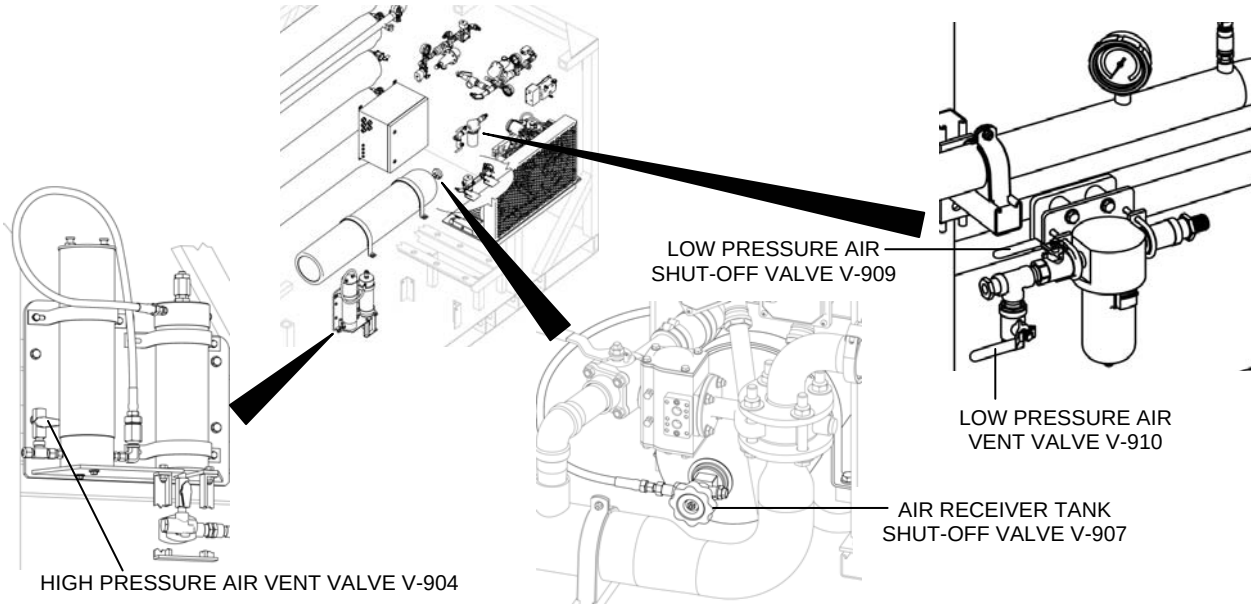

Figure 10. Low and High Pressure Air System Bleed Down.

3. Remove the 4 bolts, 4 lock washers, and 4 flat washers from the 2 upper ends of the frame cross braces at the right end of the TWPS.
4. Remove the 6 bolts, 12 flat washers, and 6 lock nuts from the middle of and the lower ends of the cross braces.
5. Tag and remove the frame cross braces (see Figure 11).

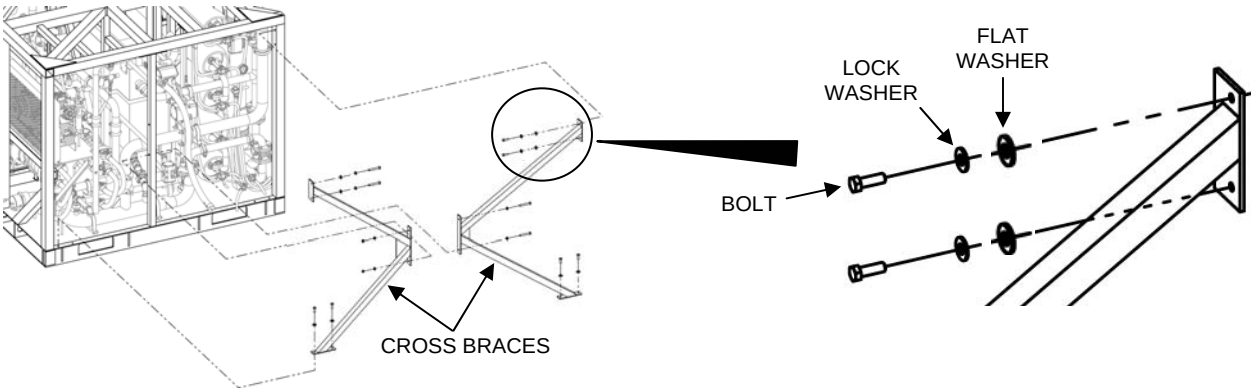

Figure 11. TWPS Frame Cross Brace Removal – Right End.

6. Remove any items stored under the HP pumps.
7. Remove High Pressure Pump Inlet Drain Valve V-214 from the High Pressure Pump Inlet Pipe Spool (see Figure 12).
8. Remove the High Pressure Pump Outlet Pipe Spool as follows (see Figure 12):
    a. Loosen the flex strut pipe support and remove the grooved coupling on the high pressure pump outlet pipe spool.
    b. Rotate the pipe spool to allow room for removing pressure gauge PI-301.
    c. Remove pressure gauge PI-301 from the High Pressure Pump (HPP) Outlet Pipe Spool.
    d. Remove the grooved coupling from the right end of the HPP Outlet Pipe Spool.
    e. Remove the grooved couplings on the high pressure outlet hoses at the outlet pipe spool.
    f. Tape the outlet hoses closed.
    g. Remove the flex strut pipe support from the left end of the HPP Outlet Pipe Spool.
    h. Carefully remove the HPP Outlet Pipe Spool.

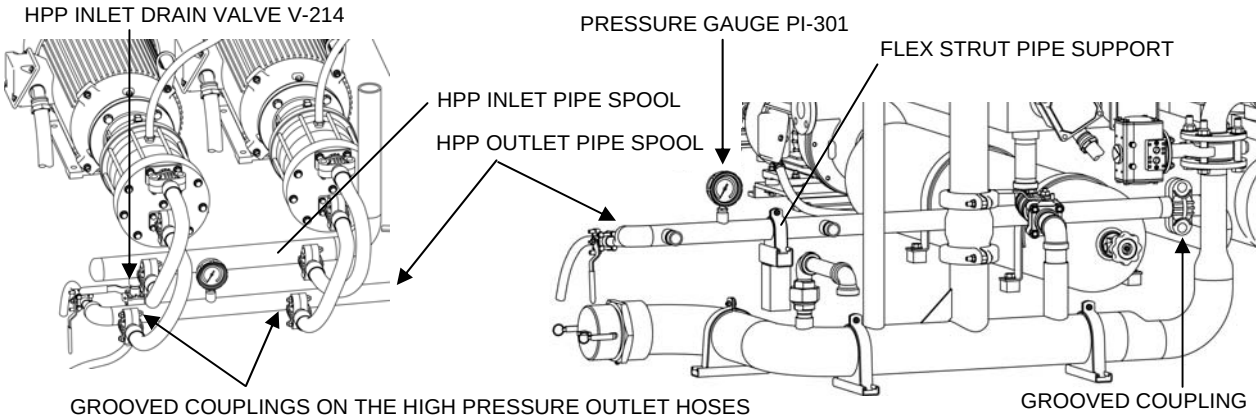

Figure 12. High Pressure Pump Outlet Pipe Spool Removal.

9. Remove the waste out pipe spool from in front of the air receiver tank as follows (see Figure 13):
    a. Disconnect the 4-in. x 5-ft. suction hose from the waste outlet (1).
    b. Remove 4 hose clamps (2) from the 2-in. rubber hose in the RO Feed Tank Drain Pipe.
    c. Remove RO Feed Tank Drain Valve V-412 (3) with the straight pipes on both sides of the valve.
    d. Remove the drain elbow with its 3 in. nipple (4) from the waste out pipe spool.
    e. Remove the two sanitary clamps and straight pipe (5) from the pipe spool upstream from MF Lower Shell Out Valve V-402.
    f. Disconnect the air tube from the MF Lower Shell Out Valve V-402 actuator (6) (see WP 0066).
    g. Remove MF Lower Shell Out Valve V-402 (6) and pipe elbow (7) (4 bolts, 8 washers, 4 nuts).
    h. Loosen the pipe coupling on the MF upper shell reject pipe spool (8) and push the coupling all the way down the lower pipe. Even pressure on both sides of the gasket (8A) makes it easier to slide the coupling down.
    i. Remove the grooved coupling (9) from the RO reject pipe spool.
    j. Remove the air tube from Shell Backwash Upper Outlet Valve V-401 (10) (see WP 0066).
    k. Remove the flex strut pipe support (11) to the right of valve V-401.
    l. Remove the sanitary clamp (12) to the right of the flex strut pipe support that was just removed.
    m. Lift out the MF Upper Reject Pipe Spool (13) with valve V-401 (10).
    n. Remove the three flex strut pipe supports (14) that secure the waste out pipe spool to the floor of the TWPS.

WARNING

Two person lift. Two people are required to safely lift the waste out pipe spool. Failure to observe this warning may result in injury.

NOTE

Lift or elevate the right end of the waste out pipe spool to assist in removal.

10. Remove the air receiver tank from the TWPS as follows (see Figure 13):

WARNING

Make sure the air system has been bled. Failure to bleed all pressure from the system may result in personal injury or damage to the equipment.

    a. Disconnect the air hose from Air Receiver Tank Shut-Off Valve V-907 (15).
    b. Remove the front bolts and washers (16) from the two bands that secure the air receiver tank to the floor of the TWPS.
    c. Remove the rear bolt and washer (17) from the band closest to the valve end of the air receiver tank and remove the band (18) and upper rubber cushion (19).

WARNING

Two person lift. Two people are required to safely lift the air receiver tank. Failure to observe this warning may result in injury.

d. Carefully lift the right end of the waste out pipe spool (20).
e. Pull the air receiver tank (21) out under the waste out pipe spool.

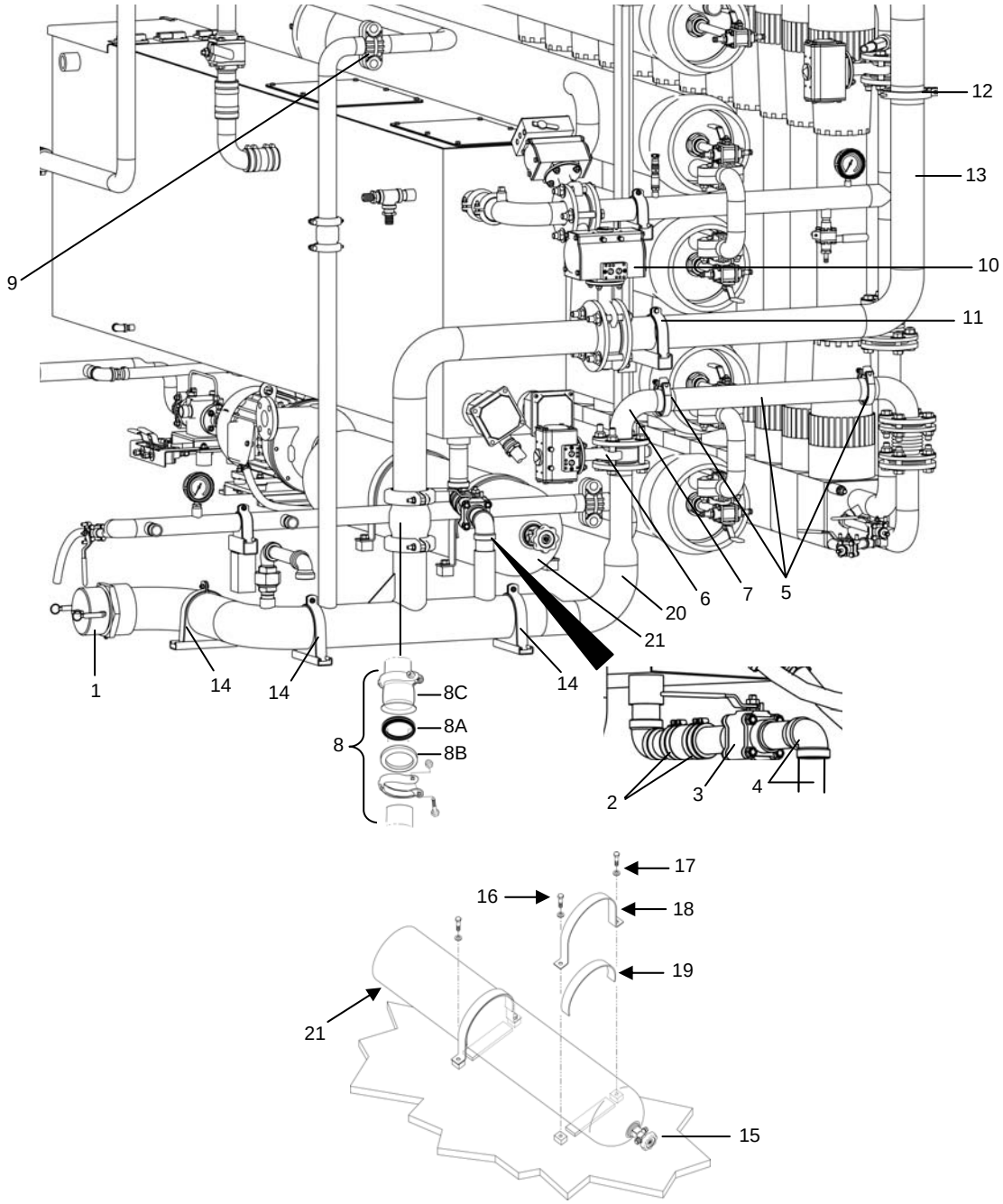

Figure 13. Waste Out Pipe Spool and Air Receiver Tank Removal.

11. Install the new air receiver tank as follows (see Figure 14).
    a. Inspect the support band rubber cushions (19) and replace if damaged or worn.
    b. Slide the new tank (21) into position under the supports bands (18).
    c. Push the tank back until it just clears the RO Feed Pump inlet pipe.
    d. Position the upper rubber cushions (19) between the tank and the support straps.

NOTE

Make sure that the air hose connector on the air tank shut off valve is horizontal to the TWPS floor and facing toward the front of the TWPS.

    e. Reinstall the bolts and washers (16 & 17) in the support straps and tighten to secure the air receiver tank to the floor of the TWPS.
    f. Connect the air hose to Air Tank Shut-Off Valve V-907 (15).
12. Reinstall the waste out pipe spool as follows (see Figure 14):
    a. Position the waste out pipe spool (20) into its original location.
    b. Reinstall but do not tighten the three flex strut pipe supports (14) that secure the waste out pipe spool to the floor of the TWPS.
    c. Slide one pipe coupling gasket retainer (8C), one gasket (8A), and the pipe joint (8C) over the 3-in. vertical waste out pipe and slide them all the way down the pipe.
    d. Slide the other gasket retainer and gasket onto the MF upper reject pipe spool.
    e. Position the MF upper shell reject pipe spool in place as follows:
        1) Install the flex strut pipe support (11) on the pipe support beam to the right of valve V-401 and slide the pipe assembly (13) onto the flex strut pipe support.
        2) Install the sanitary clamp (12) on the upper end of the MF Upper Shell Reject Pipe.
        3) Complete the 3-in. pipe coupling (8) connection on the 3-in. vertical waste out pipe, but do not tighten.
        4) Connect the air tube to the actuator for valve V-401 (10).
    f. Install the RO Feed Tank Drain Pipe assembly as follows:
        1) Install the drain elbow and nipple (4) to the 3-in. waste out pipe spool.
        2) Thread the drain pipe containing RO Feed Tank Drain Valve V-412 (3) into the drain elbow.
        3) Inspect the 2-in. rubber hose and hose clamps (2) removed earlier for wear, damage, or corrosion. Replace if needed.
        4) Lubricate the inside of the hose and the outside of the pipe sections with glycerin. Slide the four hose clamps and the 2-in. rubber hose over the ends of the RO Feed Tank Drain Pipe. Do not tighten the clamps.
    g. Connect the two open ends of the RO reject pipe spool using the grooved coupling (9).

NOTE

Make sure that the valve actuator is installed with the air tube side facing in and the valve actuator facing left.

    h. Install MF Lower Shell Out Valve V-402 (6) and pipe elbow (7) in the waste out pipe spool (21). Do not tighten.
    i. Reconnect the air tube to the valve actuator for valve V-402 (6).
    j. Inspect the sanitary clamps and gaskets (5) for wear or damage. Replace if needed.
    k. Connect the two open ends of the MF lower shell waste out pipe spool using the sanitary clamps and gaskets (5). Tighten the clamps. Tap the clamps all around to ensure that they are properly aligned and tighten again.

l. Tighten MF Lower Shell Out Valve V-402 (6) in the waste out spool.
m. Tighten the hose clamps (2) around the 2-in. rubber hose and the RO Feed Tank Drain Pipe.
n. Tighten the three flex strut pipe supports (14).

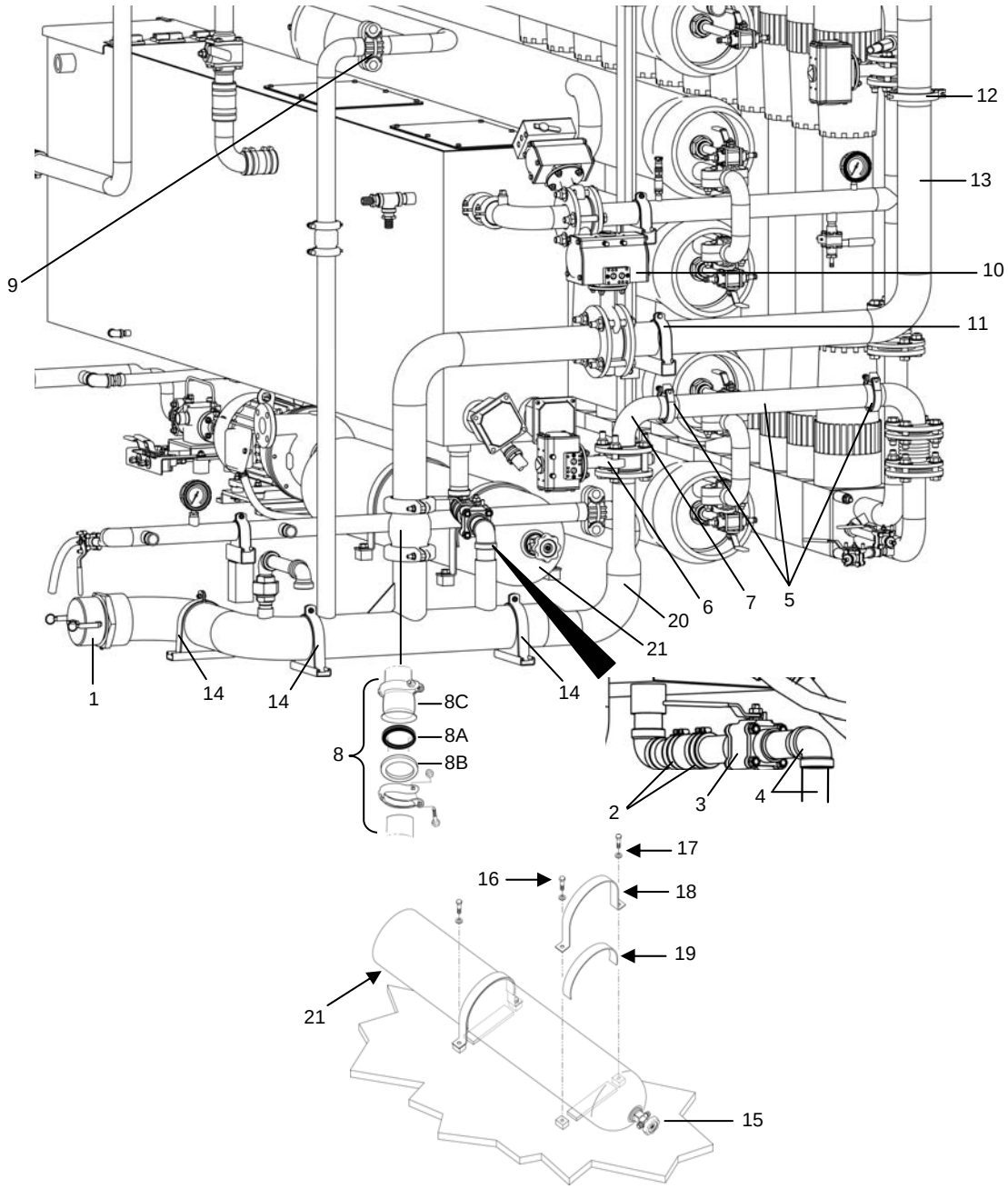

Figure 14. Waste Out Pipe Spool Installation.

13. Reinstall the High Pressure Pump Outlet Pipe Spool as follows (see Figure 15):
    a. Inspect the three grooved coupling gaskets for wear or damage. Replace if needed.
    b. Inspect the flex strut pipe support rubber cushion for wear or damage. Replace if needed.
    c. Install pressure gauge PI-301 in the left end of the HPP outlet pipe spool.
    d. Secure the left end of the High Pressure Pump Outlet Pipe Spool to the TWPS using the flex strut pipe support.
    e. Connect the right end of the High Pressure Pump Outlet Pipe Spool using the grooved coupling.
    f. Connect the two high pressure pump outlet hoses to the High Pressure Pump Outlet Pipe Spool using the two grooved couplings.
    g. Apply antiseizing tape and reinstall High Pressure Pump Inlet Drain Valve V-214 onto the High Pressure Pump Inlet Pipe Spool.

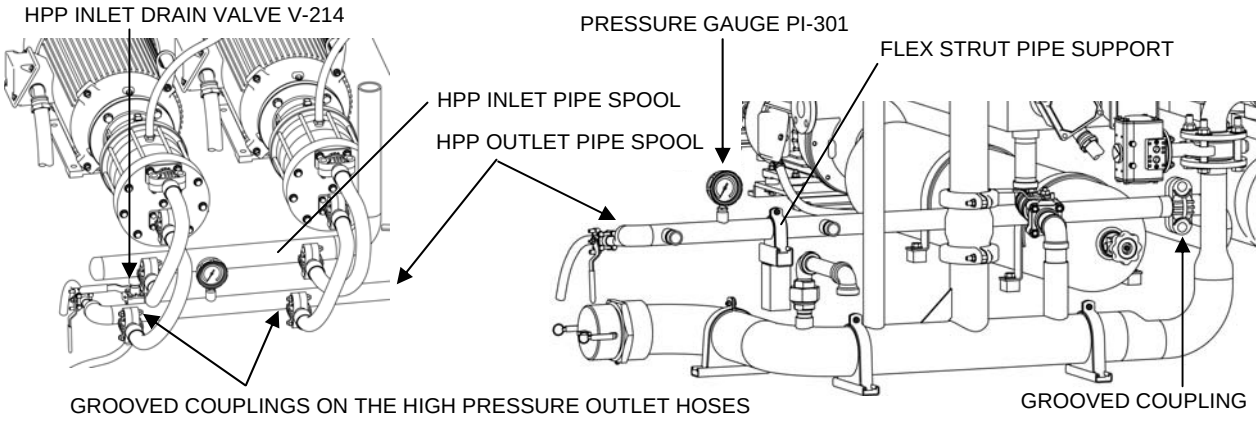

Figure 15. High Pressure Pump Outlet Pipe Spool Installation.

14. Reinstall the TWPS frame cross braces to the right end of the TWPS as follows (see Figure 16):
    a. Secure the middle of and the lower ends of the cross braces using the 6 bolts, 12 flat washers, and 6 lock nuts removed earlier.
    b. Secure the 2 upper ends of the frame cross braces at the right end of the TWPS using the 4 bolts, 4 lock washers, and 4 flat washers removed earlier.

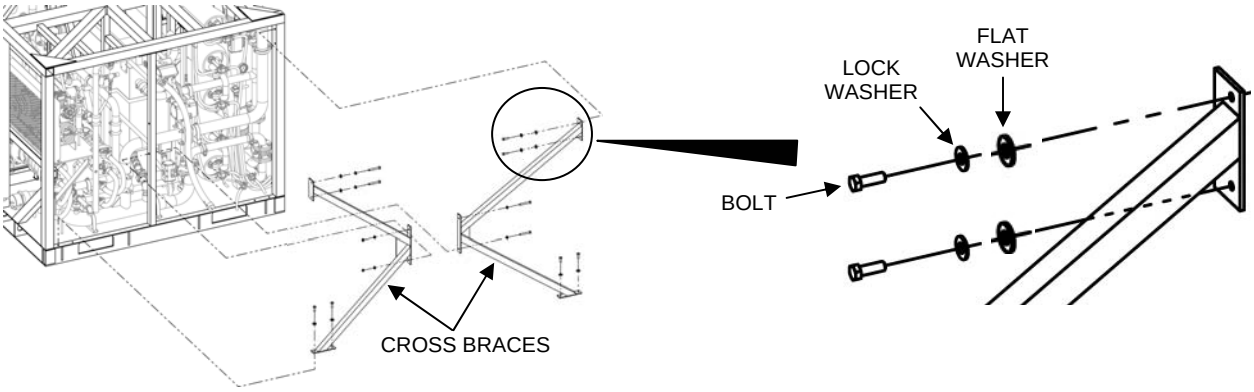

Figure 16. TWPS Frame Cross Brace Installation – Right End.

15. Reconnect the 4-in. x 5-ft. suction hose to the waste outlet.
16. Establish electrical power as described in WP 0012.
17. Start the air compressor as described in WP 0014.
18. Check the air tank shut-off valve and air hose connection at the air tank shut-off valve for leaks.
19. Start the TWPS as described in WP 0014.
20. Check all the pipe connections that were removed and reinstalled during the air receiver tank replacement procedure for leaks.

Pressure Regulating Valve PRV-901 Replacement:

Parts (TM 10-4610-309-24P):
    Pressure Regulating Valve V-901
Material:
    Tape, antiseizing (WP 0079, Table 1, item 43, 44)
    Clean, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
    TWPS in Standby Shutdown Without Draining Down
    Army: Generator off and TWPS main breaker off
    Marine Corps: TWPS disconnected from power source
    Entire air system bled down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Pressure-Regulating Valve PRV-901 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 1 assembly. Refer to **REPLACE** and **Air System Section 1 Assembly.**
3. Disconnect the cross tee pipes from the close nipples at both ends of Pressure Regulating Valve PRV-901 and remove the valve from the Air System Section 1 assembly (see Figure 17):

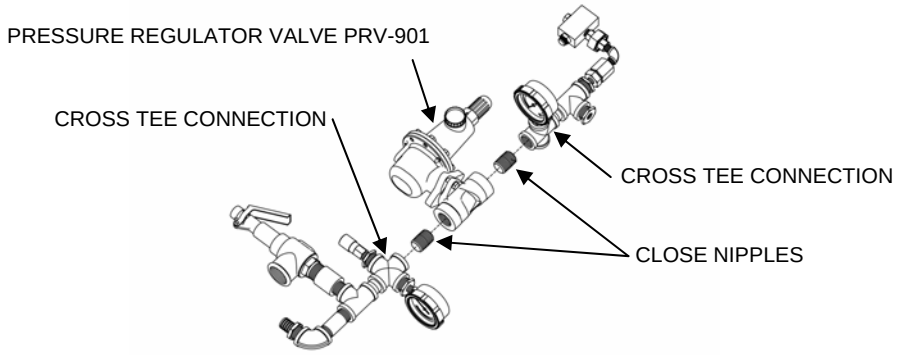

Figure 17. Pressure Regulator Valve PRV-901.

2. Place the old pressure regulating valve on a clean workbench and perform the following:
   a. Remove the two ¾-in. close nipples from both ends of the pressure-regulating valve.
   b. Clean both close nipples and install antiseizing tape on one end of nipples.
   c. Thread the taped end of the close nipples into the Pressure-Regulating Valve and tighten.
   d. Install antiseizing tape on the other ends of the close nipples.

NOTE

See Figure 17 for correct positioning of Pressure Regulating Valve PRV-901 and associated piping. Care must be taken not over-tighten. Loosening the connection once tightened could cause the connection to leak.

3. Install the pressure regulating valve onto the Air System Section 1 assembly as follows:
    a. Thread the Pressure Regulating Valve and close nipple to the cross pipe that contains Pressure Gauge PI-901 (see Figure 17 for the correct positioning of the valve).
    b. Thread the cross pipe that contains Pressure Gauge PI-902 into the other close nipple on the pressure-regulating valve (see Figure 17 for the correct positioning of the cross tee with Pressure Gauge PI-902).
4. Install the Air System Section 1 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 1 Assembly.**
5. Check the new Pressure Regulating Valve PRV-901 and associated piping for leaks.

Pressure Gauge PI-902 Replacement:

Parts (TM 10-4610-309-24P):
Pressure Gauge PI-902
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Pressure Gauge PI-902 as follows:

NOTE

Pressure Gauge PI-902 can be replaced without removing the Air System Section 1 assembly from the TWPS.

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.

2. Unscrew Pressure Gauge PI-902 from its ½-in. to ¼-in. reducer bushing (see Figure 18).
3. Clean and apply antiseizing tape to the threads of the new Pressure Gauge PI-902.
4. Thread the new pressure gauge into its reducer bushing and tighten in the position shown in Figure 18.
5. Check the new Pressure Gauge PI-902 for leaks.

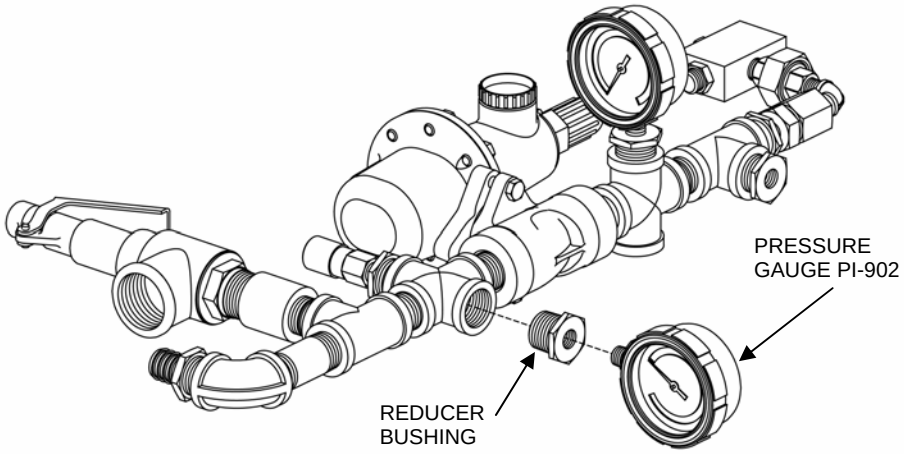

Figure 18. Pressure Gauge PI-902.

Relief Valve RV-902 Replacement:

Parts (TM 10-4610-309-24P):
Relief Valve RV-902
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Clean, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Relief Valve RV-902 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 1 assembly. Refer to **REPLACE** and **Air System Section 1 Assembly.**
3. Replace Relief Valve RV-902 as follows (see Figure 19):
   a. Remove Relief Valve RV-902 from the bell reducer.
   b. Remove the bell reducer from the close nipple and then remove the close nipple.

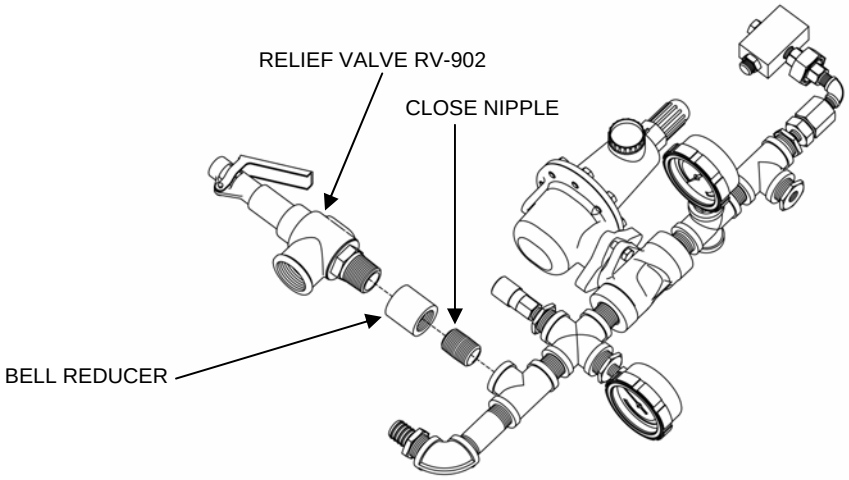

Figure 19. Relief Valve RV-902.

2. Clean the bell reducer and close nipple.
3. Install antiseizing tape to the threads of the new Relief Valve RV-902.
4. Install antiseizing tape onto both ends of the reducer bushing
5. Install the new Relief Valve RV-902 onto the bell reducer and the close nipple into the other end.
6. Tighten the relief valve in the position shown in Figure 19.
7. Install the Air System Section 1 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 1 Assembly.**
8. Check the new Relief Valve RV-902 and associated piping for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

SERVICE

CO1 Oil/Water Coalescer Sintered Metal Filter Service:

Parts (TM 10-4610-309-24P):
Sintered Metal Filter
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
High pressure air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Remove and clean or replace the oil/water coalescer sintered metal filter as follows:

1. Make sure the high-pressure air system has been bled down. Refer to **HIGH-PRESSURE AIR SYSTEM BLEED DOWN**.
2. Remove the CO1 oil/water coalescer sintered metal filter as follows (see Figure 20):
    a. Disconnect the hoses from the coalescer.
    b. Unscrew the filter head from the filter body.
    c. Unscrew the sintered metal filter from the filter head.
3. Clean or replace the sintered metal filter.
4. Reassemble the CO1oil/water coalescer sintered metal filter as follows:
    a. Screw the sintered metal filter into the filter head
    b. Screw the CO1 coalescer filter head into the filter body.
    c. Connect the hoses to the coalescer.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0054 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, HIGH PRESSURE

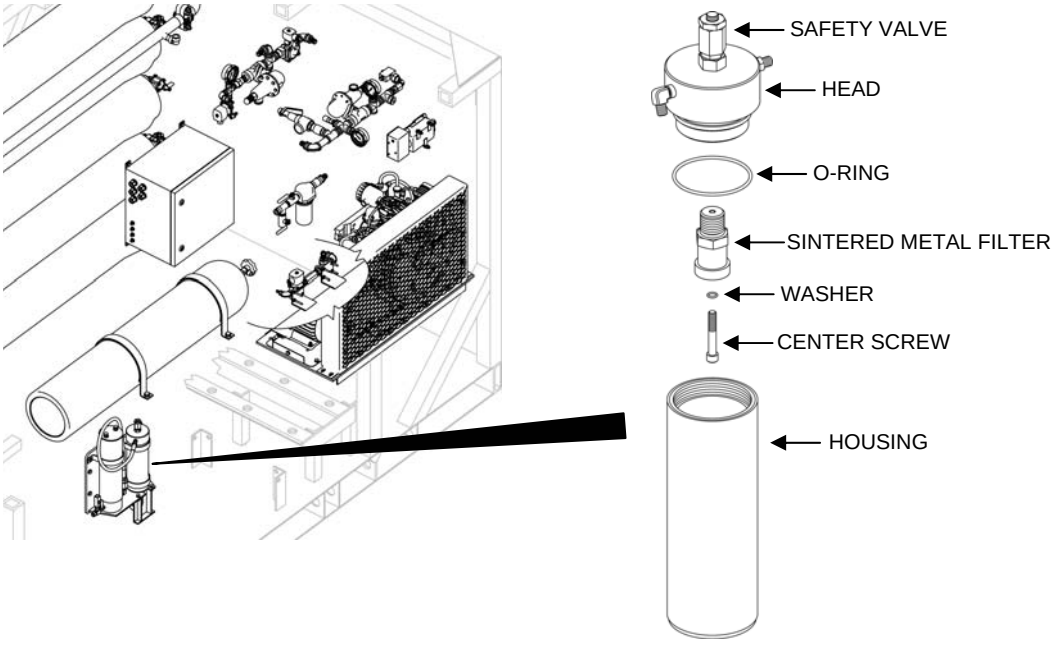

Figure 20. Coalescer CO1 Sintered Metal Filter.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Materials/Parts:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

GENERAL:

This work package contains information and instructions for replacing pressure regulators, solenoid valves and relief valves, hoses and piping in the Reduced Pressure Air System of the TWPS. The procedures covered in this work package include, in order:

- Entire Air System Bleed Down Procedures
- Air System Section 3 Assembly Replacement
- Solenoid Valve XV-901 Replacement
- Pressure Regulating Valve PRV-902 Replacement
- Pressure Gauge PI-903, 0-30 psig Replacement
- Solenoid Valve XV-903 Replacement
- Air System Section 4 Assembly Replacement
- Solenoid Valve XV-902 Replacement
- Check Valve V-908 Replacement
- Air System Section 6 Assembly Replacement
- Oil/Water Coalescer CO2 Replacement
- Manifold Maintenance Shutoff Valve V-909 Replacement
- Vent Valve V-910 Replacement
- Air System Air Hose Assemblies Replacement

All air system repair procedures in this work package, except for gauge replacement will be performed off the TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

ENTIRE AIR SYSTEM BLEED DOWN PROCEDURES

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Bleed the entire air system as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the entire air system as follows (see Figure 1 for valve location):
   a. Stop the air compressor by switching the Air Compressor control at the OCP to OFF.
   b. Close Air Receiver Tank Shut-Off Valve V-907.
   c. Make sure that Low Pressure Air Shut Off Valve V-909 is open.
   d. **Slowly** open Low Pressure Air Vent Valve V-910 to bleed the air from the air system.
   e. **Slowly** open High Pressure Air Vent Valve V-904.

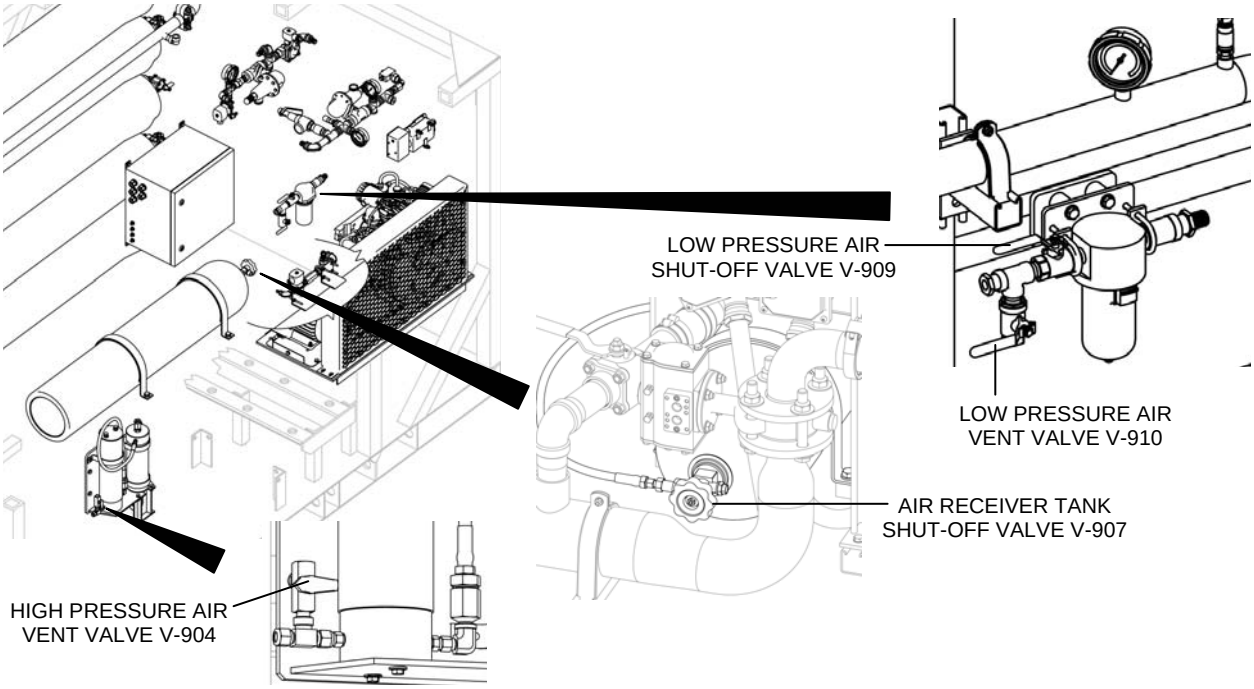

Figure 1. Valves for Bleeding the Entire Air System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

REPLACE

Air System Section 3 Assembly Replacement:

Parts (TM 10-4610-309-24P):
Air System Section 3 Assembly
Material Required:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Personnel Required:
Two
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the Air System Section 3 assembly as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the air system section 3 assembly as follows (see Figure 2):
    a. Tag and disconnect the air supply hose from the Air System Section 3 assembly.
    b. Tag and disconnect the hose from the Section 3 outlet that goes to CO2 coalescer.
    c. Tag and disconnect the hose from the Section 3 outlet that goes to MF Assembly Check Valve V-911.
    d. Tag and disconnect the hose from the Section 3 outlet that goes to the Air System Section 4 assembly Solenoid Valve XV-902.
    e. Tag and disconnect the hose from the Section 3 outlet that goes to the Air System Section 4 tee pipe.
    f. Tag and disconnect the electrical wiring from Solenoid Valve XV-901.
    g. Tag and disconnect the electrical wiring from Solenoid Valve XV-903.
    h. Cut the tie-wrap on the PT-201 HP pump inlet pressure transmitter cable from Air System Section 3 Assembly.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

CAUTION

Two people are required to safely remove the Air System Section 3 assembly from the TWPS. Failure to observe this warning may result in damage to equipment.

i. With another person holding the Air System Section 3 assembly, remove the two U-bolts, four self-locking nuts, and four flat washers that attach the assembly to the TWPS.
j. Remove the Section 3 assembly from the TWPS and place on a clean workbench.

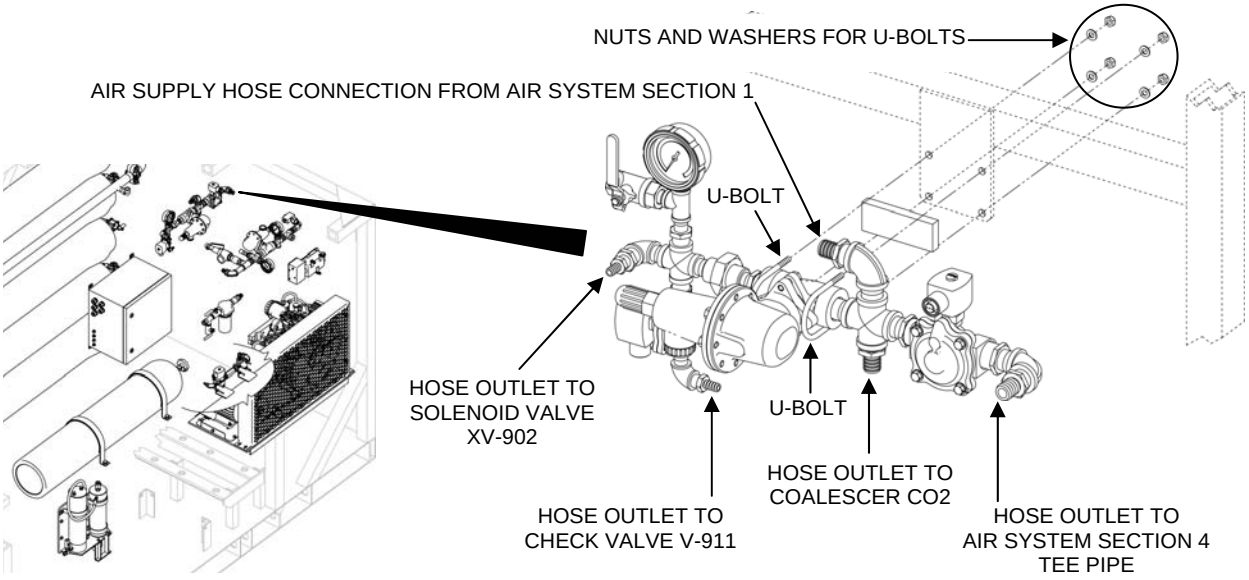

Figure 2. Air System Section 3 Assembly.

3. Install the new Air System Section 3 assembly onto the TWPS as follows (see Figure 2):
   a. With another person supporting the Air System Section 3 assembly, secure the assembly to the TWPS using the two U-bolts, four self-locking nuts, and four flat washers.
   b. Connect the electrical wiring to Solenoid Valves XV-901and XV-903.
   c. Clean the hose fitting threads for the hoses that were disconnected from Section 3.
   d. Apply anti-seize tape to the threads of the hose fitting and connect the hose from MF Assembly Check Valve V-911 to the Air System Section 3 assembly.
   e. Apply anti-seize tape to the threads of the hose fitting and connect the hose from the Solenoid Valve XV-902 in the Air System Section 4 assembly to the Air System Section 3 assembly.
   f. Apply anti-seize tape to the threads of the hose fitting and connect t the hose from the Air System Section 4 tee pipe to the Air System Section 3 assembly.
   g. Apply anti-seize tape to the threads of the hose fitting and connect the hose from CO2 Coalescer to the Air System Section 3 assembly.
   h. Apply anti-seize tape to the threads of the hose fitting and connect the air supply hose from Air System Section 1 to the Air System Section 3 assembly.
4. Start the compressor and check the Air System Section 3 assembly for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

Solenoid Valve XV-901 Replacement:

Parts:
Solenoid Valve XV-901 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Solenoid Valve XV-901 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 3 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 3 Assembly**.
3. Remove the Solenoid Valve XV-901 from the Air System Section 3 assembly as follows (see Figure 3):
    a. Disconnect Solenoid Valve XV-901 at the cross connection.
    b. Disconnect the two 1-in. to ¾-in. reducer bushings and the two ¾-in. close nipples from Solenoid Valve XV-901.
    c. Disconnect the ¾-in., 90-degree elbow from the ¾- in. close nipple that attaches to the reducer bushings.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

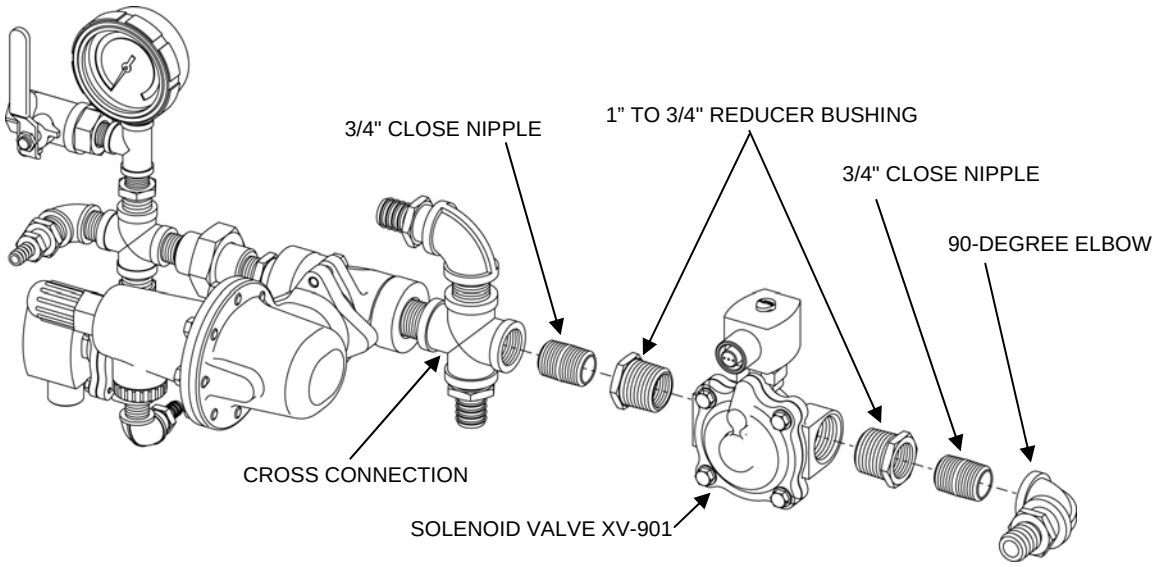

Figure 3. Solenoid Valve XV-901.

4. Place the old Solenoid Valve XV-901 on a clean workbench and perform the following:
    a. Clean all the disassembled parts.
    b. Apply antiseizing tape to both ends of the close nipples and to the reducer bushings.
5. Install the new Solenoid Valve XV-901 to the Air System Section 3 assembly as follows:
    a. Thread one of the reducer bushings and close nipples into the Solenoid Valve XV-901.
    b. Thread the ¾-in., 90-degree elbow onto the close nipple. Do not over-tighten.
    c. Make sure that the position of the elbow matches Figure 3.
    d. Thread the other ¾-in. close nipple and reducer bushing into the other end of the Solenoid Valve XV-901 and the cross connection. Do not over-tighten.
    e. Make sure that the position of Solenoid Valve XV-901 matches Figure 3.
6. Install the Air System Section 3 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 3 Assembly**.
7. Check the new Solenoid Valve XV-901and attached piping for leaks.

Pressure Regulating Valve PRV-902 Replacement:

Parts:
Pressure Regulating Valve PRV-902 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Pressure Regulating Valve PRV-902 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 3 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 3 Assembly**.
3. Remove Pressure-Regulating Valve PRV-902 from the Air System Section 3 assembly as follows (see Figure 4):
    a. Disconnect the pressure regulating valve from the assembly at the pipe union.
    b. Disconnect the pressure regulating valve from the cross tee connection.

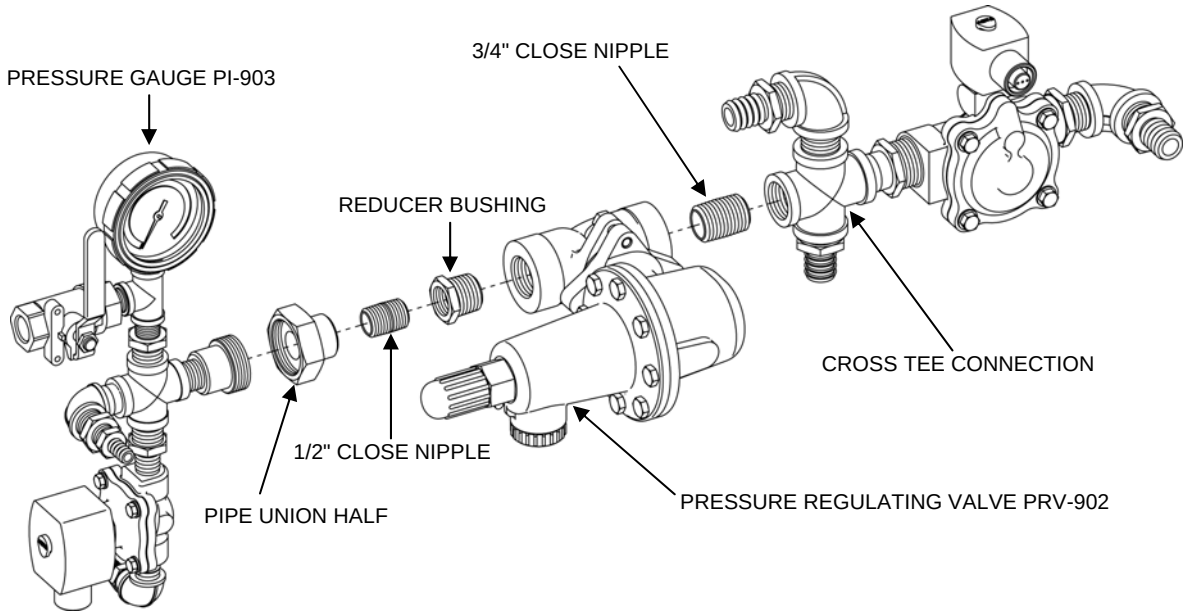

Figure 4. Pressure Regulating Valve PRV-902.

4. Place the old pressure regulating valve on a clean workbench and perform the following:
    a. Remove the ½-in. close nipple, the reducer bushing and pipe union half and ¾-in. close nipple from the ends of PRV-902.
    b. Clean all parts.

c. Apply antiseizing tape to both ends of the close nipples and the threaded end of the reducer bushing.
d. Thread the ¾-in. close nipple into the cross tee connection.

5. Install the new pressure regulating valve onto the Air System Section 3 assembly as follows:
   a. Thread the input side of the new pressure-regulating valve onto the ¾-in close nipple at the cross tee connection. Do not over-tighten.
   b. Make sure that the position of the new pressure-regulating valve matches that shown in Figure 4.
   c. Thread the pipe union half, ½-in. close nipple, and the reducer bushing together.
   d. Thread the reducer bushing into the other end of the new pressure-regulating valve and tighten.
   e. Thread the part of the Section 3 assembly that contains Pressure Gauge PI-903 onto the pipe union on the pressure regulating valve.
   f. Make sure the position of all components match Figure 4.
6. Install the Air System Section 3 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 3 Assembly**.
7. Check the new pressure regulating valve and attached piping for leaks.

Pressure Gauge PI-903, 0-30 psig Replacement:

Parts:
Pressure Gauge PI-903 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

NOTE

The pressure gauge PI-903 can be replaced with out removing the air system 100 and 15 psig MF backwash components from the TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

Replace Pressure Gauge PI-903 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Unscrew Pressure Gauge PI-903 from its pipe tee (see Figure 5):
3. Clean and apply antiseizing tape to the threads of the new Pressure Gauge PI-903.
4. Thread the new pressure gauge into the pipe tee and tighten in the position shown in Figure 5.
5. Check the new Pressure Gauge PI-903 for leaks.

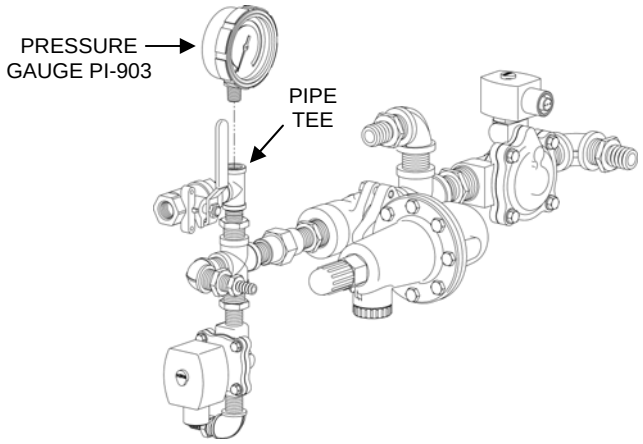

Figure 5. Pressure Gauge PI-903.

Solenoid Valve XV-903 Replacement:

Parts:
Solenoid Valve XV-903 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

Replace Solenoid Valve XV-903 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 3 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 3 Assembly**.
3. Remove Solenoid Valve XV-903 from the Air System Section 3 assembly as follows (see Figure 6):
    a. Disconnect the reducer bushing on Solenoid Valve XV-903 from the cross tee.
    b. Disconnect the reducer bushing, the two 3/8-in. close nipples, and the 3/8-in., 90-degree elbow from Solenoid Valve XV-903.

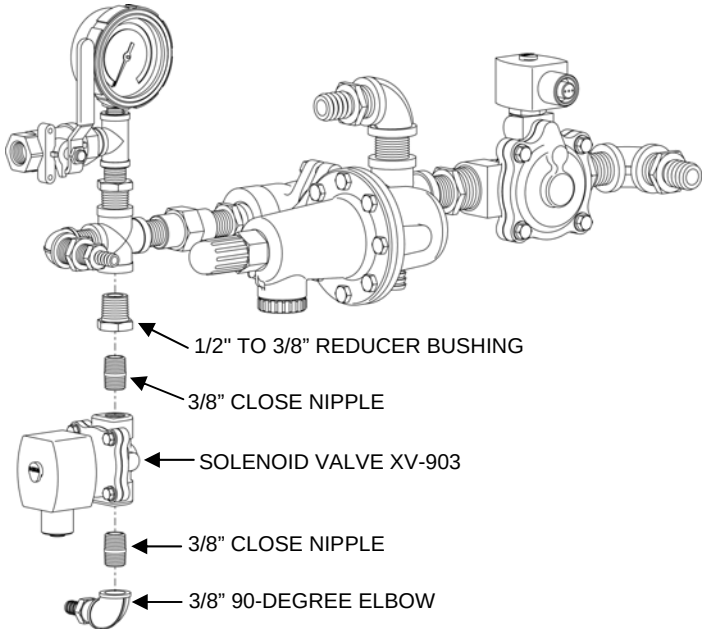

Figure 6. Solenoid Valve XV-903.

4. Place old Solenoid Valve XV-903 on a clean workbench and perform the following:
    a. Clean all disassembled parts.
    b. Apply antiseizing tape to both ends of the two close nipples and the external threads of the reducer bushing.
5. Install the new Solenoid Valve XV-903 in the Air System Section 3 assembly as follows:
    a. Thread the two 3/8" close nipples onto the solenoid valve hand tight.
    b. Thread the 1/2" to 3/8" reducer bushing into the cross tee and tighten.
    c. Thread the close nipple on the input side of the valve into the reducer bushing but do not over-tighten. Refer to Figure 6 for correct positioning of the valve.
    d. Thread the 3/8" elbow to the close nipple on the other end of the solenoid valve but do not over-tighten. Refer to Figure 6 for correct positioning of the elbow.
6. Install the Air System Section 3 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 3 Assembly**.
7. Check the new Solenoid Valve XV-903 and attached piping for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

Air System Section 4 Assembly Replacement:

Parts (TM 10-4610-309-24P):
Air System Section 4 Assembly
Material Required:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Personnel Required:
Two
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the Air System Section 4 assembly as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 4 assembly as follows (see Figure 7):
   a. Tag and disconnect the hose from Solenoid Valve XV-902.
   b. Tag and disconnect the electrical wiring from the solenoid valve.
   c. Tag and disconnect the hose coming from the Air System Section 3 assembly from the tee in Air System Section 4.
   d. Tag and disconnect the hose from the Section 4 outlet that goes to MF Check Valve V-912.

CAUTION

Two people are required to safely remove the air system section 4 assembly from the TWPS. Failure to observe this warning may result in damage to the equipment.

   e. With another person holding the Air System Section 4 assembly, disconnect the three U-bolts, 6 flat washers, and 6 self-locking nuts that attach the assembly to the TWPS.
   f. Remove the Air System Section 4 assembly from the TWPS and place it on a clean workbench.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

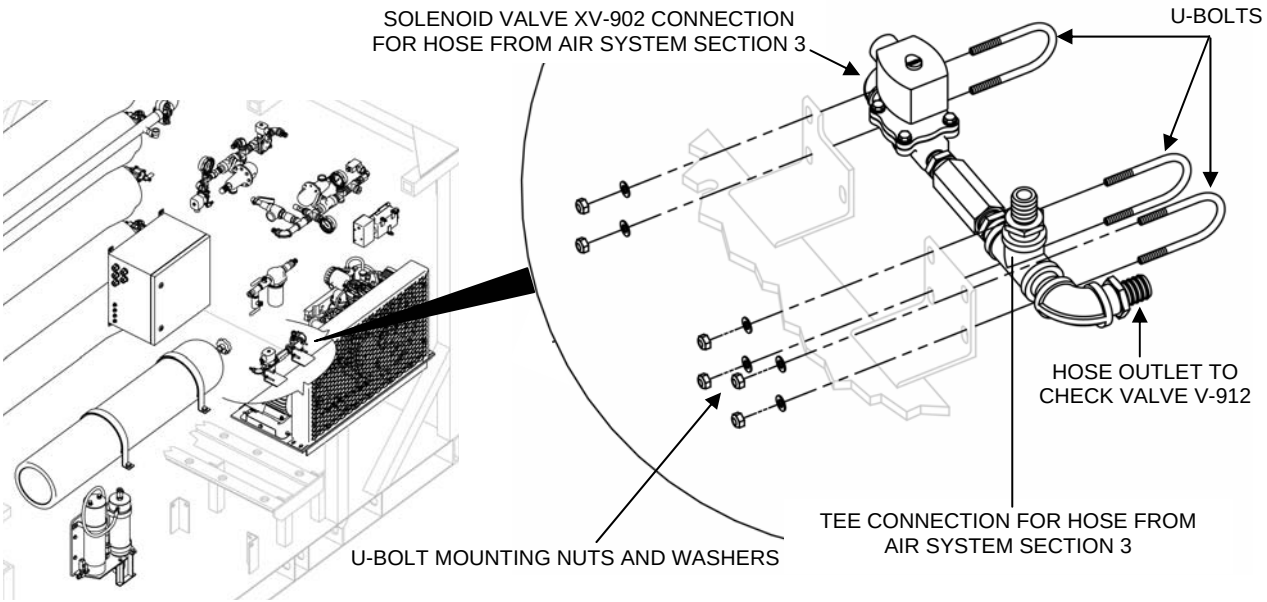

Figure 7. Air System Section 4 Assembly.

4. Install the new Air System Section 4 assembly onto the TWPS as follows (see Figure 7):
    a. With another person supporting the Air System Section 4 assembly, secure the assembly to the TWPS using the three U-bolts, 6 flat washers, and 6 self-locking nuts.
    b. Clean the hose fitting threads for the hoses that were disconnected from Section 4.
    c. Apply anti-seize tape to the threads of the hose fitting the hose from MF Check Valve V-912 to the Air System Section 4 assembly.
    d. Apply anti-seize tape to the threads of the hose fitting the hose from the Air System Section 3 assembly to the tee in the Air System Section 4 assembly.
    e. Apply anti-seize tape to the threads of the hose fitting the hose from the Air System Section 3 assembly to Solenoid Valve XV-902.
    f. Apply anti-seize tape to the threads of the hose fitting the electrical wiring to Solenoid Valve XV-902.
6. Start the compressor and check the Air System Section 4 assembly for leaks.

Solenoid Valve XV-902 Replacement:

Parts:
Solenoid Valve XV-902 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Solenoid Valve XV-902 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 4 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 4 Assembly**.
3. Remove Solenoid Valve XV-902 from the Air System Section 4 assembly as follows (see Figure 8):
    a. Disconnect Solenoid Valve XV-902, the close nipple and reducer bushing from Check Valve V-908.
    b. Disconnect the reducer bushing, the two close nipples, and the elbow from Solenoid Valve XV-902.

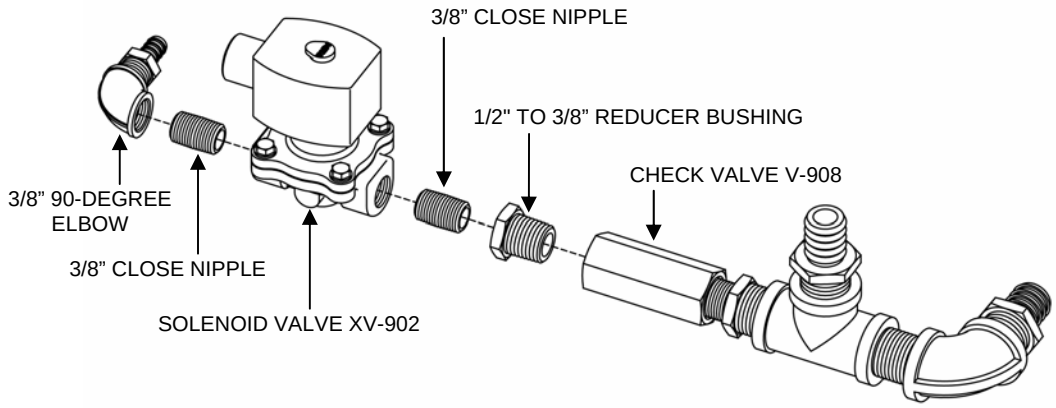

Figure 8. Solenoid Valve XV-902.

2. Place the old solenoid valve on a clean workbench and perform the following
    a. Clean all disassembled parts.
    b. Apply antiseizing tape to both ends of the two close nipples and to the external threads of the reducer bushing.

3. Install the new Solenoid Valve XV-902 as follows:
    a. Thread the two close nipples onto the solenoid valve hand tight.
    b. Thread the reducer bushing into the input side of Check Valve V-908 and tighten.
    c. Thread the close nipple on the output side of the solenoid valve into the reducer bushing. Do not over-tighten. Refer to Figure 8 for correct positioning of the valve.
    d. Thread the elbow onto the close nipple on the other end of the solenoid valve. Do not over-tighten. Refer to Figure 8 for correct positioning of the elbow.
4. Install the Air System Section 4 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 4 Assembly**.
5. Check the new Solenoid Valve XV-902 and attached piping for leaks.

Check Valve V-908 Replacement:

Parts:
Check Valve V-908 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Check Valve V-908 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 4 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 4 Assembly**.
3. Remove Check Valve V-908 from the air system section 4 assembly as follows (see Figure 9):
    a. Disconnect Check Valve V-908 from the reducer bushings at the ends of the check valve.
    b. Remove the close nipple from the check valve.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

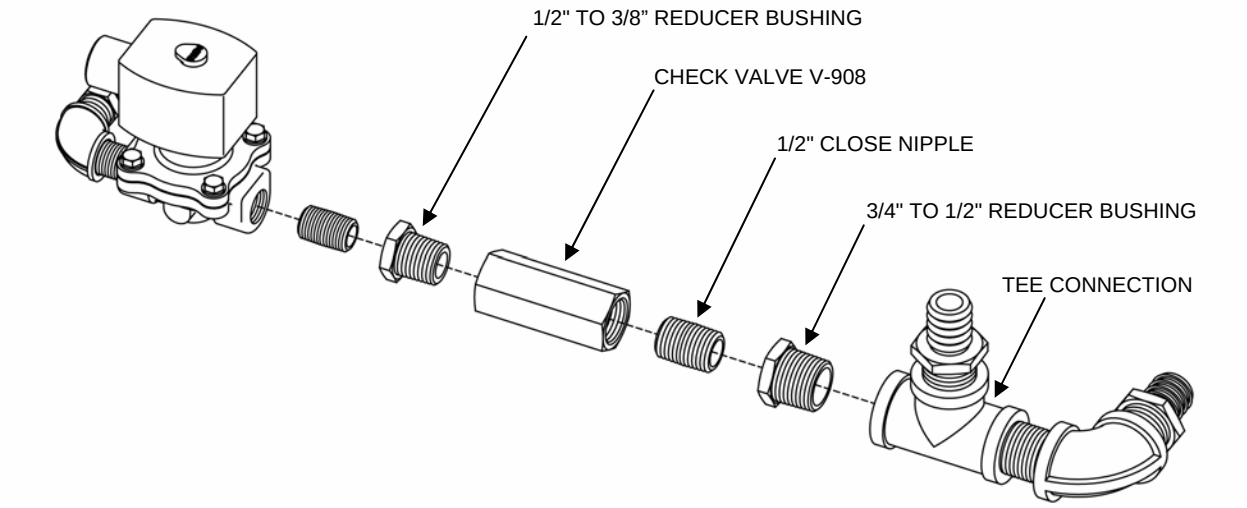

Figure 9. Check Valve V-908.

4. Place old Check Valve V-908 on a clean workbench and perform the following
    a. Clean all disassembled parts
    b. Apply pipe tape to both ends of the close nipple and the external threads of the reducer bushing.
5. Install new Check Valve V-908 as follows:
    a. Thread the close nipple onto the check valve hand tight.
    b. Thread the ½-in. to 3/8-in. reducer bushing onto the input side of Check Valve V-908 and tighten.
    c. Thread the close nipple on the output side of the check valve into the other reducer bushing. Do not over-tighten. Refer to Figure 9 for correct positioning of the Air System Section 4 assembly components.
6. Install the Air System Section 4 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 4 Assembly**.
7. Check new Check Valve V-908 and attached piping for leaks.

Air System Section 6 Assembly Replacement:

Parts:
Air System Section 6 Assembly (TM 10-4610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the Air System Section 6 assembly as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 6 assembly as follows (see Figure 10):
   a. Tag and disconnect the hose from the reducer coupling at the inlet to CO2.
   b. Tag and disconnect the hose from the reducer coupling at the valve end of Section 6.

CAUTION

Two people are required to safely remove the Air System Section 6 assembly from the TWPS. Failure to observe this warning may result in damage to equipment.

   c. With another person holding the Air System Section 6 assembly, disconnect the mounting hardware that attach the assembly to the TWPS.
   d. Remove the assembly from the TWPS and place it on a clean workbench.

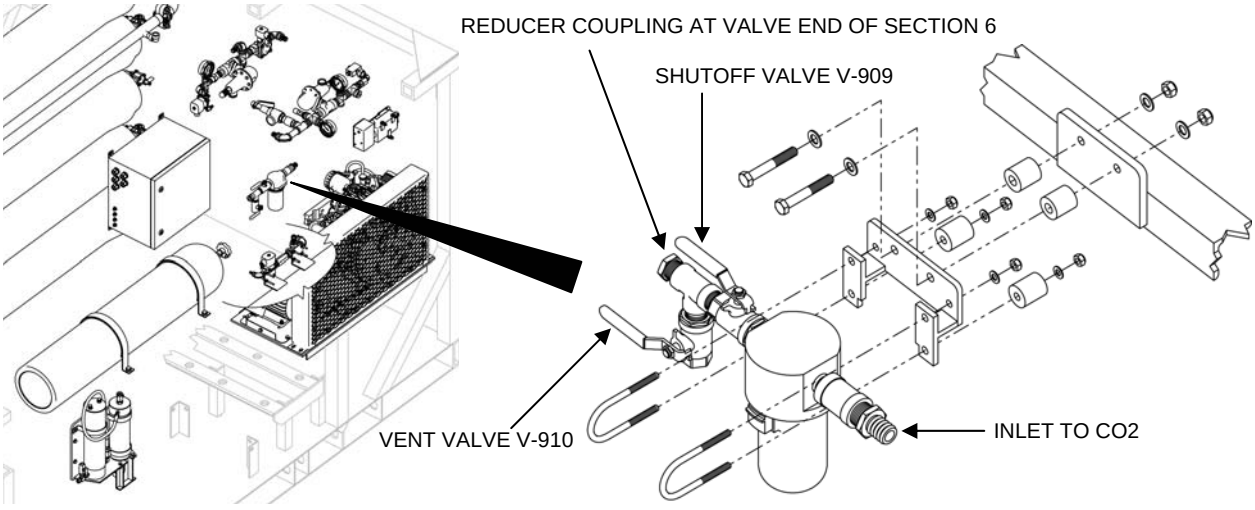

Figure 10. Air System Section 6 Assembly.

3. Install the new Air System Section 6 assembly onto the TWPS as follows:
    a. With another person supporting the Air System Section 6 assembly, secure the assembly to the TWPS using the mounting hardware. Refer to Figure 10 for the proper installation of the hardware.
    b. Connect the hose to the reducer coupling at the valve end of the Air System Section 6 assembly.
    c. Connect the hose to the reducer coupling at the inlet of CO2.
4. Check the Air System Section 6 assembly for leaks.

Oil/Water Coalescer CO2 Replacement:

Parts:
Oil/Water Coalescer CO2 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Oil/Water Coalescer CO2 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 6 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 6 Assembly**.
3. Disconnect the coalescer from the ½-in. by 1½-in. nipple that connects the coalescer to Shutoff Valve V-909 (see Figure 11).
4. Place old Oil/Water Coalescer CO2 on a clean workbench and perform the following:
    a. Remove the two ½-in. nipples and the reducer coupling from the coalescer.
    b. Clean all disassembled parts.
    c. Apply pipe tape to both ends of the close nipples.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

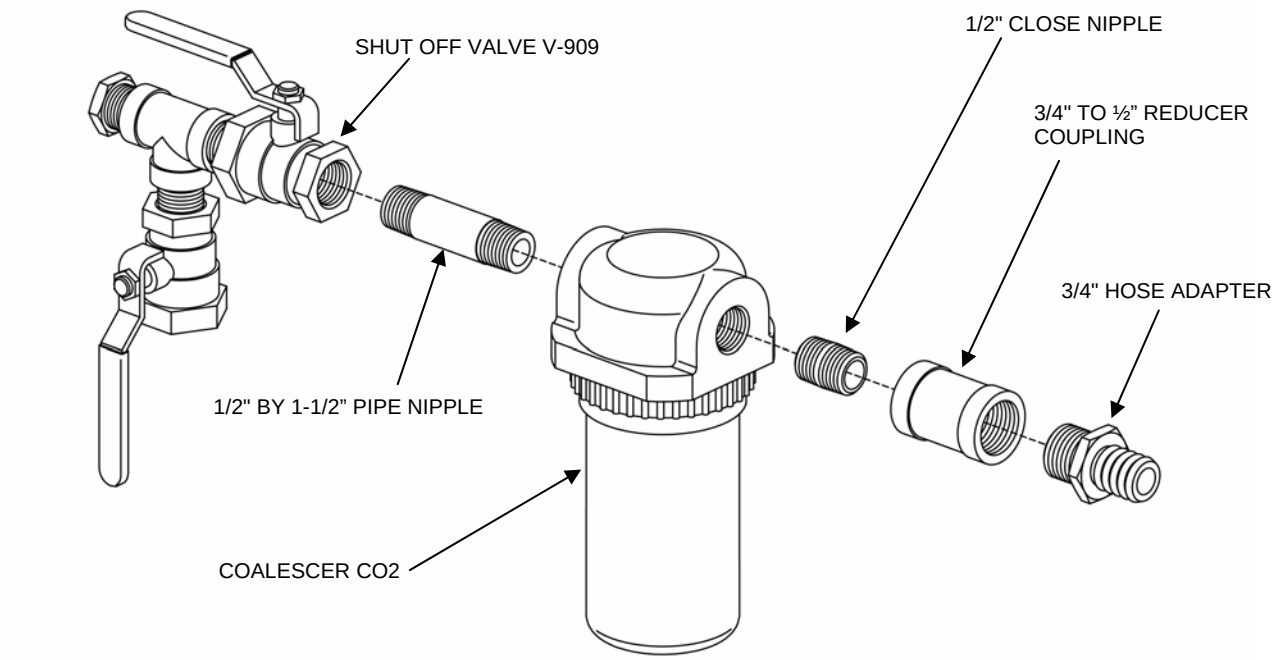

Figure 11. Oil/Water Coalescer CO2.

5. Install new Oil/Water Coalescer CO2 as follows:
   a. Thread the two nipples into the coalescer hand tight.
   b. Thread the ¾-in to ½-in. reducer coupling onto the close nipple and tighten.
   c. Thread Shut-Off Valve V-909 onto the ½-in. by 1½-in. pipe nipple. Do not over-tighten. Refer to Figure 11 for correct positioning of the valve and coalescer.
6. Install the Air System Section 6 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 6 Assembly**.
7. Check the new Oil/Water Coalescer CO2 and attached piping for leaks.

Manifold Maintenance Shutoff Valve V-909 Replacement:

Parts:
Shutoff Valve V-909 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Shutoff Valve V-909 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 6 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 6 Assembly**.
3. Disconnect Shutoff Valve V-909 from the 1/2" pipe nipple that connects the shutoff valve to the coalescer (see Figure 12).

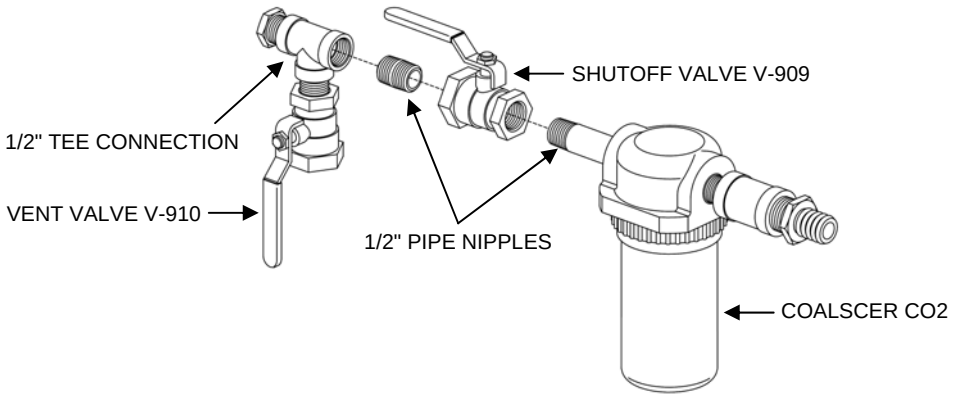

Figure 12. Shutoff Valve V-909.

4. Place old Shutoff Valve V-909 on a clean workbench and perform the following:
   a. Remove the two ½-in. pipe nipples. Clean all disassembled parts.
   b. Apply antiseizing tape to both ends of the two pipe nipples.
5. Install new Shutoff Valve V-909 as follows:
   a. Thread the two ½-in. nipples into both sides of Shutoff Valve V-909 and tighten hand tight.
   b. Thread Shutoff Valve V-909 onto the oil/water coalescer and tighten.
   c. Refer to Figure 12 for the correct positioning of Shutoff Valve V-909.
6. Install the Air System Section 6 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 6 Assembly**.
7. Check new Shutoff Valve V-909 and attached piping for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

Vent Valve V-910 Replacement:

Parts:
Vent Valve V-910 (TM 10-4610-309-24P)
Material:
Tape, antiseizing (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army: Generator off and TWPS main breaker off
Marine Corps: TWPS disconnected from power source
Entire air system bled down

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Vent Valve V-910 as follows:

1. Make sure the air system has been bled down. Refer to **ENTIRE AIR SYSTEM BLEED DOWN**.
2. Remove the Air System Section 6 assembly from the TWPS. Refer to **REPLACE** and **Air System Section 6 Assembly**.
3. Disconnect Vent Valve V-910 from the ½-in. tee that is also connected to Shutoff Valve V-909 (see Figure 13):

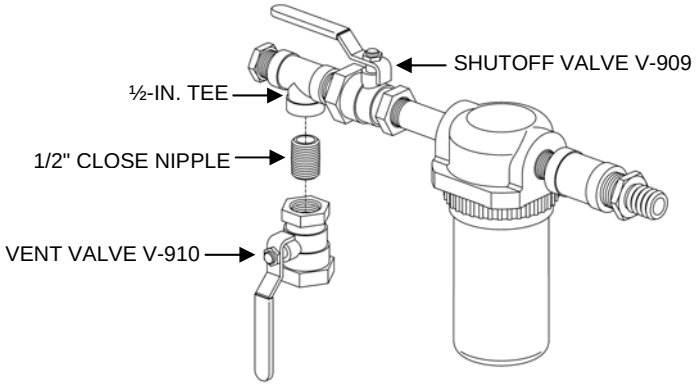

Figure 13. Vent Valve V-910.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0055 00**
UNIT MAINTENANCE PROCEDURES
AIR SYSTEM, REDUCED PRESSURE

4. Place old Vent Valve V-910 on a clean workbench and perform the following:
    a. Remove the ½-in. close nipple from Vent Valve V-910.
    b. Clean all disassembled parts.
    c. Apply antiseizing tape to both ends of the close nipple.
5. Install new Vent Valve V-910 as follows:
    a. Thread the ½-in. close nipple into the tee.
    b. Thread Vent Valve V-910 onto the close nipple and tighten.
    c. Refer to Figure 13 for the correct positioning of Vent Valve V-910.
6. Install the Air System Section 6 assembly onto the TWPS. Refer to **REPLACE** and **Air System Section 6 Assembly**.
7. Check new Vent Valve V-910 and attached piping for leaks.

Air System Air Hose Assemblies Replacement:

Refer to WP 0045, General Operator Maintenance Procedures, or WP 0066, General Unit Maintenance Procedures, for the procedures for replacing hoses and tubing.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) UNIT MAINTENANCE PROCEDURES AIR COMPRESSOR

0056 00

THIS SECTION COVERS
Replace, Service

INITIAL SETUP

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Pressure Gauge, 0 – 1000 psig (WP 0075)
References
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One (except where noted)
Equipment Condition
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

GENERAL

This work package provides procedures for replacing and servicing components and assemblies of the Air Compressor Assembly. These procedures include:

- Drive Motor Replacement
- Oil Pressure Regulator Replacement
- High-Pressure Air System Bleed Down Procedures
- Air Compressor Replacement
- Oil Pump Replacement
- First Stage Valve Head Assembly Replacement
- Second Stage Valve Head Assembly Replacement
- Third Stage Valve Head Assembly Replacement
- Temperature Switch Replacement
- Compressor Drive Belt Replacement
- Compressor Belt Tension Adjustment
- Intermediate Filter Service
- Compressor Oil Change
- Bleed the Lubrication System (Vent the Oil Pump)

All procedures except replacing the drive motor, air compressor and oil pump, can be performed without removing the compressor or motor from its mounting.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

REPLACE

Drive Motor Replacement:

Parts (TM 10-4610-309-24P):
Drive motor
Material:
Glycerin (BII) (WP 0079, Table 1, item 21)
Clean, dry, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the air compressor drive motor as follows:

1. Make sure that electrical power to the TWPS has been shut off.
2. Remove the air compressor drive belt guard and drive belt as follows:
    a. Remove the two bolts, flat washers, lock washers, and the rectangular plate on the back of the belt guard assembly at the compressor end.
    b. Remove the bolt, flat washer, lock washer, and clamp that secure the compressor temperature switch wiring to the back of the belt guard assembly.
    c. Remove the two bolts, flat washers, and lock washers that attach the belt guard assembly to the center bracket.
    d. Remove the four bolts, flat washers, and lock washers that attach the belt guard assembly to the compressor base.
    e. Remove the belt guard assembly.
    f. Loosen the four drive motor mounting nuts.
    g. Loosen the belt adjustment bolt (turn it counterclockwise) and slide the drive motor toward the compressor to loosen the belt.
    h. Remove the belt.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

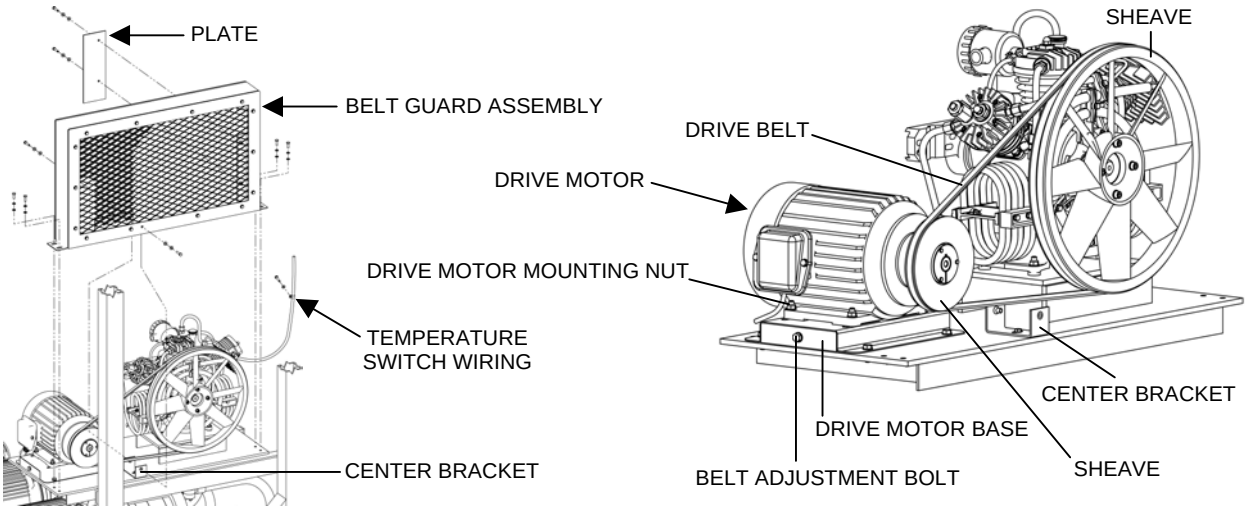

Figure 1. Compressor Drive Belt Guard and Drive Belt Removal.

3. Remove the drive motor as follows (see Figure 2):
   a. Remove the motor junction box cover. Tag and disconnect the wiring to the motor.

WARNING

Two person lift. Two people are required to remove the drive motor. Lift with your legs, not your back. Failure to observe this warning can result in injury to personnel and damage to equipment.

   b. Remove the four nuts, flat washers, and lock washers that secure the drive motor to the motor base and remove the motor.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

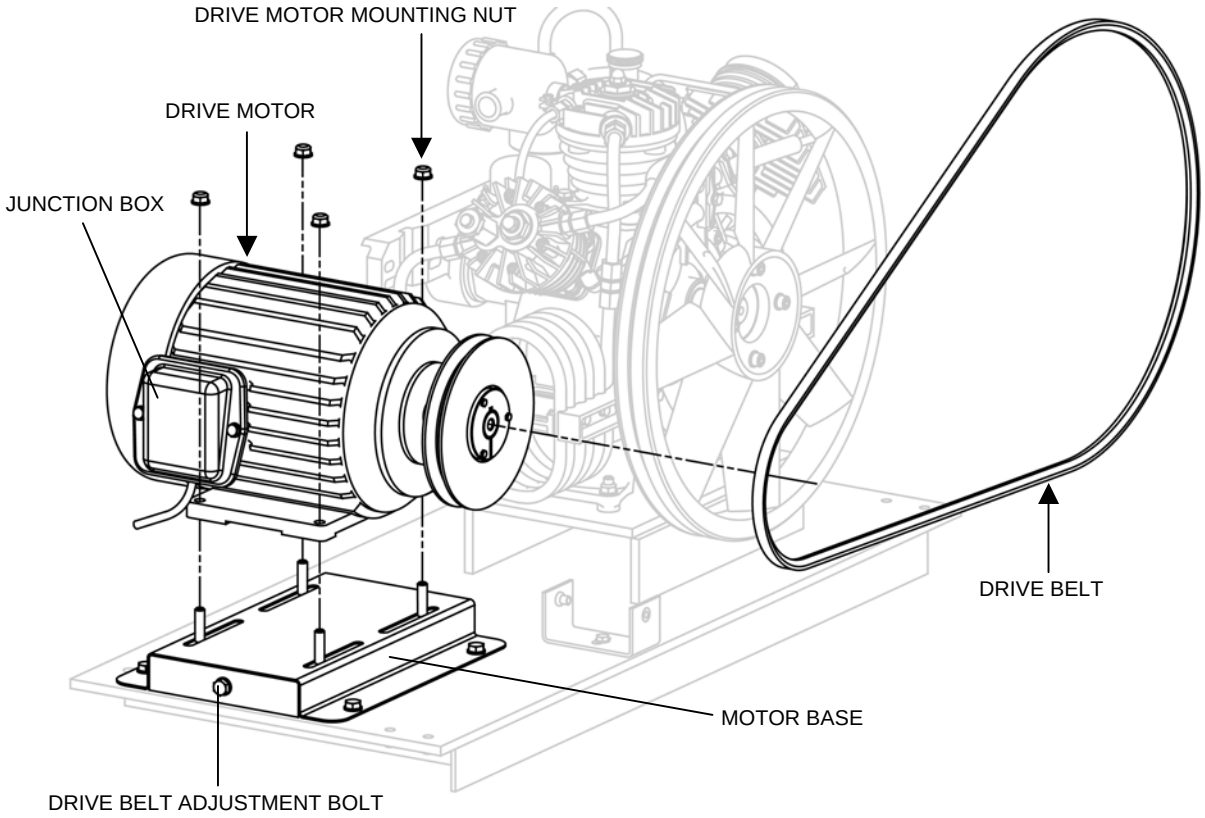

Figure 2. Drive Motor Removal.

4. Clean the motor base and inspect it for damage. Replace if necessary.
5. Inspect the air compressor for rust, corrosion, loose or missing hardware, damaged wires/parts and oil leaks.
6. Lubricate the belt adjustment bolt and base plate attaching hardware with glycerin. Wipe off any excess glycerin.
7. Install the new drive motor as follows:
    a. Install the motor on the motor base, but do not tighten the mounting nuts.
    b. Install the drive belt on the motor and compressor sheaves.
    c. Turn the belt adjustment bolt clockwise until the belt has about ¼ -in. deflection when pressing down hard in the center of the belt with your thumb.
    d. Tighten the drive motor mounting nuts.
    e. Install the belt guard assembly and reattach the wiring clamp and rectangular plate (see Figure 1).
    f. Connect the electrical wiring to the motor and install the junction box cover.
8. Start the compressor and check the new drive motor for proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Oil Pressure Regulator Replacement:

Parts (TM 10-460-309-24P):
Oil pressure regulator
Test Equipment:
Pressure gauge, 0-1000 psig (WP 0075)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace and adjust the oil pressure regulator as follows:

1. Make sure that electrical power to the TWPS has been shut off.
2. Remove the oil pressure regulator as follows (see Figure 3):
   a. Disconnect the top and bottom tubing connections.
   b. Remove the top left and bottom right cap screws. Do not remove the other two.
   c. Remove the regulator.

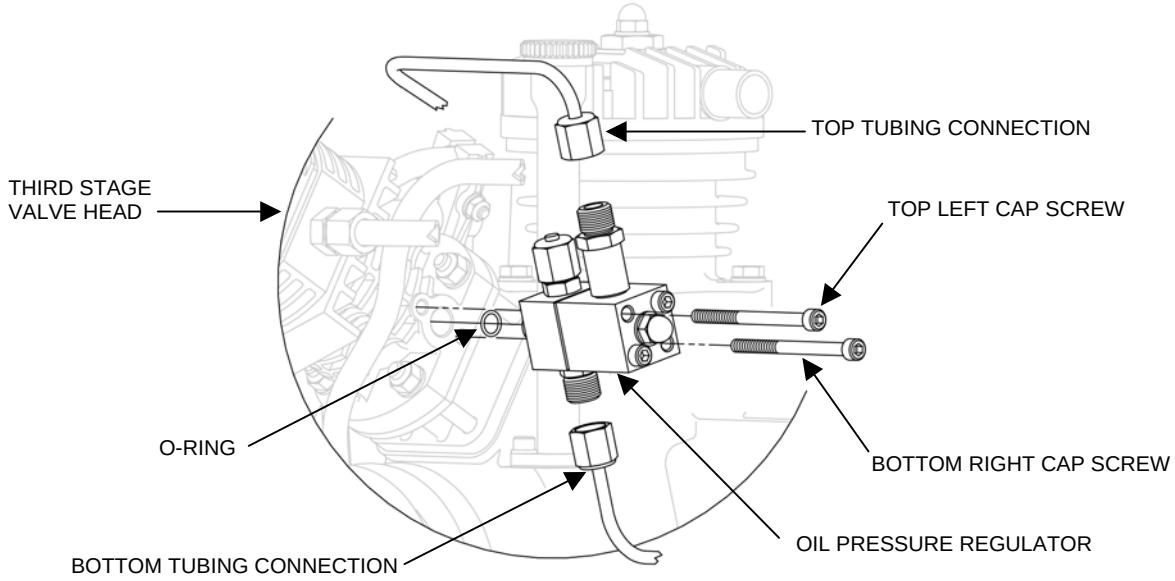

Figure 3. Oil Pressure Regulator Removal.

3. Inspect the regulator mounting for dirt and damage.
4. Install the new regulator and secure with the two cap screws.
5. Connect the top and bottom tubing connections.
6. Adjust the new regulator as follows (see Figure 4):

NOTE

Turn the regulator adjusting screw clockwise to increase pressure or counterclockwise to decrease pressure.

a. Remove the gauge port cap.
b. Install the 0-1000 psig pressure gauge to the gauge port of the regulator.
c. Remove the cap nut and washer.
d. With the compressor running, set the regulator pressure to 850 ± 70 psig.
e. Install the washer and cap nut.
f. Stop the compressor, remove the pressure gauge, and reinstall the cap on the gauge port.

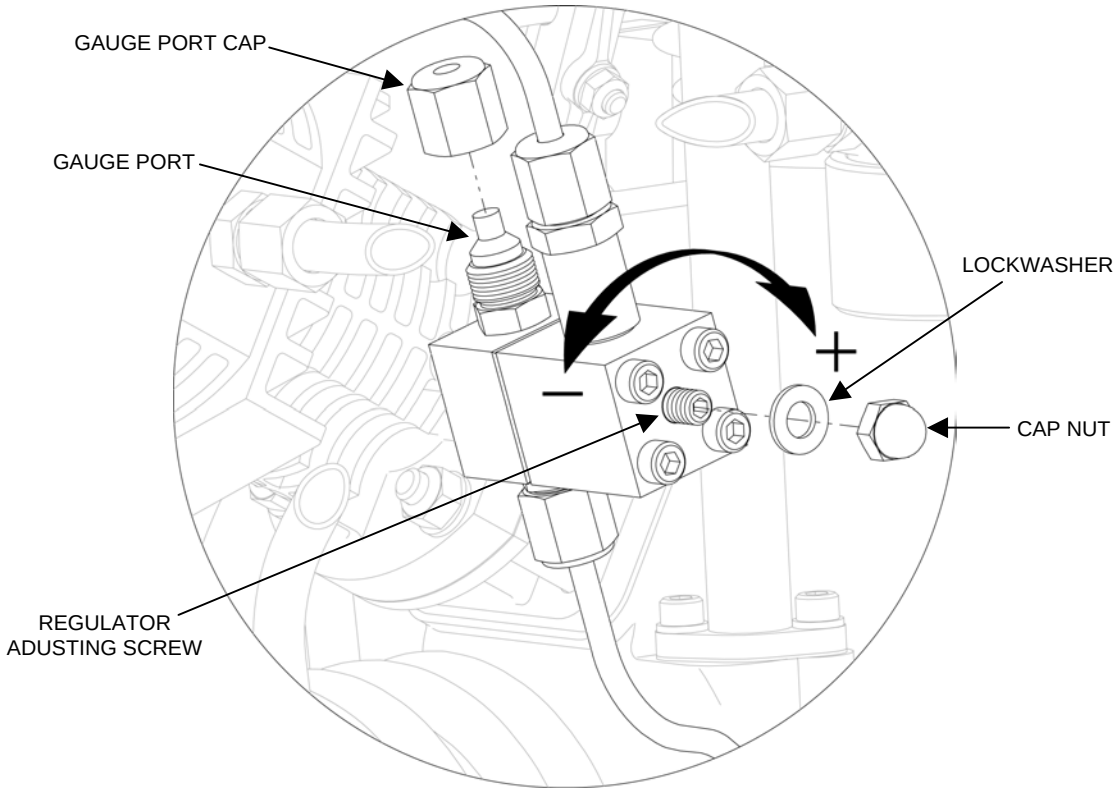

Figure 4. Oil Pressure Regulator Adjustment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

High Pressure Air System Bleed Down Procedures:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to performing maintenance on some of the components of the air compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

Bleed the high-pressure air system as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the high pressure air system as follows (see Figure 5 for valve location):
    a. Switch the Air Compressor control at the OCP to OFF.
    b. **Slowly** open High Pressure Air Vent Valve V-904 to bleed the air from the high-pressure system. Then close the valve.

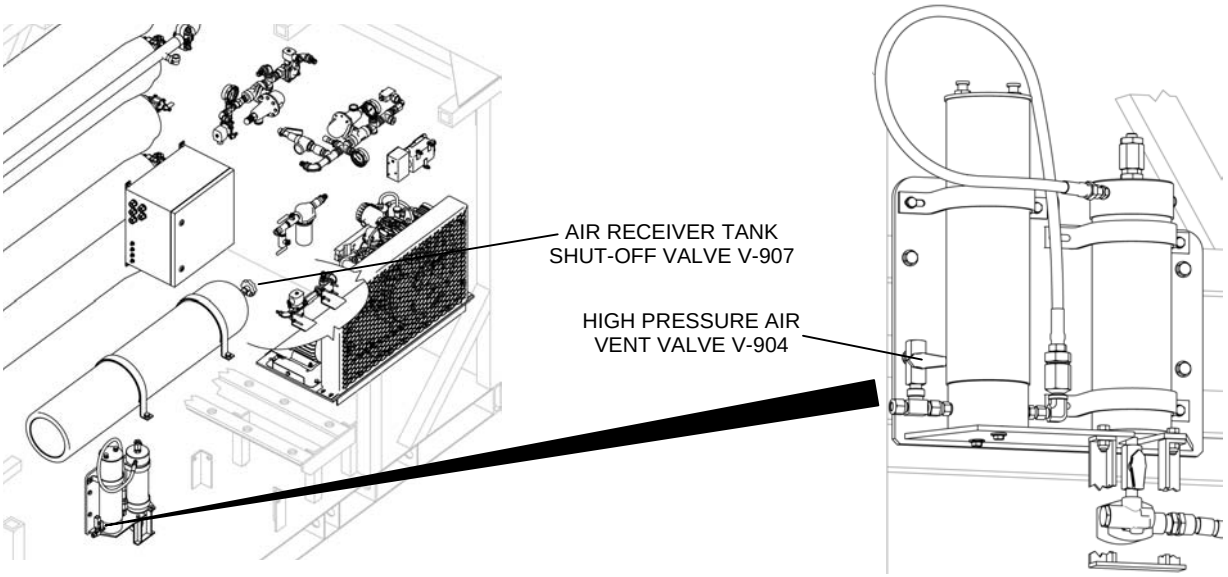

Figure 5. Valves for Bleeding the High Pressure Air System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Air Compressor Replacement:

Parts (TM 10-4610-309-24P):
Compressor
Materials:
Oil, Compressor (BII)
Clean, dry, lint-free rags (WP 0079, Table 1, item 23)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the air compressor as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to removing the air compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

Burn hazard. If the compressor has been running, the compressor and other components may be hot. Allow the compressor and its components to cool before handling. Failure to observe this warning can result in burns.

1. Make sure that electrical power to the TWPS has been shut off.
2. Make sure the high pressure air system has been bled down. Refer to **High-Pressure Air System Bleed Down Procedures**.
3. Remove the air compressor as follows (see Figure 6):
    a. Remove the belt guard assembly and drive belt. Refer to **REPLACE** and **Drive Belt**.
    b. Disconnect the compressor third stage temperature switch wiring connector.
    c. Disconnect the Intermediate Separator Automatic Drain Valve V-901 solenoid wiring connector.
    d. Remove the intermediate separator drain line and Drain Valve V-901 by unscrewing the line from the bottom of the separator housing.
    e. Disconnect the air output hose from the compressor outlet fitting.
    f. Remove the four compressor mounting bolts, nuts and washers.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

WARNING

Two person lift. Two people are required to safely move the compressor. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

g. Lift and remove the air compressor.

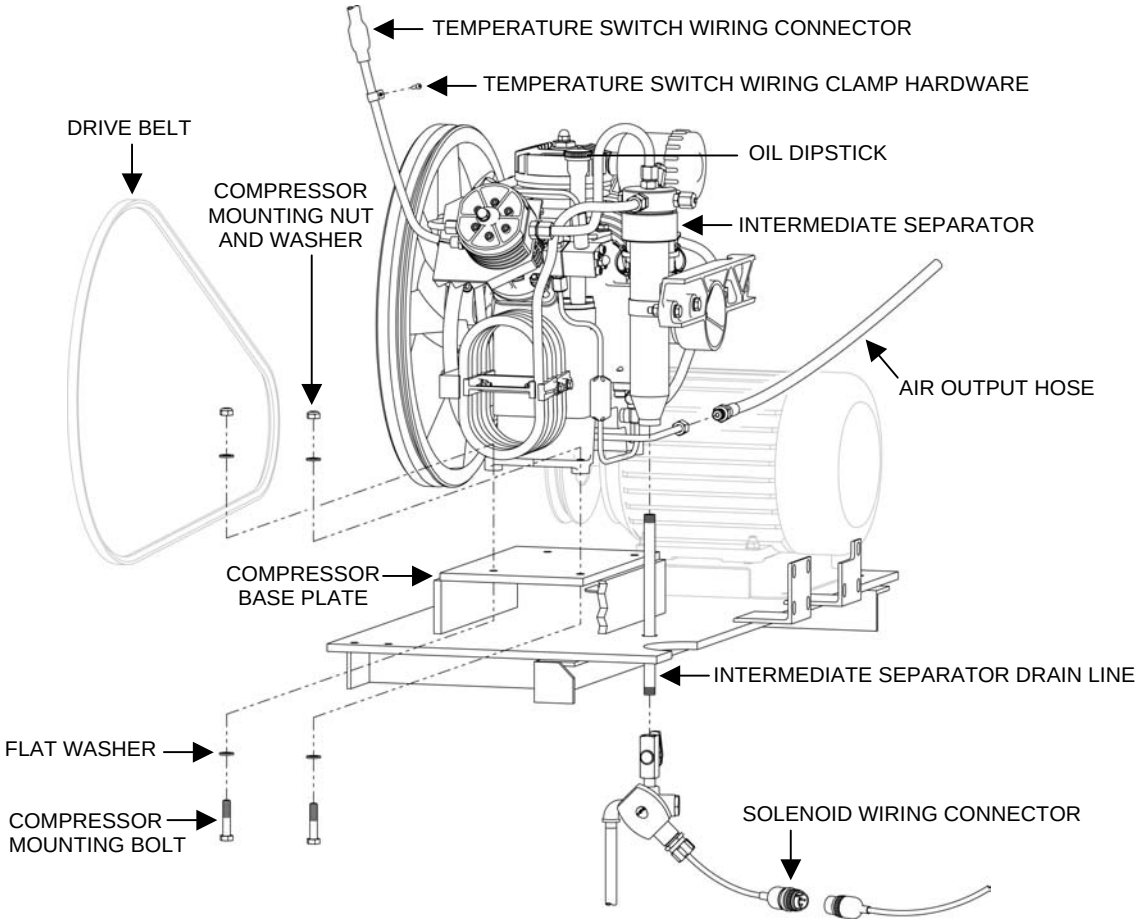

Figure 6. Air Compressor Removal.

4. Before installing the new air compressor, perform the following:
   a. Clean the compressor mounting base plate and inspect it for damage.
   b. Inspect the drive motor for rust corrosion, and loose or missing mounting hardware.
   c. Inspect the motor electrical connections for correct installation, cuts and signs of burnt wiring.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

WARNING

Two person lift. Two people are required to safely move the compressor. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

5. Install the new air compressor as follows (see Figure 6):
   a. Lift the compressor up and onto the mounting base and secure it with four bolts, nuts, and washers.
   b. Connect the air hose to the compressor outlet fitting.
   c. Install and adjust the drive belt. Refer to **REPLACE** and **Drive Belt**.
   d. Install the belt guard assembly.
   e. Connect the wiring to the compressor third stage temperature switch.
   f. Install the intermediate separator drain line and valve V-901 to the separator assembly.
   g. Connect the wiring connector for the valve V-901 solenoid.

CAUTION

New compressors are shipped without lubricating oil. Fill the crankcase with oil (approximately 1.5 quarts) before operating the compressor, or equipment damage will result. (See Figure 6 for oil dipstick / fill port location).

6. Start the compressor and check for proper operation.

Oil Pump Replacement:

Parts (TM 10-4610-309-24P):
Oil pump
Gasket
Material:
Oil, compressor (BII)
Test Equipment
Pressure gauge, 0-1000 psig (WP 0075)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Replace the air compressor oil pump as follows:

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to removing the air compressor oil pump. Failure to observe this warning can result in injury to personnel and damage to equipment.

1. Make sure that electrical power to the TWPS has been shut off.
2. Remove the air compressor. Refer to **REPLACE** and **Air Compressor**.

WARNING

Two person lift. Two people are required to safely move the compressor. Failure to observe this warning may result in back injury.

3. Remove the oil pump as follows (see Figure 7):
   a. Tilt the compressor forward to gain access to the oil pump.
   b. Place a suitable container under the compressor to catch any oil that might come out when the pump is removed.
   c. Remove the oil pump supply tubing.
   d. Remove the three socket head cap screws that hold the oil pump in place.
   e. Remove the oil pump and gasket.

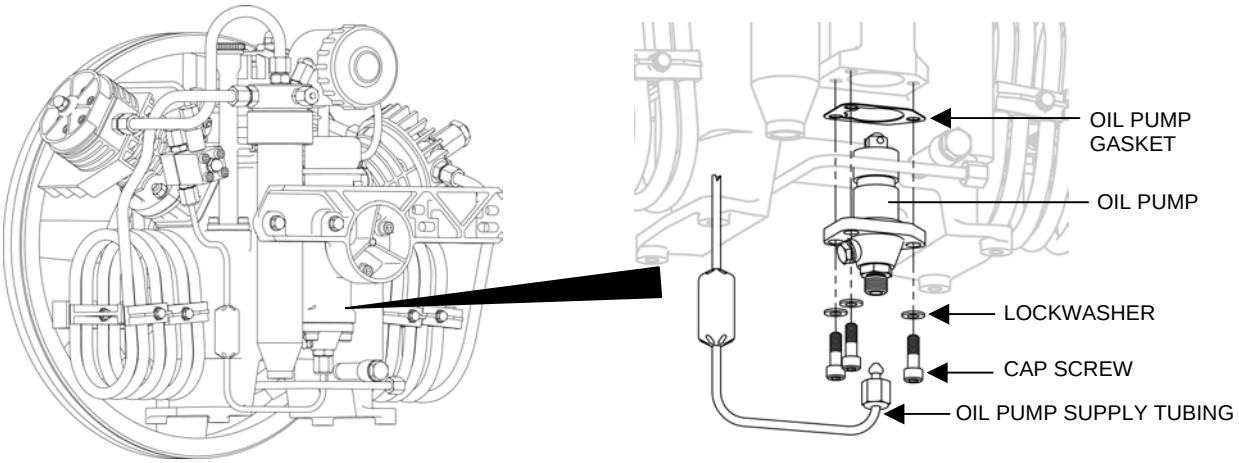

Figure 7. Oil Pump Replacement.

4. Inspect the area of the compressor housing where the oil pump mounts to ensure the entire gasket is removed and the area is clean.
5. Install the oil pump as follows:
    a. Install the new oil pump and gasket to the compressor with the three cap screws.
    b. Install the oil supply tubing.
    c. Install the air compressor. Refer to **REPLACE** and **Air Compressor**.
6. Check the compressor oil level and add oil as necessary.
7. Install the pressure gauge on the oil pressure regulator gauge port (see Figure 4).
8. Start the compressor and check the new oil pump for leaks and proper oil pressure.
9. If no or low oil pressure builds up, vent the oil pump. Refer to **SERVICE** and **Bleed the Lubrication System**.
10. If necessary, adjust the oil pressure regulator. Refer to **REPLACE** and **Oil Pressure Regulating Valve**.

First Stage Valve Head Assembly Replacement:

Parts (TM 10-4610-309-24P):
First Stage Valve Head Assembly
Materials:
Adhesive, silicone (WP 0079, Table 1, item 1)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to removing the 1st stage valve head assembly. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the first stage valve head assembly as follows:

1. Make sure that electrical power to the TWPS has been shut off.
2. Make sure the high-pressure air system has been bled down. Refer to **High-Pressure Air System Bleed Down Procedures**.
3. Remove the first stage valve head assembly as follows (see Figure 8):
    a. Loosen the clamp that secures the Air Intake Filter AF-1 Assembly to the first stage head and remove the assembly and clamp.
    b. Disconnect the intercooler assembly tube from the compressor first stage head valve assembly.

c. Disconnect the flexible tube between the compressor first stage valve head assembly and the crankcase demister.
d. Remove the three socket head screws holding the first stage valve head assembly to the first stage piston cylinder.
e. Remove the first stage valve head, O-ring and intake valve plate.
f. Cover the piston cylinder to prevent dirt from entering the cylinder.

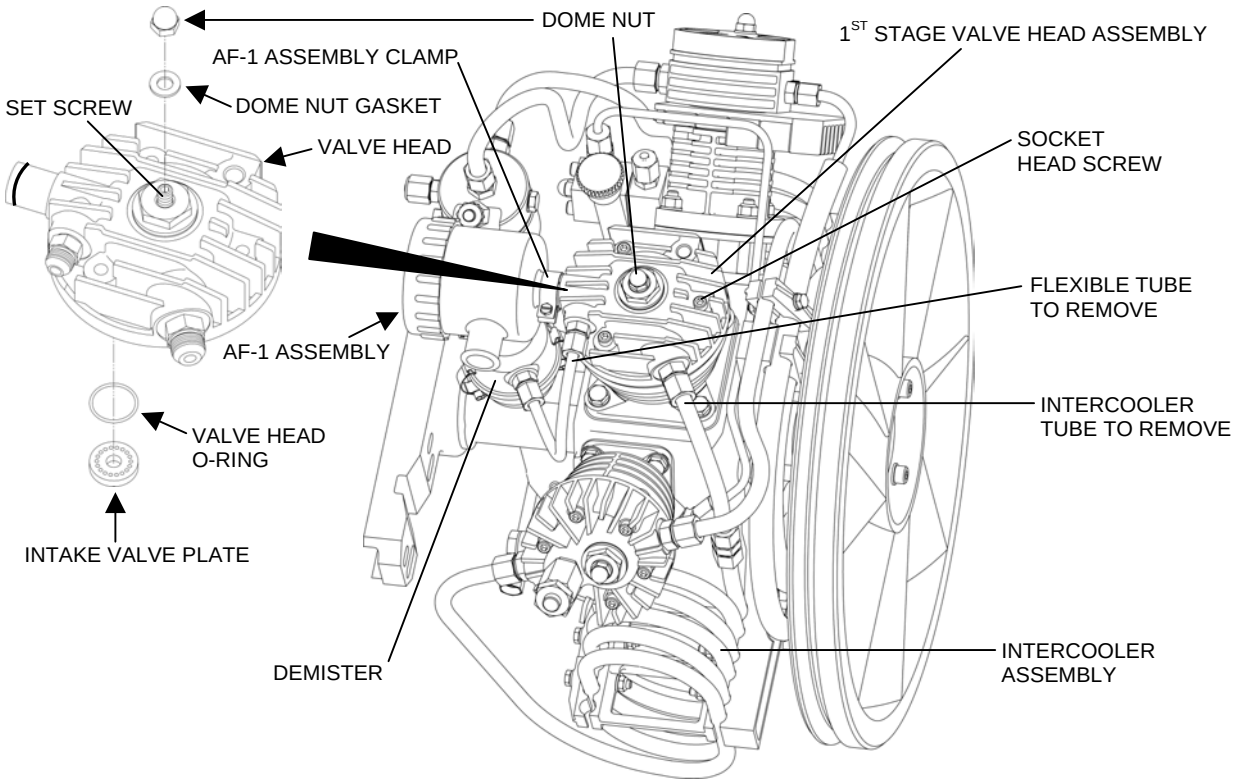

Figure 8. First Stage Valve Head Assembly Replacement.

4. Install the new first stage valve head assembly as follows (see Figure 8):
   a. Place the intake valve plate and valve head O-ring into the valve seat of the piston cylinder.

CAUTION

To avoid damage to the valve body, loosen the pressure valve set screw before installing the valve head.

   b. Remove the dome nut and dome nut gasket from the top of the valve head.
   c. Loosen the first stage pressure valve set screw.
   d. Apply silicone adhesive to the sealing surface of the valve head.

e. Install the valve head on the cylinder with the 3 socket head cap screws. Torque the screws to 206 in.-lbs.
f. Tighten the pressure valve set screw until seated.
g. Install the dome nut gasket and dome nut.
h. Connect the flexible tube from the demister to the new first stage valve head.
i. Connect the intercooler tube to the new first stage valve head.
j. Install and secure the Air Intake Filter AF-1 Assembly to the first stage head with the clamp removed earlier.

5. Turn the compressor manually using the flywheel to make sure that all components have been correctly installed.

CAUTION

After replacing a valve head assembly on the compressor, the compressor should be stopped after 30 minutes of operation and the socket head screws and cap nut at the top of the valve head should be tightened. Failure to observe this CAUTION may result in the valve head gasket(s) leaking.

6. Thirty minutes after restarting the compressor, stop the compressor and let it cool to ambient temperature. Retighten the socket head screws and the cap nut at the top of the valve head.

Second Stage Valve Head Assembly Replacement:

Parts (TM 10-4610-309-24P):
Second Stage Valve Head Assembly
Materials WP0079):
Corrosion preventive compound (WP 0079, Table 1, item 17)
Adhesive, silicone (WP 0079, Table 1, item 1)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to removing the 2nd stage valve head assembly. Failure to observe this warning can result in injury to personnel and damage to equipment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Replace the second stage valve head assembly as follows (see Figure 9).

1. Make sure that electrical power to the TWPS has been shut off.
2. Make sure the high-pressure air system has been bled down. Refer to **High-Pressure Air System Bleed Down Procedures**.
3. Remove the second stage valve head assembly as follows:
    a. Disconnect the two intercooler tubes from the second stage valve head assembly.
    b. Remove the six socket head cap screws that hold the second stage valve head assembly to the cylinder.
    c. Remove the second stage valve head assembly from the piston cylinder.
    d. Cover the piston cylinder to prevent dirt from entering the cylinder.

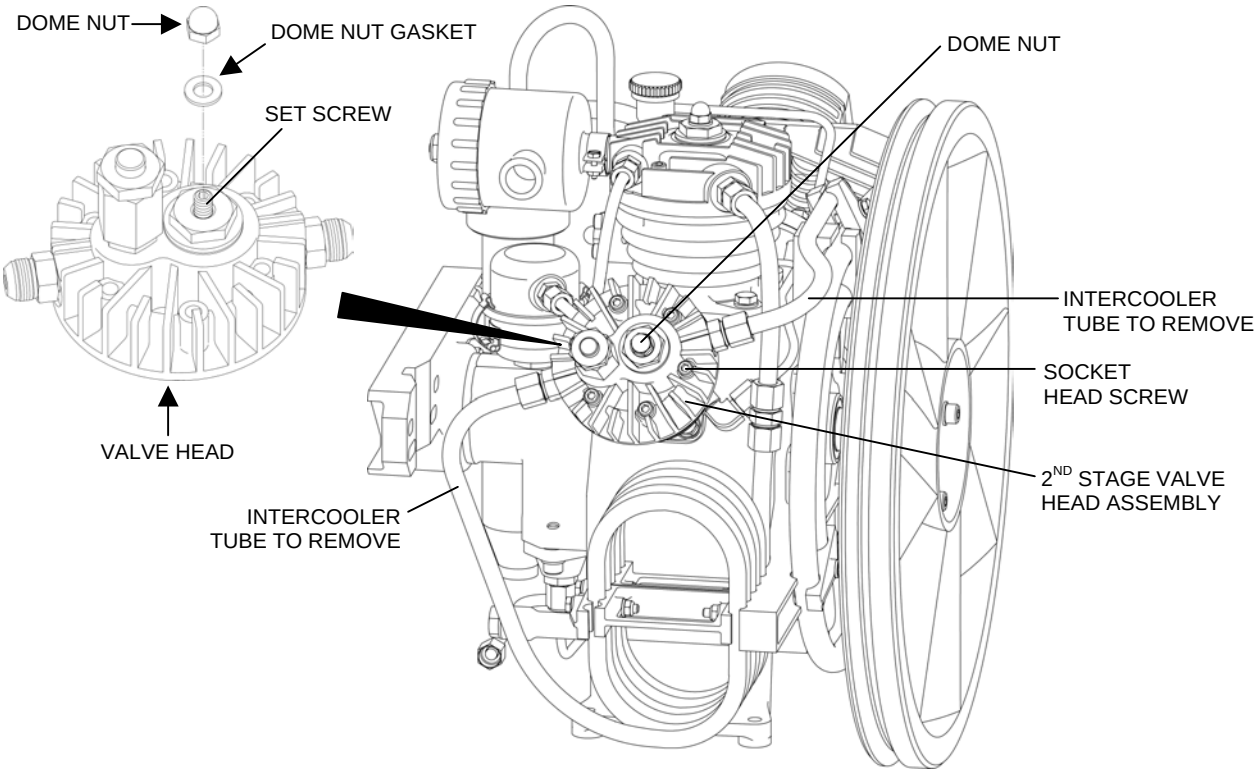

Figure 9. Second Stage Valve Head Assembly Replacement.

4. Install the new second stage valve head assembly as follows (see Figure 9):

CAUTION

To avoid damage to the valve body, loosen the pressure valve set screw before installing the valve head.

a. Remove the dome nut and dome nut gasket from the top of the valve head.
b. Loosen the second stage pressure valve set screw.
c. Apply a thin layer of silicone adhesive to the sealing surface of the valve head.
d. Install the valve head assembly on the piston cylinder.
e. Apply corrosion preventive compound to the six socket head cap screws and secure the valve head and piston cylinder in place. Torque the cap screws to 206 in.-lbs in the sequence shown in Figure 10.

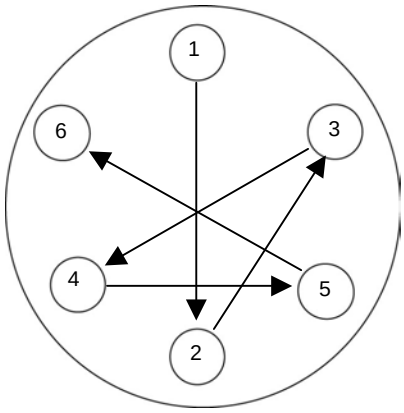

Figure 10. Second Stage Valve Head Cap Screw Torque Sequence.

f. Tighten the pressure valve set screw.
g. Install the dome nut gasket and dome nut.
h. Connect the two intercooler tubes to the new second stage valve head.

5. Turn the compressor manually using the flywheel to make sure that all components have been correctly installed.

CAUTION

After replacing a valve head assembly on the compressor, the compressor should be stopped after 30 minutes of operation and the socket head screws and cap nut at the top of the valve head should be tightened. Failure to observe this CAUTION may result in the valve head gasket(s) leaking.

6. Thirty minutes after restarting the compressor, stop the compressor and let it cool to ambient temperature. Retighten the socket head screws and the cap nut at the top of the valve head.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Third Stage Valve Head Assembly Replacement:

Parts (TM 10-4610-309-24P):
Third Stage Valve Head Assembly
Materials:
Corrosion preventive compound (WP 0079, Table 1, item 12)
Adhesive, silicone (WP 0079, Table 1, item 1)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

Equipment tag-out procedures are required. The TWPS unit must be properly tagged out prior to performing maintenance. Failure to observe this warning could result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to removing the third stage valve head assembly. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the third stage valve head assembly as follows:

1. Make sure that electrical power to the TWPS has been shut off.
2. Make sure the high-pressure air system has been bled down. Refer to **High-Pressure Air System Bleed Down Procedures**.
3. Remove the third stage valve head assembly as follows (see Figure 11):
    a. Remove the tubing between the third stage head assembly and the intermediate filter.
    b. Disconnect the intercooler tube from the third stage valve head assembly.
    c. Remove and discard the dome nut and gasket. Unscrew the setscrew three or four turns.
    d. Remove the six socket head cap screws that secure the valve head to the piston cylinder.
    e. Remove the valve head cover and the valve head together.
    f. Unscrew the temperature switch off the valve head.
    g. Cover the piston cylinder to prevent dirt from entering the cylinder.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

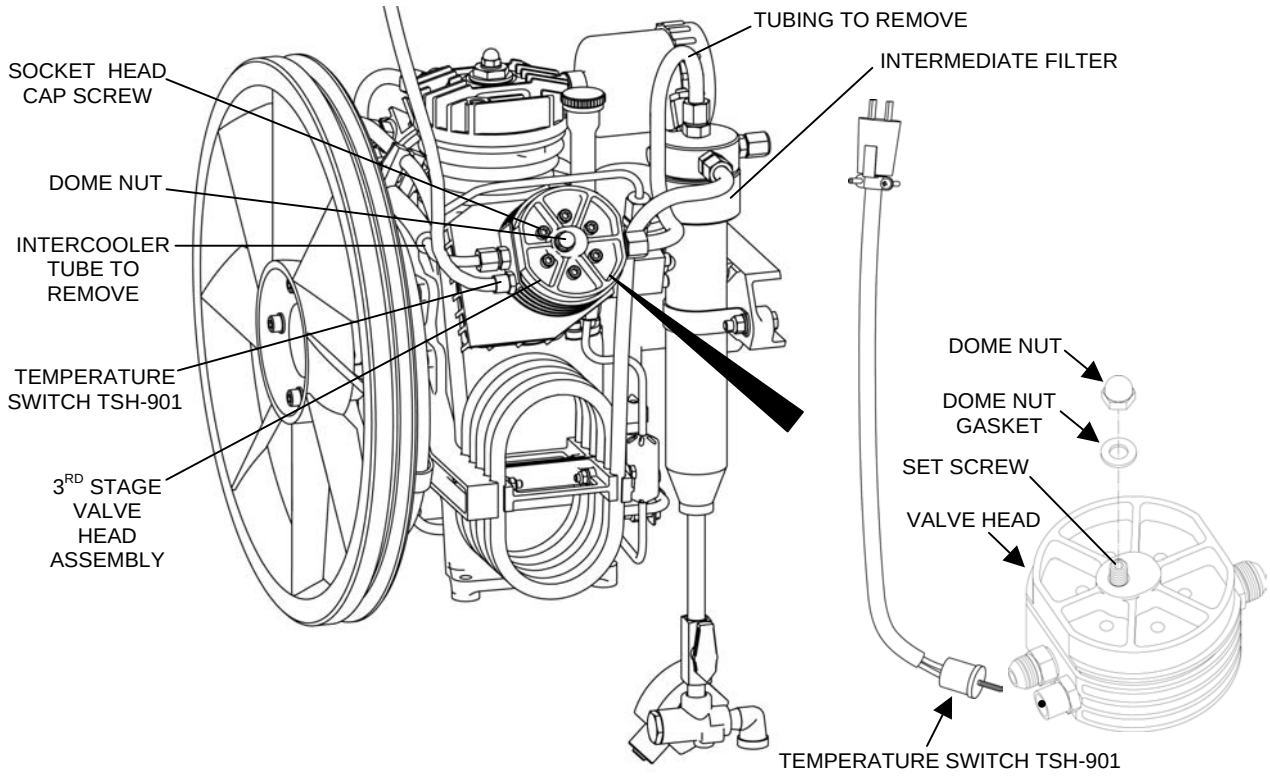

Figure 11. Third Stage Valve Head Assembly Replacement.

NOTE
Do not use a sealing compound on the third stage head.

4. Install the new third stage valve head assembly as follows (see Figure 11):

CAUTION

To avoid damage to the valve body, loosen the pressure valve set screw before installing the valve head.

NOTE
Do not use sealing compound on the third stage valve head.

a. Remove the dome nut and dome nut gasket from the top of the valve head.
b. Loosen the third stage pressure valve set screw.
c. Install the temperature switch finger tight onto the valve head.
d. Position the valve head cover and the valve head on the compressor cylinder.
e. Apply corrosion preventive compound to the six socket head cap screws and secure the valve head and piston cylinder.

f. Insert and torque the cap screws to 206 in.-lbs using the sequence shown in Figure 12.

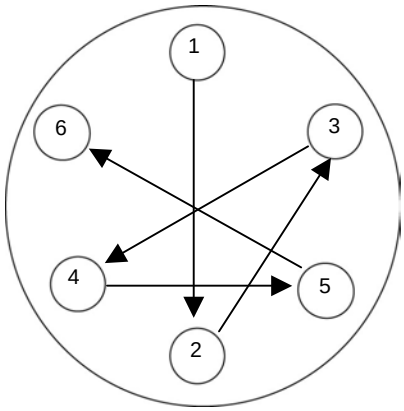

Figure 12. Third Stage Valve Head Cap Screw Torque Sequence.

g. Screw in the pressure valve set screw by hand until seated.
h. Install the dome nut gasket and dome nut.
i. Connect the intercooler tube to the new third stage valve head.
j. Connect the tubing between the third stage valve head and the intermediate filter.

5. Turn the compressor manually using the flywheel to make sure that all components have been correctly installed.

CAUTION

After replacing a valve head assembly on the compressor, the compressor should be stopped after 30 minutes of operation and the socket head screws and cap nut at the top of the valve head should be tightened. Failure to observe this CAUTION may result in the valve head gasket(s) leaking.

6. Thirty minutes after restarting the compressor, stop the compressor and let it cool to ambient temperature. Retighten the socket head screws and the cap nut at the top of the valve head.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Temperature Switch Replacement:

Parts (TM 10-4610-309-24P)
Temperature switch assembly
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the temperature switch as follows (see Figure 13):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

1. Make sure that electrical power to the TWPS has been shut off.
2. Remove the bolt, flat washer, lock washer, and clamp that secure the compressor temperature switch wiring to the back of the belt guard assembly.
3. Disconnect the compressor third stage temperature switch wiring connector.
4. Unscrew the temperature switch from the third stage compressor valve head.
5. Screw a new temperature switch assembly into the thirds stage compressor valve head.
6. Reconnect the compressor third stage temperature switch wiring connector.
7. Secure the temperature switch wiring to the back of the belt guard assembly using the bolt, flat washer, lock washer, and clamp that were removed earlier.

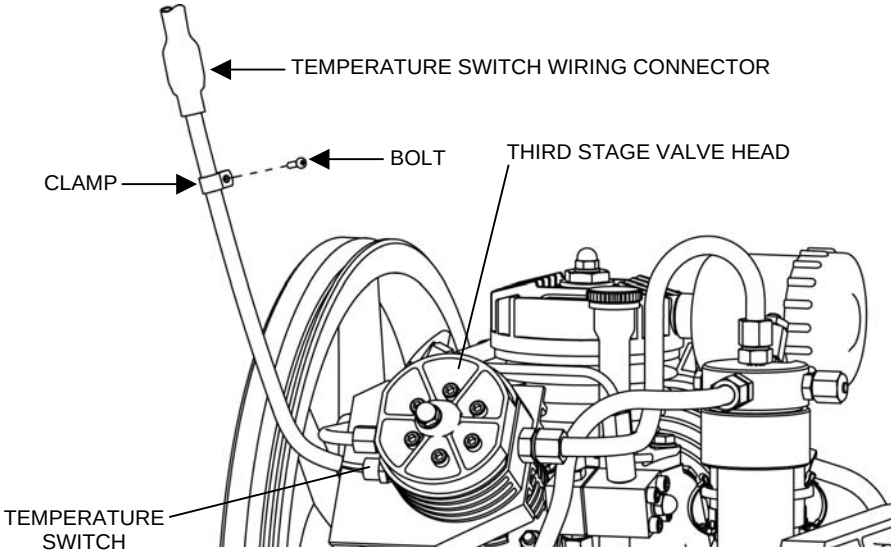

Figure 13. Temperature Switch Assembly Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Compressor Drive Belt Replacement:

Parts (TM 10-4610-309-24P):
Belt, V
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace the air compressor drive belt as follows:

1. Make sure that electrical power to the TWPS has been shut off.
2. Remove the air compressor assembly drive belt as follows (see Figure 14):
   i. Remove the 15 cap screws, 15 lock washers, and 15 flat washers from the front of the belt guard assembly and lift the front screen off the belt guard assembly.
   j. Loosen the four drive motor mounting nuts.
   k. Loosen the belt adjustment bolt (turn it counterclockwise) and slide the drive motor toward the compressor to loosen and remove the belt.

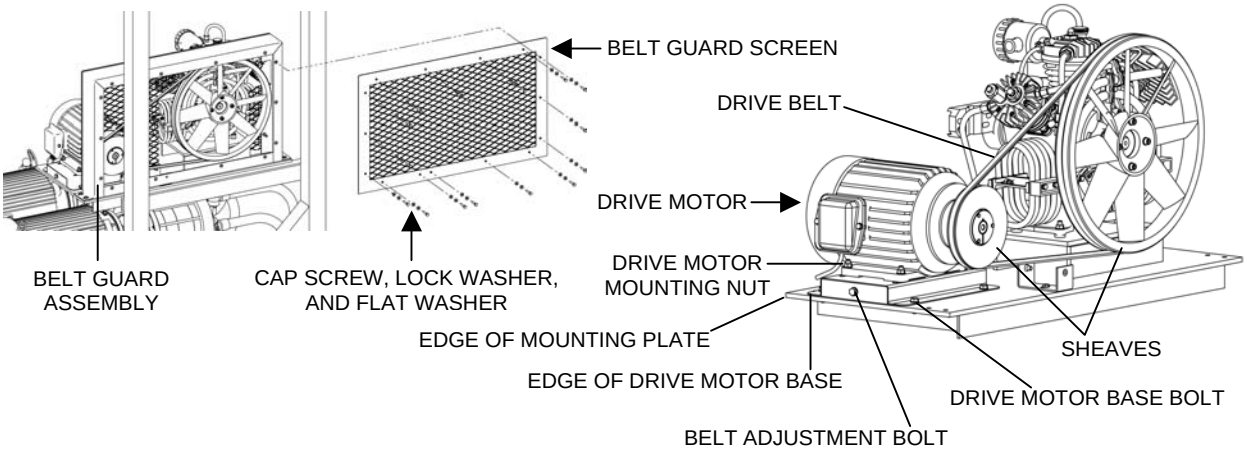

Figure 14. Drive Belt Replacement.

3. Check that the air compressor and drive motor sheaves are secure.
4. Remove any debris from the front area of the motor and compressor.

5. Check the compressor and motor sheave alignment and adjust if necessary as follows (see Figure 14):
    a. Loosen the drive motor base bolts.
    b. Measure from the edge of the mounting plate to the edge of the drive motor base at both ends of the same side.
    c. Set the drive motor base for 2 inches on both side of the base. Then tighten the bolts slightly.
    d. Sight along the compressor sheave to the motor sheave and move the motor base slightly as needed to bring the motor sheave in line with the compressor sheave.
    e. Measure the distance to the edge of the mounting plate again at both ends. Adjust the motor base slightly as needed to make the distance equal on both ends.
    f. Repeat steps d and e as needed to ensure alignment.
    g. Tighten the drive motor base bolts.
6. Install the new drive belt as follows:
    a. Install the belt onto the compressor and motor sheaves.
    b. Turn the belt adjustment bolt clockwise until the belt has about ¼ -in. deflection when pushing down hard in the center of the belt with your thumb.
    c. Tighten the drive motor mounting nuts.
    d. Install the belt guard screen using the 15 cap screws, 15 lock washers, and 15 flat washers.
    e. Start the compressor and check for proper operation.
7. Check the belt tension after 50 hours of operation and readjust if necessary.

SERVICE

Compressor Belt Tension Adjustment:

Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

If the compressor belt has rolled over (turned inside out, usually because of insufficient tightness), replace the belt. Do not reuse or continue to use the belt. Failure to observe this warning can result in the belt breaking during operation causing equipment damage and possible injury.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Sight along the compressor sheave to the motor sheave to determine if they are in line with each other. If they are not, adjust the compressor and motor sheave alignment as follows (see Figure 15):

1. Make sure that electrical power to the TWPS has been shut off.
2. Loosen the four drive-motor mounting nuts.
3. Turn the belt adjustment bolt counterclockwise to loosen the belt.
4. Loosen the drive motor base bolts.
5. Measure from the edge of the mounting plate to the edge of the drive motor base at both ends of the same side.
6. Set the drive motor base for 2 inches on both side of the base. Then tighten the bolts slightly.
7. Sight along the compressor sheave to the motor sheave and move the motor base slightly as needed to bring the motor sheave in line with the compressor sheave.
8. Measure the distance to the edge of the mounting plate again at both ends. Adjust the motor base slightly as needed to make the distance equal on both ends.
9. Repeat steps d and e as needed to ensure alignment.
10. Tighten the drive motor base bolts.

Adjust the air compressor drive belt tension as follows (see Figure 15):

1. Make sure that electrical power to the TWPS has been shut off.
2. Loosen the four drive-motor mounting nuts if not already loosened to adjust sheave alignment.
3. Reach in behind the belt guard assembly and push down hard in the center of the belt with your thumb to check the belt tension. The belt should deflect about ¼ -in.
4. Turn the belt adjustment bolt clockwise to tighten the belt or counterclockwise to loosen the belt until the belt has about ¼ -in. deflection when pushed down with your thumb.
5. Tighten the four drive-motor mounting nuts.
6. Check that the air compressor and drive motor sheaves are secure.
7. Remove any debris from the front area of the motor and compressor.
8. Start the compressor and check for proper operation.

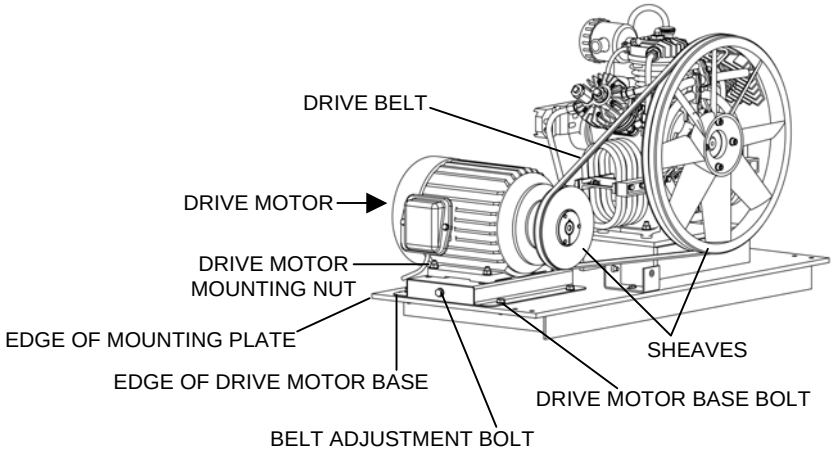

Figure 15. Compressor Belt Tension Adjustment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Intermediate Filter Service:

Parts (TM 10-4610-309-24P):
Filter element
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Clean or replace the intermediate filter as follows (see Figure 16):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to removing the intermediate filter. Failure to observe this warning can result in injury to personnel and damage to equipment.

1. Make sure that electrical power to the TWPS has been shut off.
2. Make sure the high-pressure air system has been bled down. Refer to **High-Pressure Air System Bleed Down Procedures**.
3. Disconnect the tubing from the fittings on the filter head.
4. Unscrew the knurled nut and remove the filter head assembly.
5. Remove the center screw, filter, baffle cone, and distribution plate.
6. Inspect the filter and clean or replace as necessary. To clean the filter, wash it in hot, soapy water and blow it dry with compressed air.
7. Install the center screw, filter, baffle cone, and distribution plate on the filter head.
8. Install the filter head assembly and tighten the knurled nut.
9. Connect the tubing to the fittings on the filter head.
10. Operate the air compressor and check for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

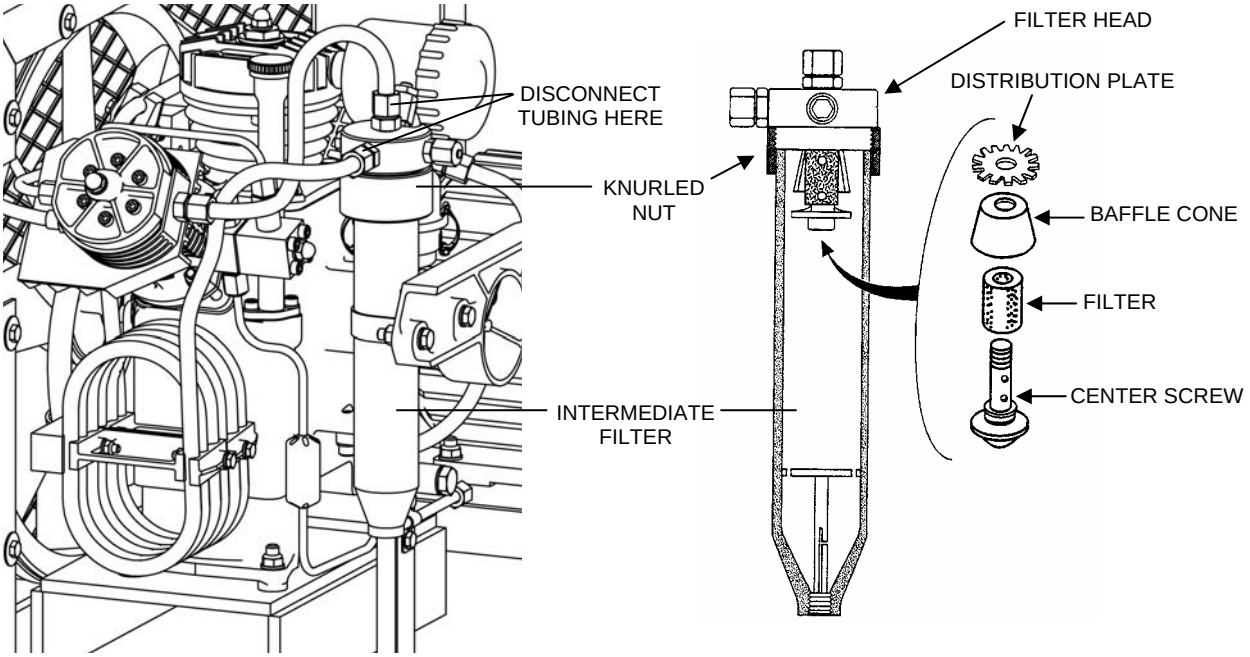

Figure 16. Intermediate Filter.

Compressor Oil Change:

Material:
- Compressor Oil, Bauer Oil-0024, 1-½ quarts (recommended oil – synthetic)
- Clean rags (WP 0079, Table 1, item 33)
- Drip pan

Equipment Condition:
- TWPS in Standby Shutdown Without Draining Down
- Army TWPS: Generator off and TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Change the compressor oil as follows (see Figure 17):

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air Compressor. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The high pressure air system must be bled prior to changing the compressor oil. Failure to observe this warning can result in injury to personnel and damage to equipment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

1. Change the compressor oil right after the compressor has been running to ensure that the compressor oil is warm.
2. Make sure that electrical power to the TWPS has been shut off.
3. Make sure the high-pressure air system has been bled down. Refer to **High-Pressure Air System Bleed Down Procedures**.
4. Place a suitable container under the compressor oil drain plug to catch the oil.
5. Remove the oil cap/dipstick from the oil filler neck.
6. Remove the oil drain plug and allow the oil to drain into the container.
7. After the oil has completely drained, reinstall the drain plug.
8. Slowly pour about 1-½ quarts of new oil into the oil filler neck until the level reaches the maximum notch on the dipstick.
9. Wait a few minutes after adding the oil, then check and adjust the oil level if necessary before putting the compressor into operation.
10. Reinstall the oil cap/dipstick.
11. Start the compressor and check the oil sight glass for bubbles. If bubbles are visible, vent the oil pump. Refer to **SERVICE** and **Bleed the Lubrication System**.
12. Properly dispose of the old oil.

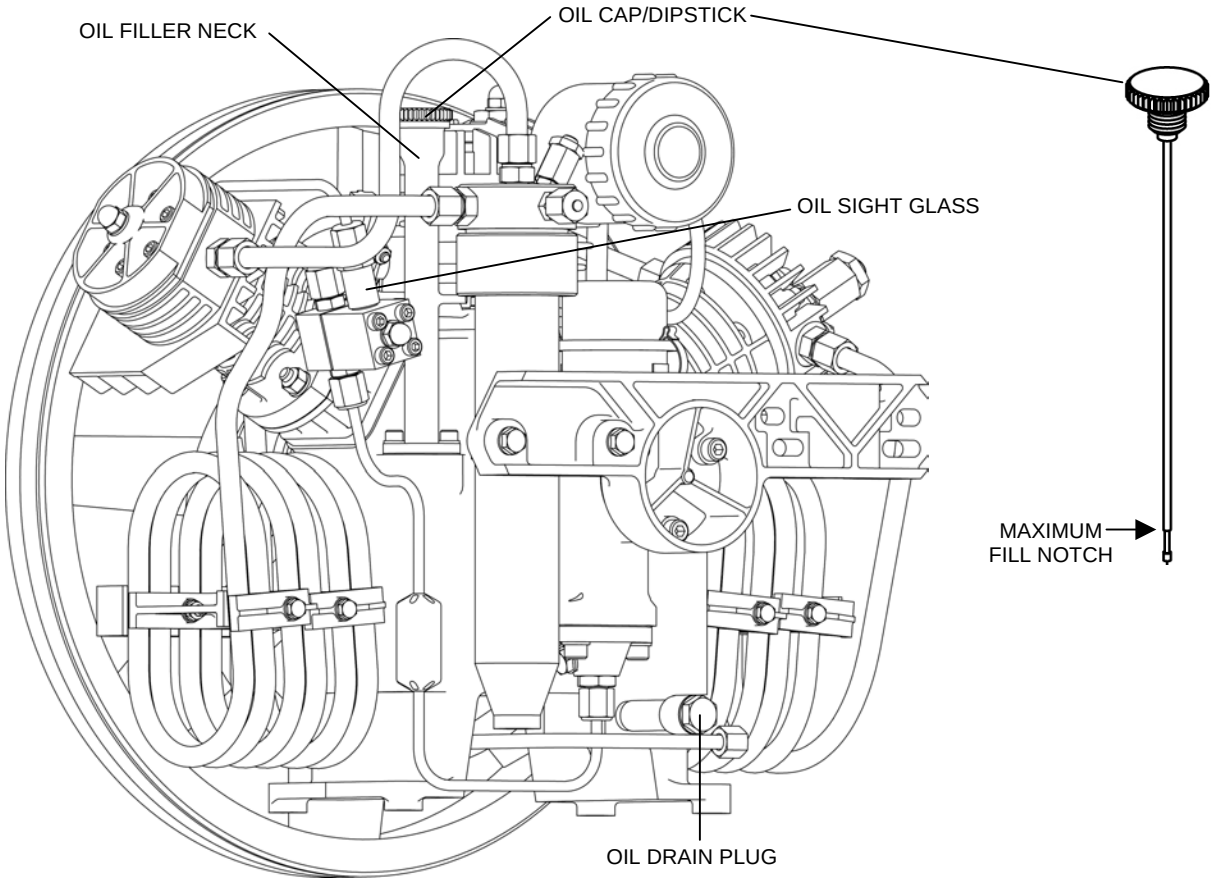

Figure 17. Compressor Oil Change.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0056 00**
UNIT MAINTENANCE PROCEDURES
AIR COMPRESSOR

Bleed the Lubrication System (Vent the Oil Pump):

Material:
Clean rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown without Drain-Down

Bleed the air compressor lubrication system (vent the oil pump) as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the air from the high pressure air system as follows:
   a. Switch the Air Compressor control at the OCP to OFF.
   b. **Slowly** open High Pressure Air Vent Valve V-904 to bleed the air from the high-pressure system. Then close the valve (see Figure 18 for valve location).

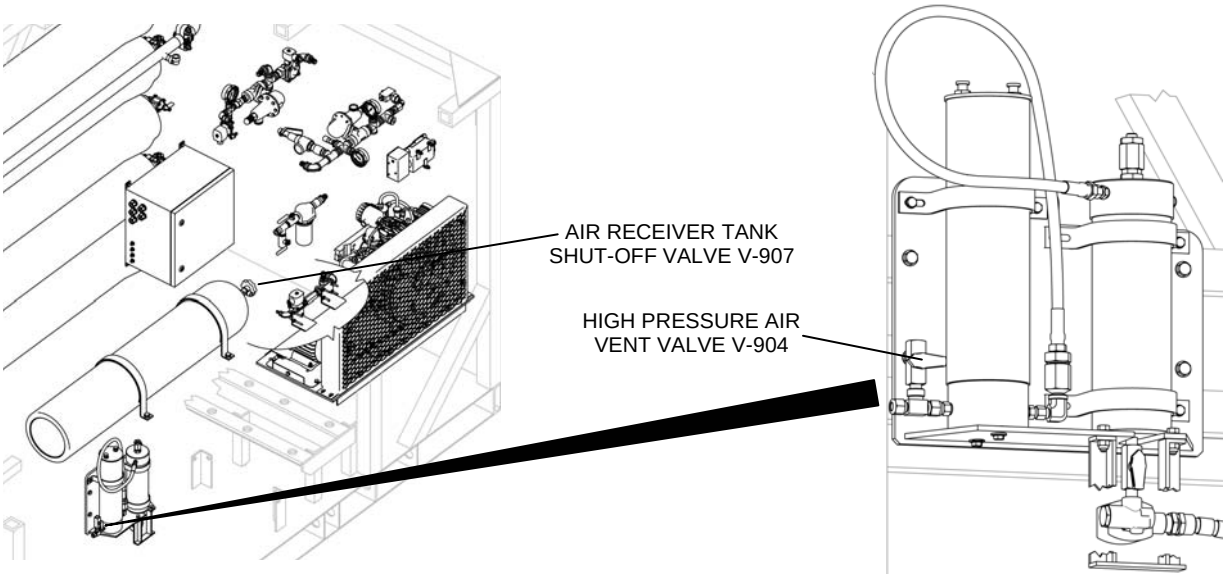

Figure 18. Valve for Bleeding the High Pressure Air System.

WARNING

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to bleeding the air compressor lubrication system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Moving parts. The compressor must not be allowed to operate during this procedure. Make sure the Air Compressor control at the OCP is switched to OFF before disconnecting tubing from the compressor oil pump and turning the compressor flywheel. Failure to observe this warning may result in serious injury.

3. Bleed the air compressor lubrication system (vent the oil pump) as follows (see Figure 19):
    a. Remove the 15 cap screws, 15 lock washers, and 15 flat washers from the front of the belt guard assembly and lift the front screen off the belt guard assembly to provide access to the flywheel.
    b. Place a rag under the compressor oil pump.
    c. Unscrew the tube nut and disconnect the oil pump supply tubing from the bottom of the oil pump.
    d. Turn the compressor flywheel counterclockwise by hand until bubble-free oil comes from the fitting. This should only take a few turns of the flywheel.
    e. Reconnect the supply tubing to the oil pump.
    f. Reinstall the belt guard screen.

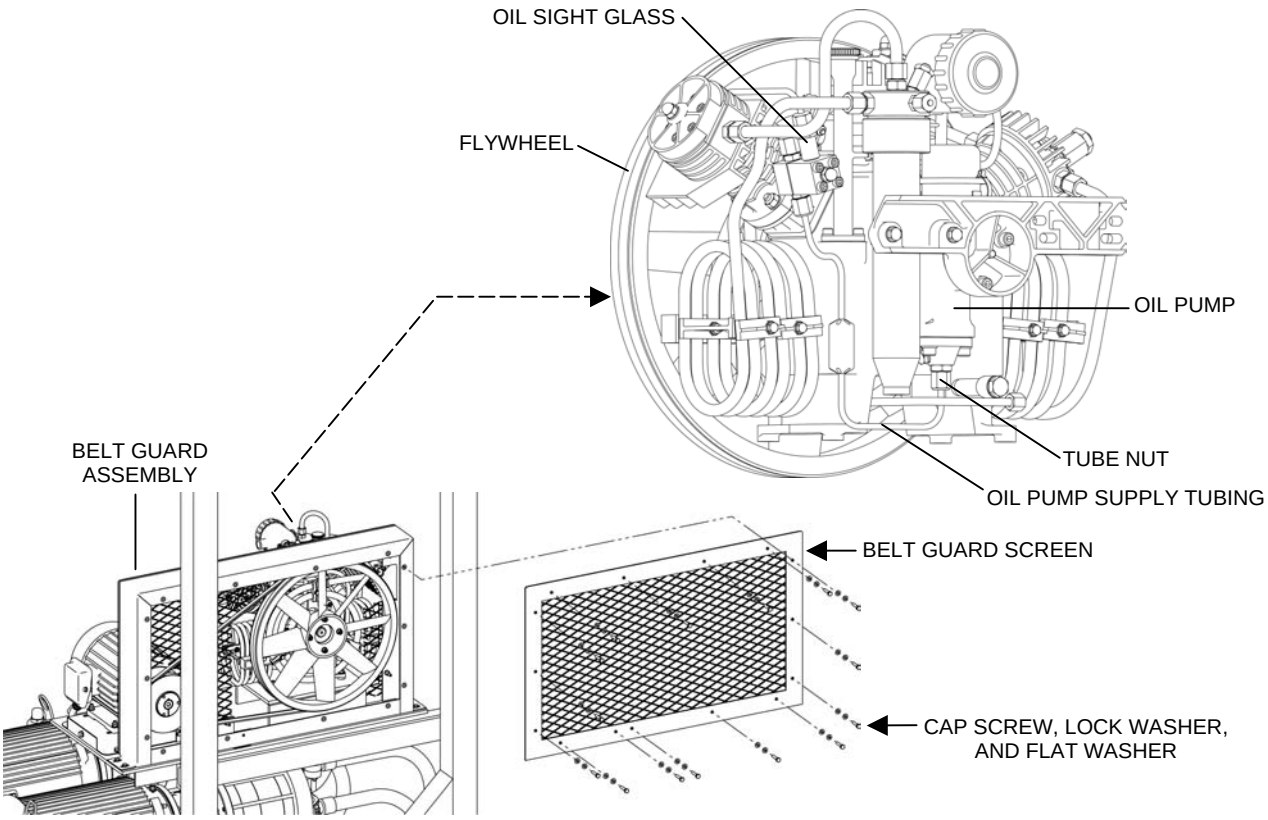

Figure 19. Air Compressor Oil Pump Supply Tubing and Flywheel.

4. Make sure Air Receiver Tank Shut-Off Valve V-907 is open.
5. Switch the Air Compressor control at the Operator Control Panel (OCP) to AUTO.
6. While the compressor is operating, check the oil sight glass for oil flow and that there are no air bubbles visible.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0057 00**
UNIT MAINTENANCE PROCEDURES
CHEMICAL INJECTION SYSTEM

THIS SECTION COVERS:
Replace, Repair

INITIAL SETUP

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Materials/Parts:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS in Standby Shutdown with power "ON" initially and "OFF" when specified

GENERAL

This procedure contains information and instructions for testing, replacing, and repairing components in the Chemical Injection System of the TWPS. The procedures covered in this work package include:

- Chemical Injection Pump Replacement (CP1, CP2, and CP3)
- Injection Check Valve Assembly Replacement (V-613, V-623 and V-633)
- Foot Valve Assembly Replacement (V-611, V-621, and V-631)
- Chemical Injection Pump Repair / Four-Function Valve (V-612, V-622 and V-632)
- Chemical Injection Pump Repair / Pump Head
- Chemical Injection Pump Repair / Pump Diaphragm
- Chemical Injection Pump Repair / Discharge Cartridge Valve, O-Ring, and Flat Washer
- Chemical Injection Pump Repair / Suction Valve Assembly

REPLACE

Chemical Injection Pump Replacement (CP1, CP2, and CP3):

Parts (TM 10-4610-309-24P):
Chemical injection pump
Electrical tie-down straps
Material:
Five-gallon bucket
Equipment Condition:
TWPS in Standby Shutdown with power "ON" initially and "OFF" when specified

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Replace any one or all three of the TWPS chemical injection pumps as follows (see Figure 1):

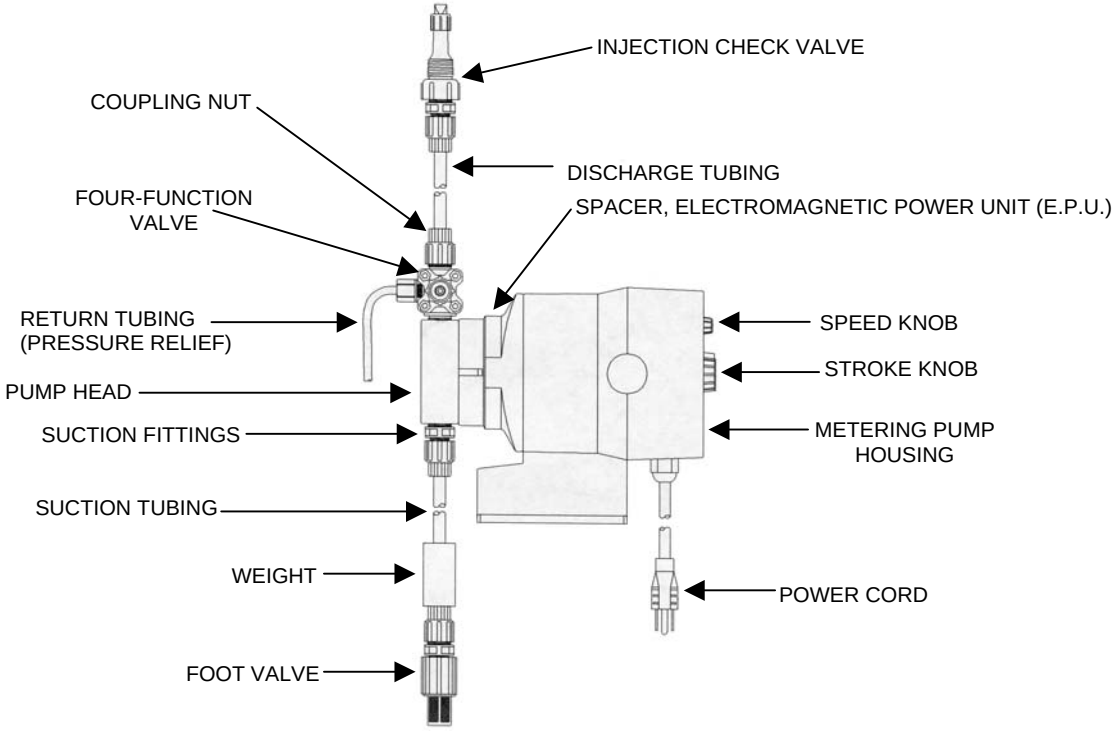

Figure 1. Chemical Injection Pump.

1. Depressurize the chemical injection pump discharge tubing as follows:

WARNING

Hazardous liquid chemical or fumes. Wear a protective face shield and chemical gloves when handling liquid sodium bisulfite, antiscalant, or calcium hypochlorite solutions. Avoid inhaling chemical fumes. Failure to observe this warning may result in gastrointestinal irritation, nausea, diarrhea, irritation of the nose, throat, mucous membranes, eyes, and skin. Ingestion of calcium hypochlorite can be fatal. Calcium hypochlorite can cause blindness if it comes in contact with the eyes.

   a. Turn the relief knob (black knob) ¼ turn either direction and pull out the anti-siphon knob (yellow knob) and hold it out for 5-10 seconds (see Figure 2).
   b. The discharge tubing is now depressurized.

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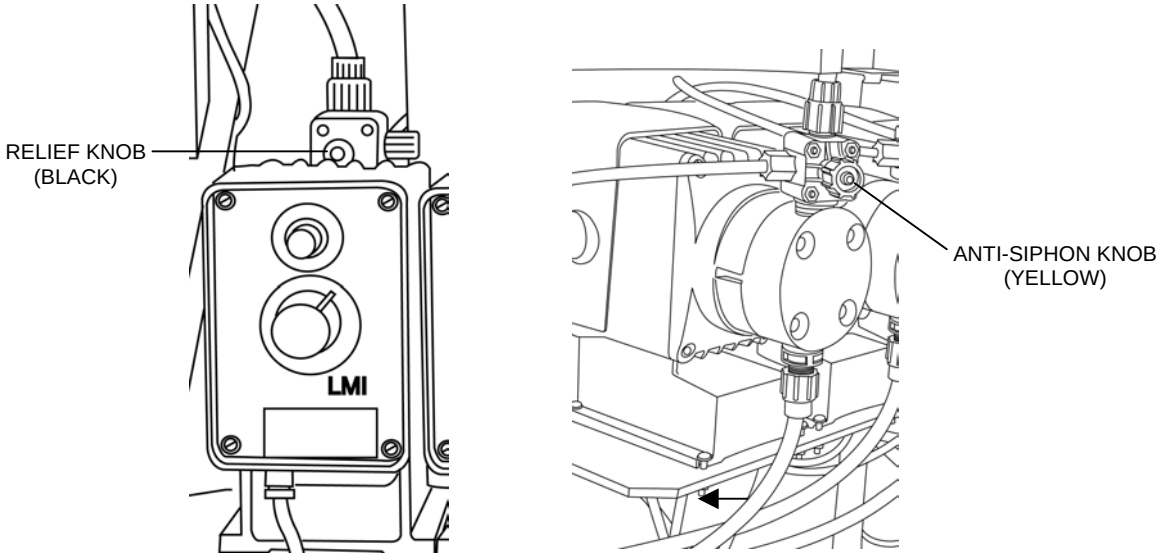

Figure 2. Chemical Pump Relief and Anti-Siphon Knobs.

2. Drain the Chemical Injection Pump as follows:
    a. Disconnect the discharge tubing.
    b. Place the foot valve into a five-gallon bucket of water or other neutralizing solution.
    c. Switch the pump to “ON” at the operator control panel (OCP) to flush the pump head assembly.
    d. Once the pump head assembly has been flushed, lift the foot valve out of the solution. Continue to pump air into the pump head until the pump head is purged of water or neutralizing solution.
    e. Turn the pump switch on the OCP back to “AUTO”.
    f. Turn the relief knob (black) and the anti-siphon knob (yellow) on the four-function valve 1/4 turn to the normal position (see Figure 2).
3. Remove the Chemical Injection Pump from the TWPS as follows (see Figure 3):
    a. Turn the speed knob fully counter-clockwise until it clicks. This is the off position.

WARNING

Electrical hazard. The TWPS unit must be properly de-energized before opening the terminal box for the chemical injection pumps. Failure to observe this warning may result in injury or death from electrocution.

    b. Place the TWPS in Standby Shutdown without Draining Down, including switching the Main Circuit Breaker on the power distribution panel (PDP) to OFF (WP 0017).
    c. Loosen the four screws on the chemical pump terminal box cover and remove the cover.

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NOTE

Each chemical pump power cable has a dedicated circuit that is controlled by the PLC (Programmable Logic Controller) in the PDP. Each pump power cable must be wired to it's specific circuit in order for the pump to operate as controlled by the PLC. Do not mix the wiring.

d. Trace the power cable from the pump to be replaced to the terminal box.
e. Tag and disconnect the three wires for the chemical pump to be replaced from the other wires in the terminal box.
f. Unscrew the lock nut from the terminal box and pull out the cable strain relief and cable.

CAUTION

Do NOT use a pliers or pipe wrench on coupling nuts or fittings. Failure to observe this caution could result in stripping the threads on the nuts or fittings.

g. Tag and disconnect the discharge tubing from the four-function valve.
h. Tag and disconnect the suction tubing from the pump.
i. Tag and disconnect the return tubing from the four-function valve.
j. Remove the four bolts, nuts, and washers that secure the chemical injection pump to the TWPS and slide the pump out from its mounting.

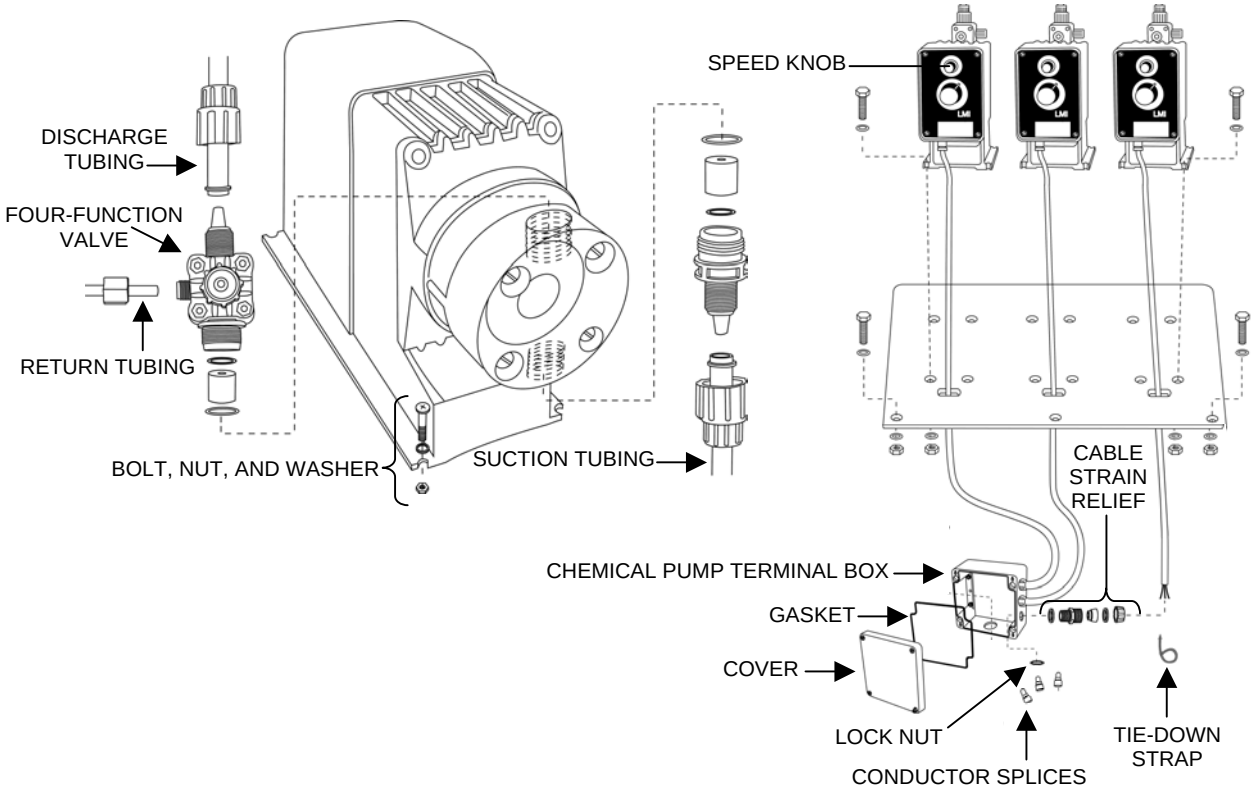

Figure 3. Chemical Pump Replacement.

4. Install the new chemical injection pump onto the TWPS as follows (see Figure 3):

NOTE

All new Chemical Injection Pumps are pre-primed with water when shipped from the factory. Before priming the pump, drain the water from the pump and refill the pump head with the solution to be pumped. This will aid in priming.

a. Slide the new Chemical Injection Pump onto its mounting on the TWPS and secure it with the four bolts, nuts and washers.

CAUTION

All fittings should be hand-tightened. It may be necessary to turn the fitting an additional 1/ 8 – 1/4 turn after the fitting contacts the seal ring to provide a leak-proof seal. Excessive over-tightening or using a pipe wrench can cause damage to the fittings, seals, or pump head.

b. Connect the return tubing to the four-function valve.
c. Connect the suction tubing to the suction side of the pump.
d. Connect the discharge tubing to the discharge side of the four-function valve.

WARNING

Electrical hazard. The TWPS unit must be properly de-energized before opening the terminal box for the chemical injection pumps. Failure to observe this warning may result in injury or death from electrocution.

NOTE

Each chemical pump power cable has a dedicated circuit that is controlled by the PLC (Programmable Logic Controller) in the PDP. Each pump power cable must be wired to it's specific circuit in order for the pump to operate as controlled by the PLC. Do not mix the wiring.

e. Cut the plug off the end of the new pump power cable and strip about 1-in of insulation off each of the 3 wires.
f. Slide the cable strain relief and washer over the power cable wires for the new pump.
g. Slide the power cable wires through the terminal box opening and fit the strain relief into the opening.
h. Slide the lock nut over the wires, thread it onto the strain relief, and tighten.
i. Connect the chemical pump wires to the wires inside the terminal box as tagged using conductor splices.
j. Secure the wires together using an electrical tie-down strap.
k. Make sure the terminal box cover gasket is in place in the cover.
l. Secure the cover to the box using the four screws.

5. Start up the TWPS from Stand-by Shutdown (WP 0015).

6. Start-up/prime the new Chemical Injection Pump as follows (see Figure 4):

CAUTION

The speed knob turns the injection pump on and must be set first. Do not attempt to adjust the stroke knob until the speed knob is set. Damage to the injection pump will result if the speed knob is not set first.

a. Turn the speed knob clockwise to turn the pump on.
b. Set the speed knob at 80%.
c. Then set the stroke knob at 100%.

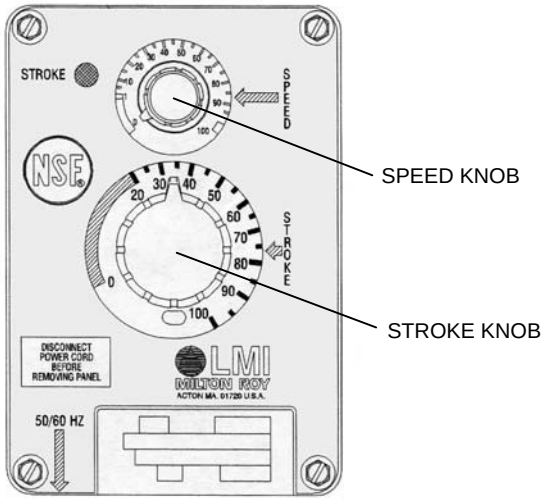

Figure 4. Chemical Injection Pump Control Knobs.

d. Turn the relief knob (black knob) of the four-function valve 1/4 turn (see Figure 2).
e. The suction tubing should begin to fill with solution from the chemical solution bucket.
f. A small amount of solution will begin to discharge out the return tubing of the four-function valve. Once this happens, turn the relief knob another ¼ turn (black knob – see Figure 2)
g. The pump is now primed.

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Injection Check Valve Assembly Replacement (V-613, V-623, V-633):

Parts (TM 10-4610-309-24P):
Injection check valve assembly
Material:
Antiseizing tape (WP 0079, Table 1, item 30, 31)
Five gallon bucket
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down with power “ON”

Replace an injection check valve assembly as follows (see Figure 5 for the location of the three injection check valves):

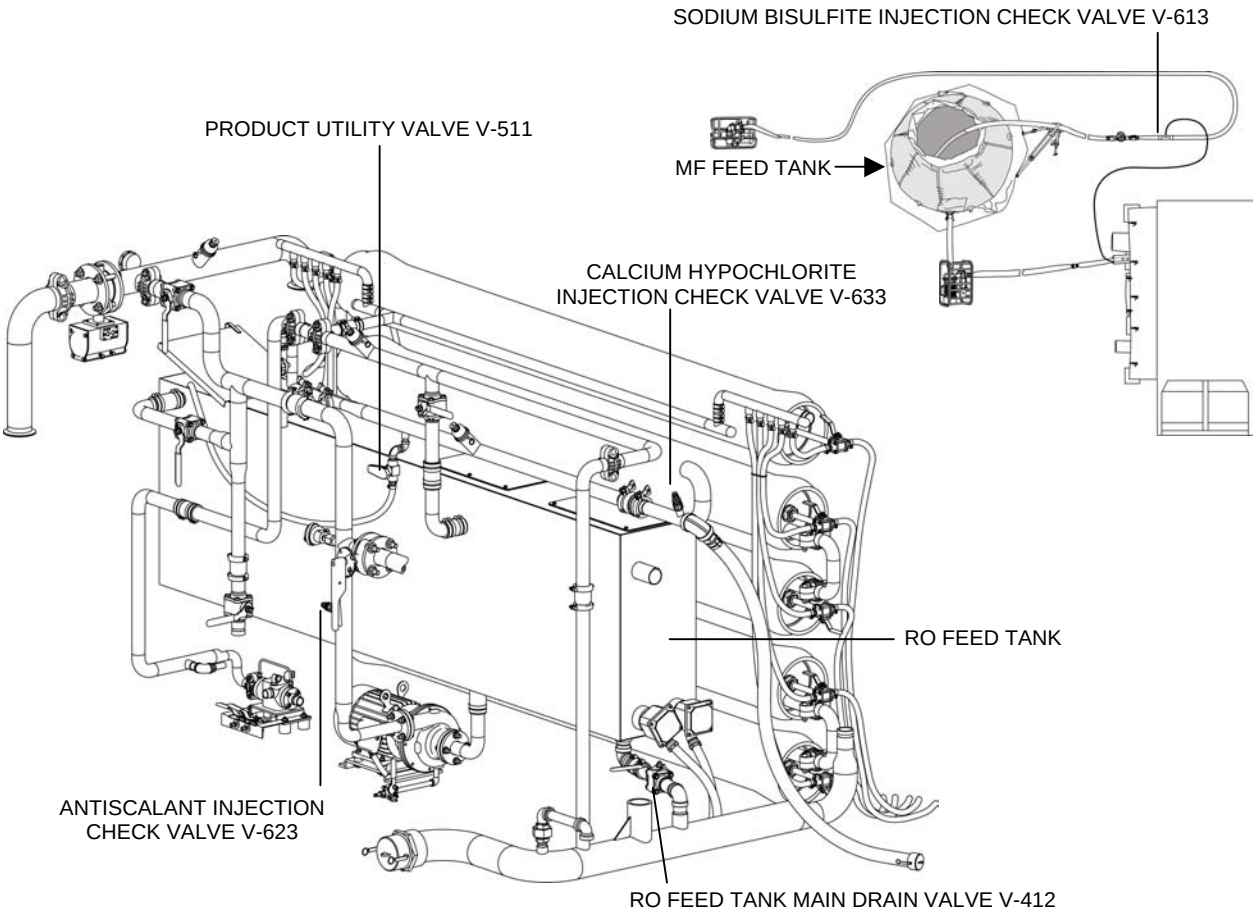

Figure 5. Injection Check Valve Locations.

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CAUTION

Be sure the return tubing is connected to the four-function valve and runs back to the chemical solution bucket.

The RO tank must be drained prior to removing Injection Check Valve V-623. Failure to observe this caution could result in filtrate spilling out of the RO tank onto the unit and working area.

1. Depressurize the chemical injection pump discharge tubing as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
2. When replacing Antiscalant Injection Check Valve V-623, open RO Feed Tank Main Drain Valve V-412 and drain the RO tank (see Figure 5 for valve V-412 location).
3. When replacing Calcium Hypochlorite Injection Check Valve V-633, open Product Utility Valve V-511 and drain the product line (see Figure 5 for valve V-511 location).
4. Remove the old injection check valve assembly as follows (see Figure 6):
    a. Unscrew the coupling nut from the injection check valve housing and disconnect the discharge tubing from the injection check valve housing.
    b. Remove and discard the clamp ring and coupling nut from the discharge tubing.
    c. Place a bucket or suitable container under the injection check valve assembly.
    d. Unscrew the injection check valve body from the process pipe.
    e. Discard the injection check valve assembly including the coupling nut, clamp ring, valve housing, flat washer injection seat, check valve ball, spring, O-ring, injection check valve body and flapper valve.

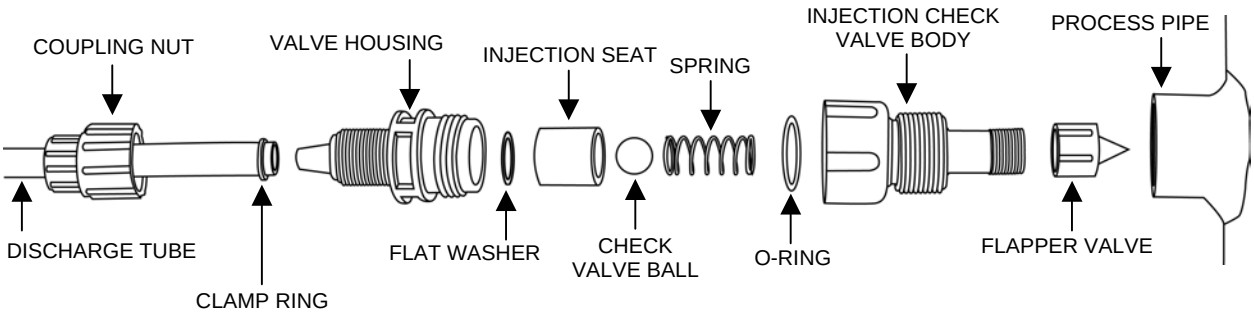

Figure 6. Injection Check Valve Assembly Replacement.

CAUTION

Do not use pliers or pipe wrench on coupling nuts or fittings.

5. Install the new injection check valve assembly as follows (see Figure 6):
    a. Apply antiseize tape only to the pipe threads of the injection check valve body that threads into the process pipe.

b. Thread the new injection check valve assembly into the process pipe.
c. Make sure the discharge tubing is cut square.
d. Slide the new coupling nut over the discharge tubing so that the nut threads are facing toward the end of the tubing.
e. Install the clamp ring about 1/4 –inch onto the end of the tubing.
f. Insert the end of the discharge tube over the cone-shaped end of the valve housing.
g. Thread the coupling nut onto the valve housing and tighten hand-tight.

6. Start up the TWPS from Standby Shutdown and prime the pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
7. Observe the injection check valve to determine that it does not leak.

Foot Valve Assembly Replacement (V-611, V-621 and V-631):

Parts:
Foot valve assembly (TM 10-4610-309-24P)
Material:
Five-gallon bucket
Equipment Condition:
TWPS electric power "ON"

Replace a chemical injection pump foot valve assembly as follows:

1. Depressurize the chemical injection pump discharge tubing as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
1. Remove the foot valve and suction tubing from the chemical solution bucket and place it in the empty five-gallon bucket to drain the suction line.
2. Remove the foot valve assembly from the suction tube as follows:
   a. Unscrew the coupling nut from the foot valve housing and remove the foot valve assembly from the suction tubing.
   b. Remove the clamp ring and coupling nut from the suction tubing.
   c. Discard the clamp ring, coupling nut, foot valve housing, flat washer, cartridge valve, O-ring, foot valve seat, and foot valve screen.

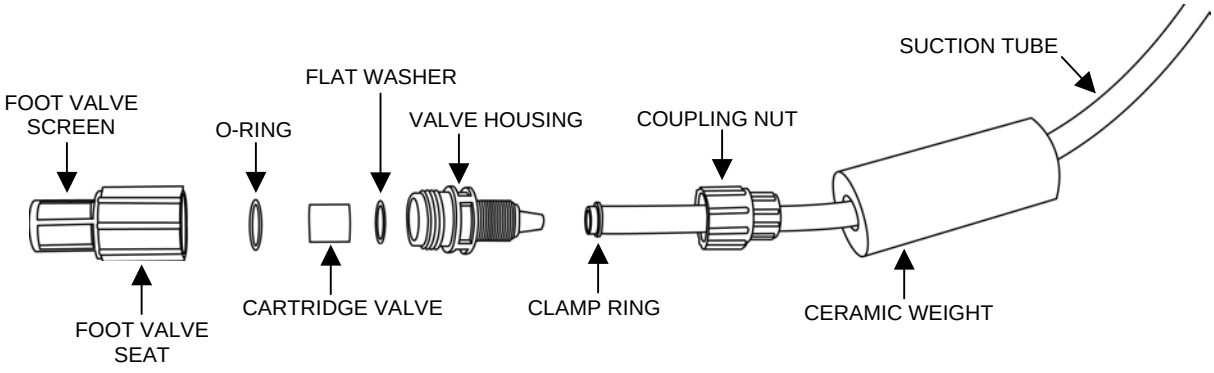

Figure 7. Foot Valve Assembly Replacement.

3. Install the new foot valve assembly as follows (see Figure 7):
    a. Make sure that the ceramic weight is inserted over the suction tubing.
    b. Slide the new coupling nut onto the suction tubing so that the nut threads are facing toward the end of the tubing.
    c. Install the clamp ring about 1/4 –inch onto the end of the tubing.
    d. Insert the end of the suction tube over the cone-shaped end of the valve housing.
    e. Thread the coupling nut onto the foot valve housing and tighten hand-tight.
    f. Place the new foot valve in the chemical solution bucket.
    g. Make sure that the suction tubing is completely vertical and two inches from the bottom of the chemical solution bucket.
4. Start up the TWPS from Standby Shutdown and prime the pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
5. Operate the chemical injection pump and check for leaks.

REPAIR

Chemical Injection Pump Repair / Four-Function Valve (V-612, V-622 and V-632):

Parts (TM 10-4610-309-24P):
Four-function valve
Material:
Antiseizing tape (WP 0079, Table 1, item 30, 31)
Five gallon bucket
Equipment Condition:
TWPS electric power "ON"

Replace the four-function valve on a chemical injection pump as follows:

1. Remove the chemical injection pump four-function valve as follows (see Figure 8):
    a. Depressurize the chemical injection pump discharge tubing as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
    b. Remove the foot valve from the chemical solution bucket and place it in the empty five-gallon bucket to drain the suction line.
    c. Remove the return tubing from the side of the four-function valve.
    d. Remove the discharge tubing from the top of the four-function valve.
    e. Remove the old four-function valve from the top of the pump head.
    f. Remove the clamp ring and coupling nut from the discharge tubing.
    g. Retain the flat washer (clear washer inside the bottom of the four-function valve), the discharge cartridge valve, and the O-ring.

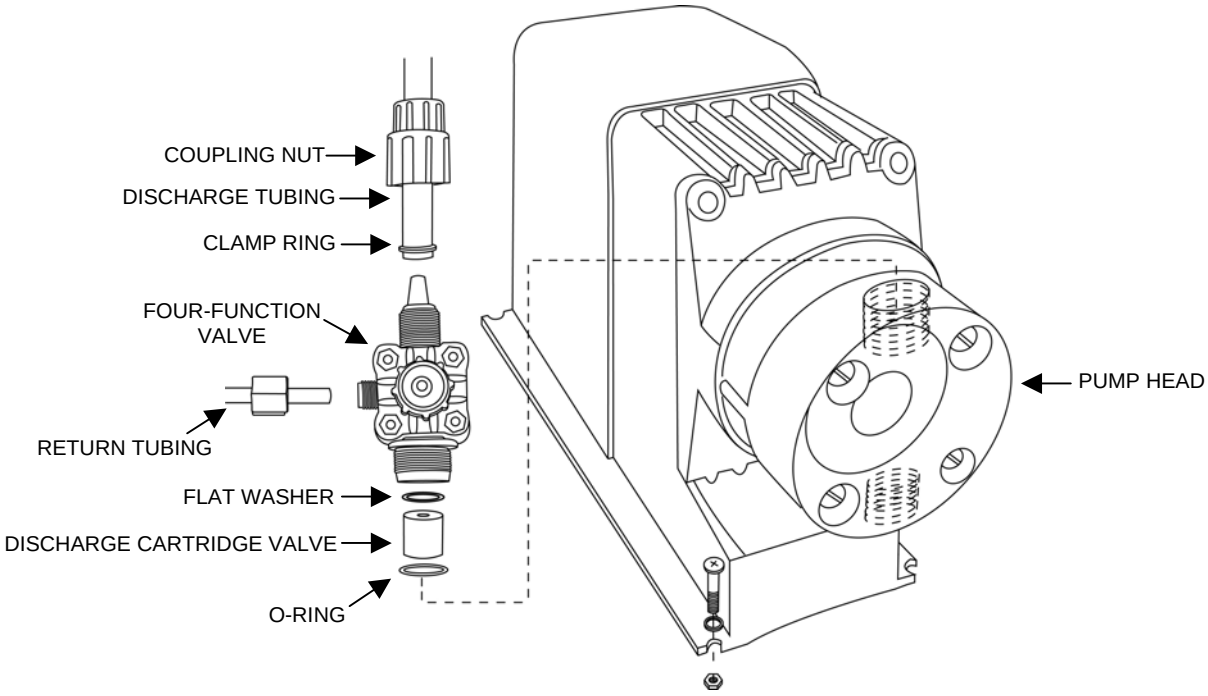

Figure 8. Chemical Injection Pump Four-Function Valve Replacement.

2. Install the new four-function valve as follows (see Figure 8):
   a. Insert the o-ring all the way down into the opening at the top of the pump head.
   b. Set the discharge cartridge valve into the opening at the top of the pump head with the flat end of the cartridge up.
   c. Insert the flat washer into the bottom of the new four-function valve.
   d. Apply anti-seize tape to the bottom threads only of the four-function valve.
   e. Screw in the new four-function valve until it contacts the O-ring.
   f. Add an additional 1/8 – 1/4 turn to prevent leaks.
   g. Slide the new coupling nut over the discharge tube so that the nut threads are facing toward the new four-function valve.
   h. Install the clamp ring about ¼ inch onto the end of the tubing.
   i. Thread the coupling nut onto the four-function valve and tighten hand-tight.

NOTE
To ensure priming, the return tubing must not be submerged in the solution.

   j. Connect the return tubing to the side of the new four-function valve.
   k. Place the foot valve back into the chemical solution bucket.
   l. Make sure that the suction tubing is completely vertical and two inches from the bottom of chemical solution bucket.
   m. Start up the TWPS from Standby Shutdown and prime the pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
   n. Operate the pump and check for leaks.

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Chemical Injection Pump Repair / Pump Head Assembly:

Parts:
Pump Head Assembly (TM 10-4610-309-24P)
Material:
Five gallon bucket
Equipment Condition:
TWPS Electrical Power "ON" initially and "OFF" when specified

Replace the pump head assembly on a chemical injection pump as follows:

1. Remove the pump head assembly from the chemical injection pump as follows (see Figure 9):
   a. Depressurize the discharge tubing and drain and flush the chemical injection pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
   b. Place the TWPS in Standby Shutdown without draining down, including switching the main circuit breaker on the power distribution panel (PDP) to OFF (WP 0017).
   c. Remove the discharge, return, and suction tubes from the pump.
   d. Remove the 4 screws, washers, and nuts that secure the pump to the mounting base and reposition the pump as desired for easy access to the pump head assembly.
   e. Remove the four-function valve, flat washer, discharge cartridge valve, and O-ring from the top of the pump head.
   f. Remove the suction valve housing, flat washer, suction cartridge valve, and O-ring from the bottom of the head.
   g. Remove the four bolts and washers that secure the pump head to the chemical injection pump drive assembly and remove the pump head assembly.

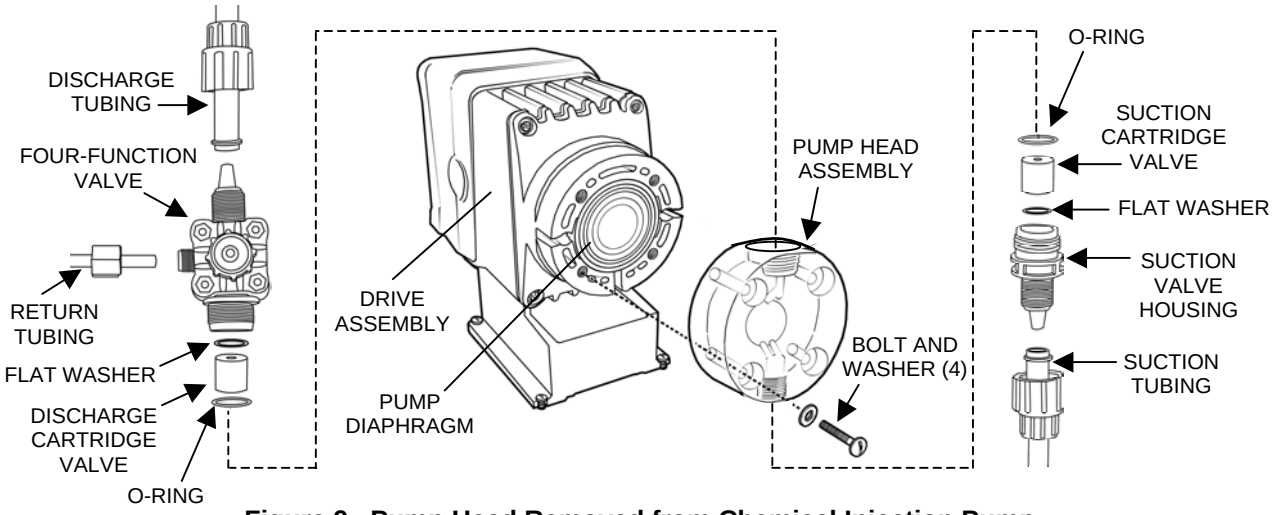

Figure 9. Pump Head Removed from Chemical Injection Pump.

2. Inspect the condition of the pump diaphragm before installing the new pump head assembly. Make sure the pump diaphragm is properly positioned with the spacer as shown in Figure 10. If the diaphragm is damaged or improperly positioned, replace or reposition the diaphragm. Refer to the **Chemical Injection Pump Repair / Pump Diaphragm** procedure that follows this procedure.

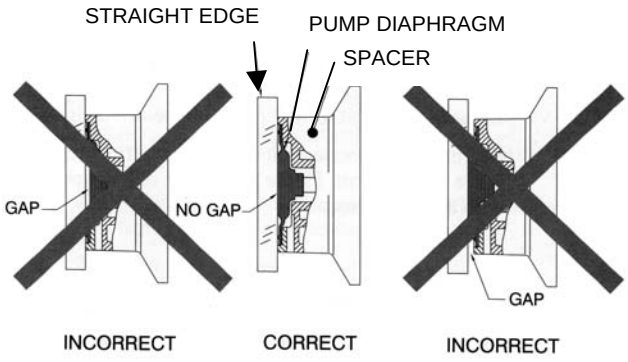

Figure 10. Pump Diaphragm Positioning.

3. Install the new pump head assembly as follows:
    a. Secure the pump head assembly to the pump drive assembly with the 4 mounting bolts.
    b. Install the suction O-ring, cartridge valve, flat washer, and suction valve housing into the bottom of the head.
    c. Install the O-ring, discharge cartridge valve, flat washer, and four-function valve into the top of the pump head.
    d. Position the pump and secure it to the mounting plate using the 4 screws, washers and nuts removed earlier.
    e. Reconnect the discharge, return, and suction tubes to the pump.
4. Startup the TWPS from Standby Shutdown and prime the chemical injection pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
5. Check the new pump head for leaks.

Chemical Injection Pump Repair / Pump Diaphragm:

Parts:
Pump Diaphragm (TM 10-4610-309-24P)
Material:
Five gallon bucket
Equipment Condition:
TWPS Electrical Power “ON” initially and “OFF” when specified

Replace the Pump Diaphragm on the chemical injection pump as follows:

1. Remove the Chemical Injection Pump Diaphragm as follows:
    a. Depressurize the discharge tubing and drain and flush the chemical injection pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
    b. Place the TWPS in Standby Shutdown without draining down, including switching the main circuit breaker on the power distribution panel (PDP) to OFF (WP 0017).
    c. Remove the discharge, return, and suction tubes from the pump.
    d. Remove the 4 screws, washers, and nuts that secure the pump to the mounting base and reposition the pump as desired for easy access to the pump head assembly.

e. Remove the four bolts and washers that secure the pump head to the chemical injection pump drive assembly and remove the pump head assembly (see Figure 9).
f. Remove the pump diaphragm from the spacer by carefully grasping the outer edge of the diaphragm and turning it counter-clockwise (see Figure 11).

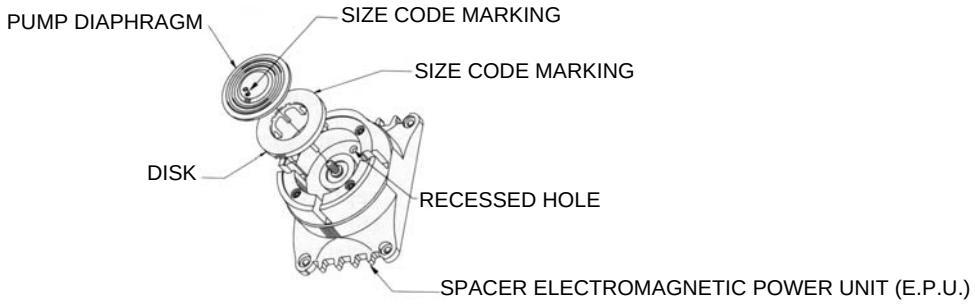

Figure 11. Pump Diaphragm Removed from Pump Head Spacer.

2. Install the new pump diaphragm as follows (see Figure 11):
   a. Check that the size code on the new diaphragm matches the size code on the on the front of the disk.
   b. Switch the main circuit breaker on the power distribution panel (PDP) to “ON”.
   c. Turn the pump switch on the operator control panel (OCP) to “ON”.
   d. Start the pump by turning the speed knob clockwise.
   e. Turn the stroke knob to “90%”.
   f. With the pump stroking (running), screw on the new pump diaphragm clockwise until the center begins to buckle inward, then stop the pump.
   g. Turn the pump switch on the OCP to “OFF”.
   h. Switch the main circuit breaker on the PDP to “OFF”.
   i. Grasp the outer edge of the diaphragm and screw it in or out as needed so that the center of the diaphragm is flush with the outside edge of the spacer (see Figure 12).

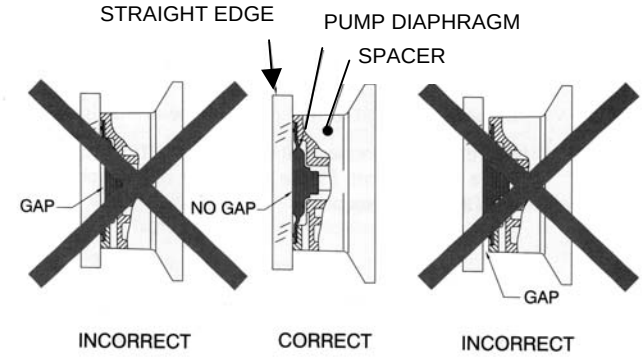

Figure 12. Diaphragm Positioning.

   j. Once the diaphragm is properly positioned, secure the pump head to the spacer using the four screws.
   k. Tighten the four screws in a criss-cross pattern.

l. Position the pump and secure it to the mounting plate using the 4 screws, washers and nuts removed earlier.
m. Reconnect the discharge, return, and suction tubes to the pump.

3. Startup the TWPS from Standby Shutdown and prime the chemical injection pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
4. Operate the chemical injection pump and check for leaks.
5. After one week of operation, recheck the pump head screws and tighten if necessary.

Chemical Injection Pump Repair / Discharge Cartridge Valve, O-Ring, and Flat Washer:

Parts (TM 10-4610-309-24P):
Discharge cartridge (valve) assembly
O-ring
Flat washer
Material:
Antiseizing tape (WP 0079, Table 1, item 30, 31)
Five gallon bucket
Equipment Condition:
TWPS Electrical Power “ON”

Replace the chemical injection pump discharge cartridge valve, o-ring, and flat washer as follows:

1. Depressurize the chemical injection pump discharge tubing as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
2. Remove the foot valve from the chemical solution bucket and place it in the empty five-gallon bucket to drain the suction line.
3. Remove the chemical injection pump discharge valve assembly as follows (see Figure 13):
   a. Remove the return tubing from side of the four-function valve.
   b. Remove the discharge tubing from the top of the four-function valve.
   c. Remove the four-function valve from the top of the pump head.
   d. Remove and discard the discharge cartridge valve, O-ring, and flat washer from inside the top of the pump head.

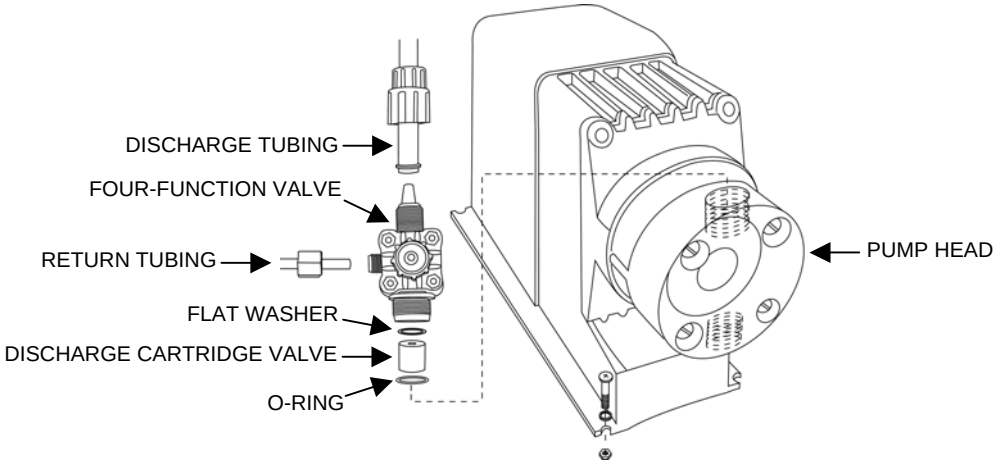

Figure 13. Chemical Injection Pump Discharge Cartridge, O-Ring, and Flat Washer Replacement.

4. Install the new discharge cartridge valve, o-ring, and flat washer as follows (see Figure 13):
    a. Insert the new O-ring all the way down into the opening at the top of the pump head.
    b. Set the discharge cartridge valve into the opening at the top of the pump head with the flat end of the cartridge up.
    c. Insert the new flat washer into the bottom of the four-function valve.
    d. Apply anti-seize tape to the bottom threads only of the four-function valve.
    e. Screw the four-function valve into the opening at the top of the pump head until the valve contacts the O-ring.
    f. Add an additional 1/8 – 1/4 turn to prevent leaks.
    g. Connect the return tubing to the threaded port at the side of the four-function valve.

NOTE
To ensure priming, the return tubing must not be submerged in the solution.

    h. Connect the discharge tubing to the top of the four-function valve assembly. Thread the coupling nut onto the four-function valve and tighten hand-tight.
5. Place the foot valve back into the chemical solution bucket.
6. Make sure that the suction tubing is completely vertical and two inches from the bottom of chemical solution bucket.
7. Prime the chemical injection pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
8. Operate the pump and check for leaks.

Chemical Injection Pump Repair / Suction Valve Assembly:

Parts (TM 10-4610-309-24P):
    Suction valve assembly
Material:
    Five gallon bucket
Equipment Condition:
    TWPS Electrical Power “ON”

Replace the chemical injection pump suction valve assembly as follows:

1. Depressurize the chemical injection pump discharge tubing as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
2. Remove the foot valve from the chemical solution bucket and place it in the empty five-gallon bucket to drain the suction line.
3. Remove the chemical injection pump suction valve assembly as follows (see Figure 14):
    a. Unscrew the coupling nut from suction valve housing and pull the suction tube off the valve housing.
    b. Remove and discard the clamp ring and coupling nut from the suction tubing.
    c. Unscrew the suction valve housing from the bottom of the pump head.
    d. Remove and discard the suction cartridge valve, o-ring, and flat washer from inside the bottom of the pump head.

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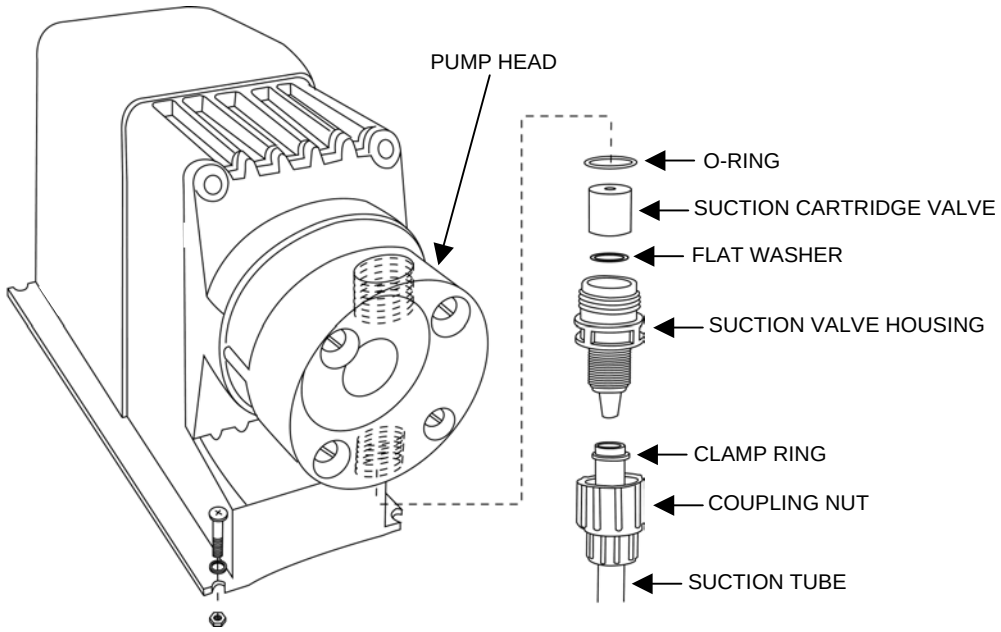

Figure 14. Chemical Injection Pump Suction Valve Assembly Replacement.

4. Install the new suction valve assembly as follows (see Figure 14):
    a. Insert the new O-ring all the way into the opening at the bottom of the pump head.
    b. Insert the new flat washer into the suction valve housing.
    c. Set the suction cartridge valve into the suction valve housing with the flat end of the cartridge in.
    d. Thread the suction valve housing into the opening at the bottom of the pump head until it contacts the O-ring.
    e. Add an additional 1/8 – 1/4 turn to prevent leaks.
    f. Slide the new coupling nut over the suction tubing so that the nut threads are facing toward the end of the tubing.
    g. Install the clamp ring about 1/4–inch onto the end of the tubing.
    h. Connect the suction tubing to the suction valve housing.
    i. Thread the coupling nut onto the valve housing and tighten hand-tight.
5. Place the foot valve back into the chemical solution bucket.
6. Make sure that the suction tubing is completely vertical and two inches from the bottom of chemical solution bucket.
7. Prime the pump as described in the **Chemical Injection Pump Replacement** procedure earlier in this WP.
8. Operate the pump and check for leaks.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0058 00**
UNIT MAINTENANCE PROCEDURES
PRODUCT WATER DISTRIBUTION SYSTEM

THIS SECTION COVERS:
Inspect, Repair, Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS removed from service or during operation as required

GENERAL:

This work package contains information and instructions for repairing and replacing components in the Product Water Distribution System. These include:

- P-7 Skid Frame Replacement
- P-7 Skid Junction Box Replacement
- P-7 Skid Power Cable Replacement
- P-7 Pump Motor Cable Replacement
- P-7 Pump Replacement
- P-7 Pump Motor Replacement
- Product Water Distribution Hose Repair/Replacement
- Adaptor Assembly A-08 Repair/Replacement
- Adaptor Assembly A-07 and A-15 Repair/Replacement
- Dispensing Nozzle V-523 Replacement
- Auxiliary Hose Assembly P06 Replacement
- P-7 and P-8 Pump Overhaul

Refer to TM 10-5430-237-12&P (Marine Corps TM 01034E-12&P/1) for inspection and repair procedures for the collapsible product water distribution tank.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0058 00**
UNIT MAINTENANCE PROCEDURES
PRODUCT WATER DISTRIBUTION SYSTEM

REPLACE

P-7 Skid Frame Replacement:

Parts (TM 10-4610-309-24P):
P-7 pump skid frame
Equipment Condition:
P-7 Pump assembly removed from service and drained.

Inspect the P-7 pump skid frame for damage. If frame damage is repairable by welding, contact Direct Support Maintenance. Replace the frame if it is beyond repair.

Replace the skid frame as follows (see Figure 1):

1. Disconnect the motor cable at the junction box.
2. Remove the four screws and washers that secure the junction box to the skid frame, and remove the junction box.
3. Remove the four bolts, flat washers, and lock washers that secure the pump/motor unit to the frame.

WARNING

Two person lift. Two people are required to safely move the pump/motor assembly. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

4. Slide the pump/motor unit out the side of the frame.
5. Position the pump/motor unit onto the new frame and secure it with the four bolts, flat washers, and lock washers.
6. Attach the junction box to the new frame using the four screws and washers. Be sure to orient the box so the side with the receptacles is facing inward.
7. Connect the electric motor cable to the proper connector on the junction box.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0058 00**
UNIT MAINTENANCE PROCEDURES
PRODUCT WATER DISTRIBUTION SYSTEM

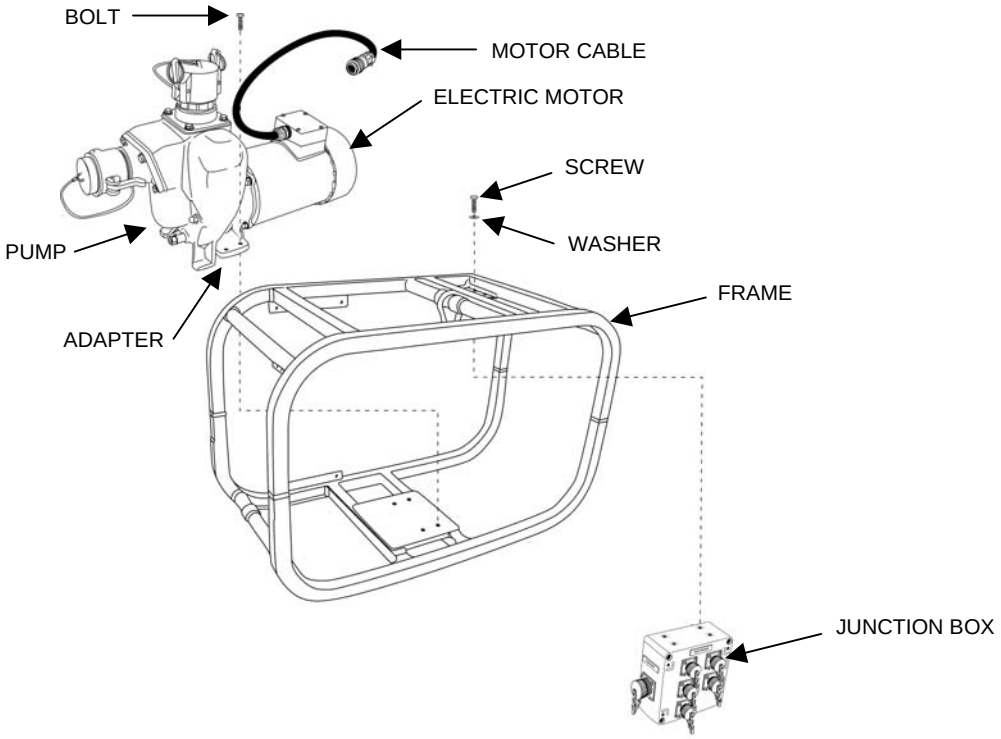

Figure 1. Product Water Pump P-7 Assembly Components.

P-7 Skid Junction Box Replacement:

Parts (TM 10-4610-309-24P):
P-7 pump skid junction box
Equipment Condition:
P-7 pump assembly removed from service

Inspect the junction box for damage or corroded connectors. Replace the box if damage or corrosion is severe enough to make unsafe or non-functional as follows (see Figure 1):

1. Disconnect the motor cable from the junction box.
2. Remove the four screws and washers that secure the junction box to the frame. Remove the junction box.
3. Secure the new junction box to the frame using the four screws and washers. Be sure to orient the box so the side with the receptacles is facing inward.
4. Connect the motor cable to the proper connector on the junction box.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0058 00**
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PRODUCT WATER DISTRIBUTION SYSTEM

P-7 Skid Power Cable Replacement:

Parts (TM 10-610-309-24P):
P-7 skid power cable
Equipment Condition:
P-7 Pump assembly removed from service

Inspect the power cable that connects the P-7 Pump Junction Box to the Power Distribution Panel. If the cable or the cable connectors are damaged so that it is unsafe to use, replace the cable.

P-7 Pump Motor Cable Replacement:

Parts (TM 10-4610-309-24P):
P-7 Pump Motor Cable
Equipment Condition:
P-7 Pump assembly removed from service

Inspect the motor cable for damage. If the cable or the cable connectors are damaged so that it is unsafe to use, replace the cable.

1. Disconnect the motor cable at the junction box.
2. Remove the motor terminal box cover.
3. Inspect the terminal box gasket and replace if needed.
4. Tag and disconnect the motor terminal wires from the motor cable wires.
5. Unscrew the cable ring nut from the terminal box.
6. Pull the cable end out of the terminal box and discard the old motor cable.
7. Insert the wire end of the new cable into the terminal box and secure with the ring nut.
8. Connect the motor cable wires to the motor terminal wires in accordance with the tags.
9. Install the terminal box cover gasket and cover and secure with the two nuts.

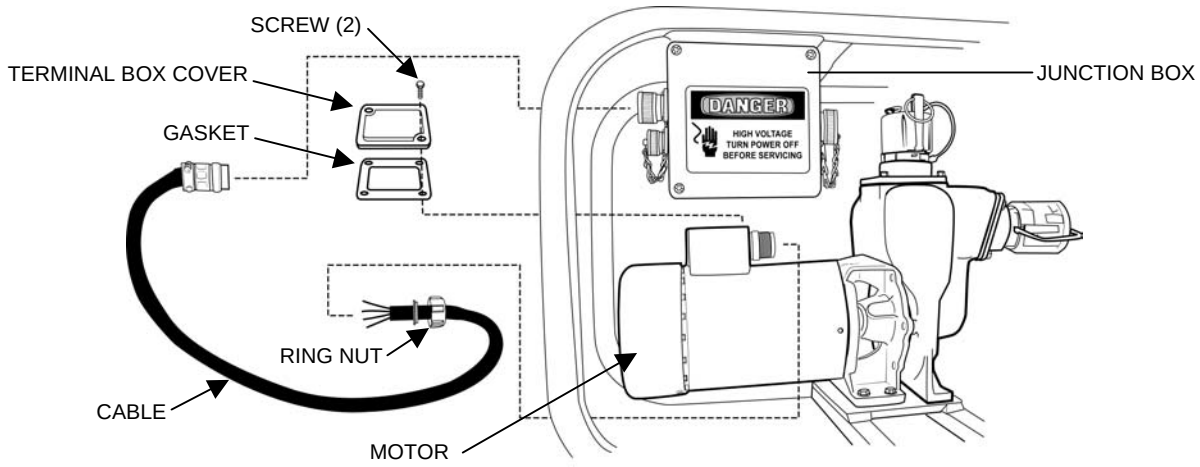

Figure 2. P-7 Pump Motor Cable Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0058 00**
UNIT MAINTENANCE PROCEDURES
PRODUCT WATER DISTRIBUTION SYSTEM

P-7 Pump Replacement:

Parts (TM 10-4610-309-24P):
P-7 Pump
Material:
Cloth, Abrasive (WP 0079, Table 1, item 15)
Corrosion Preventive Compound (WP 0079, Table 1, item 17)
Sealing Compound (WP 0079, Table 1, item 36)
Clean, dry rags (WP 0079, Table 1, item 33)
Equipment Condition:
P-7 Pump assembly removed from service and drained.

Replace the P-7 pump as follows (see Figure 3):

1. Remove the pump as follows:
   a. Disconnect the pump motor cable from the junction box.
   b. Remove the four bolts and washers that attach the pump/motor unit to the skid frame.

WARNING

Two person lift. Two people are required to safely move the pump/motor unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

   c. Slide the pump/motor unit out the side of the skid.
   d. Remove the six nuts that attach the pump housing to the adapter, then loosen and remove the pump housing.
   e. Remove and discard the coupling clamp assembly.
   f. Carefully pry the impeller/drive sleeve assembly off the motor drive shaft and discard it.
   g. Remove the four cap screws and lock washers that attach the adapter to the motor.
   h. Discard the adapter.

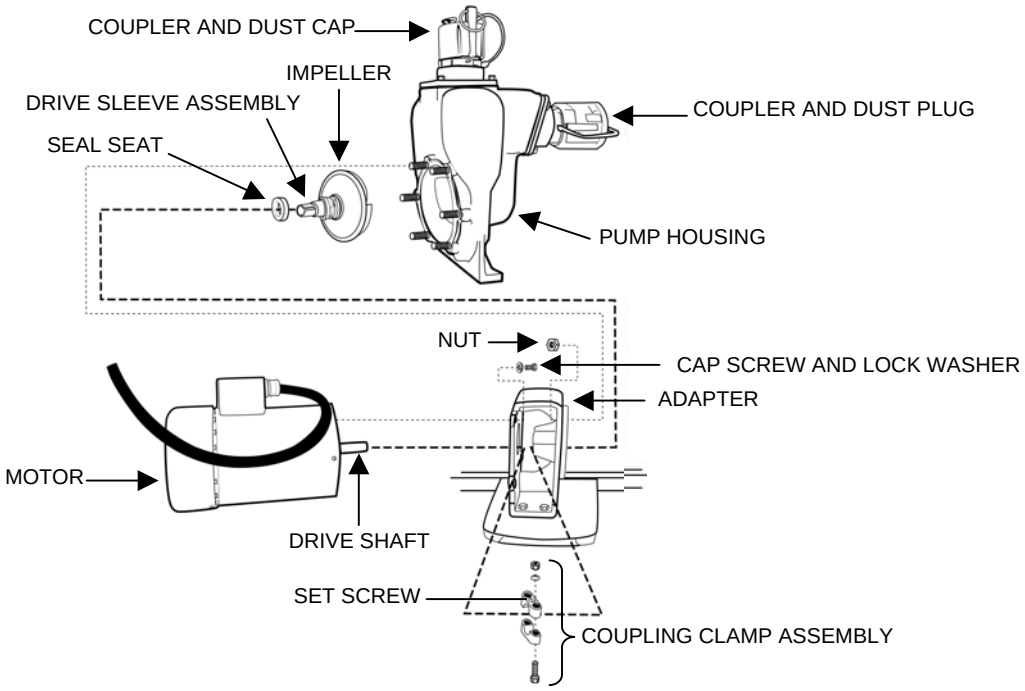

Figure 3. P-7 Pump and Motor Removal.

2. Install a new pump as follows:
   a. Polish the motor shaft with fine abrasive cloth to remove any rust or corrosion.
   b. Lubricate the shaft and the inside diameter of the drive sleeve on the new pump with corrosion preventive compound.

CAUTION

Improper assembly can result in damage to the drive sleeve and the motor drive shaft. Do NOT place a key between the drive shaft and the drive sleeve. Do NOT force the drive sleeve onto the shaft. Failure to observe this caution can make impeller clearance adjustments and the future removal of the drive sleeve difficult, and may result in damage to the drive sleeve and/or the motor drive shaft.

Replacement pump assemblies come with a pump housing, impeller, drive sleeve assembly, coupling clamp assembly, and adapter already assembled together. A temporary impeller spacer is installed inside the pump between the impeller and wear plate. Do NOT rotate the pump until the spacer has been removed, or equipment damage may result. Do NOT remove the spacer until the motor has been mounted to the pump and the coupling clamp assembly has been tightened.

c. Loosen but do not remove the coupling clamp assembly on the new pump.
d. Position the replacement pump, align the coupling clamp set screw, a drive sleeve slat, and the engine drive shaft keyway and slide the drive sleeve onto the drive shaft.

NOTE

If the shaft does not easily slide into the drive sleeve, it may be necessary to remove burrs from the shaft.

e. Attach the motor to the pump adapter using the four cap screws and four lock washers.
f. Torque the coupling clamp assembly nuts to 216 in.-lbs.
g. Tighten the coupling clamp set screw into the drive shaft keyway.

WARNING

Two person lift. Two people are required to safely move the pump/motor unit. Lift with your legs, not your back. Failure to observe this warning may result in back injury.

h. Position the pump/motor unit on the skid and bolt it in place using four bolts and washers.
i. Remove the plastic protective caps from the pump inlet and outlet openings.
j. Remove the temporary impeller spacer by pulling it out through the pump outlet opening.

3. Remove the adapter and dust cap from the outlet of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 36).
4. Remove the coupler and dust plug from the inlet of the old pump and install them on the new pump. Use sealing compound on the coupler threads (WP 0079, Table 1, item 36).
5. Remove the drain valve from the old pump. Remove the drain plug from the new pump and install the drain valve on the new pump. Use sealing compound on the valve threads (WP 0079, Table 1, item 36).
6. Connect the motor cable to the proper receptacle on the junction box.
7. Place the pump back into service and inspect it for leaks.

P-7 Pump Motor Replacement:

Parts (TM 10-4610-309-24P):
P-7 Electric Motor Assembly
Kit, Pump Seal Repair
Material:
Cloth, Abrasive (WP 0079, Table 1, item 15)
Corrosion Preventive Compound (WP 0079, Table 1, item 17)
Glycerin (WP 0079, Table 1, item 21)
Clean, dry rags (WP 0079, Table 1, item 33)
Sealing Compound (WP 0079, Table 1, item 35)
Equipment Condition:
P-7 Pump assembly removed from service and drained.

NOTE

The pump must be taken apart to separate it from the motor. This is because the impeller clearance must be set when the pump is installed on the new motor. The seal seat, seal assembly, housing gasket, and drive sleeve will also be replaced.

Replace the P-7 Pump electric motor as follows (see Figure 4 and Figure 5):

1. Remove the pump motor as follows:
   a. Disconnect the motor cable at the skid junction box.
   b. Remove the six nuts that attach the pump housing to the adapter.
   c. Remove the pump housing and gasket. Discard the gasket.
   d. Remove the coupling clamp assembly.

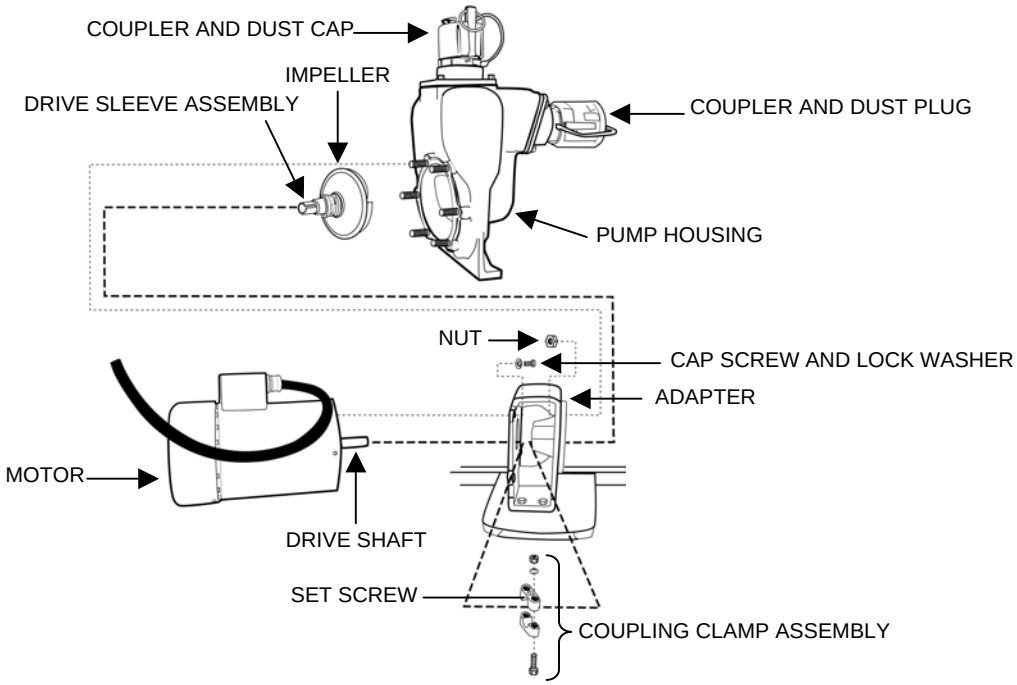

Figure 4. Pump P-7 Electric Motor Replacement.

   e. Carefully pry the impeller/drive sleeve assembly off the motor drive shaft.
   f. Remove the lock nut and drive sleeve from the impeller (see Figure 5). Discard the sleeve and the seal assembly. Attach the new sleeve to the impeller using the lock nut.
   g. Lubricate the new seal assembly with glycerin. With the rubber boot end toward the impeller, twist and slide the assembly onto the drive sleeve.
   h. Remove the four cap screws and four lock washers that attach the motor to the adapter and remove the motor.
   i. Push the seal seat out of the adapter and discard it.
   j. Clean the adapter bore and mounting faces.
   k. Clean the new seal seat and lubricate it with glycerin. Insert the beveled end of the seal seat into the adapter bore and press it into the adapter.

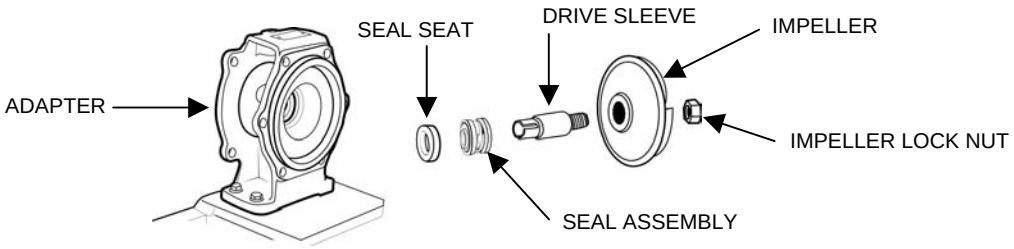

Figure 5. Drive Sleeve, Impeller, and Seal Assembly.

2. Install the new motor as follows:
   a. If necessary, polish the new motor's drive shaft with fine abrasive cloth to remove any rust or corrosion.
   b. Attach the new motor to the adapter using the four cap screws and four lock washers.
   c. Disconnect the motor cable from the old motor and attach it to the new motor. Refer to **REPLACE** and **P-7 Pump Motor Cable.**
   d. Lubricate the motor drive shaft and the inside diameter of the drive sleeve with corrosion preventive compound.

CAUTION

Improper assembly can result in damage to the drive sleeve and the motor drive shaft. Do NOT place a key between the drive shaft and the sleeve. Do NOT force the drive sleeve onto the shaft. Failure to observe this caution can make impeller clearance adjustments and the future removal of the drive sleeve difficult, and may result in damage to the drive sleeve and/or the motor drive shaft.

   e. Slide the drive sleeve and impeller assembly onto the drive shaft.

NOTE

If the sleeve does not easily slide onto the shaft, it may be necessary to remove burrs from the shaft.

   f. Install the coupling clamp assembly but do not tighten it.
   g. Place a new housing gasket between the adapter and the pump housing.
   h. Fit the pump onto the adapter and thread a nut on two opposing threaded studs to secure the pump to the adapter. Tighten the two nuts.
3. Set the gap between the impeller and the pump wear plate as follows (see Figure 6):
   a. Remove the four cap screws and 4 lock washers that secure the outlet flange to the pump housing.
   b. Carefully remove the pump flange to avoid damaging the gasket between the flange and the pump housing.
   c. If the gasket is damaged, replace it.
   d. Look through the outlet into the pump. Turn the impeller drive sleeve and impeller by hand until you see the impeller near the wear plate.
   e. Insert a 0.015 – inch feeler gauge between the impeller and wear plate. Move the impeller forward or backward as needed to provide a gap of 0.015 to 0.017-inch.

f. Turn the impeller drive sleeve / impeller assembly by hand to make sure that there is a minimum gap of 00.015-inch through the entire rotation of the impeller.
g. Make sure the coupling clamp set screw, a drive sleeve slat, and the motor shaft keyway are aligned.
h. Tighten the coupling clamp assembly to secure the impeller drive sleeve to the motor drive shaft. Torque the nuts to 216 in.-lbs.
i. Tighten the coupling clamp set screw into the drive shaft keyway.

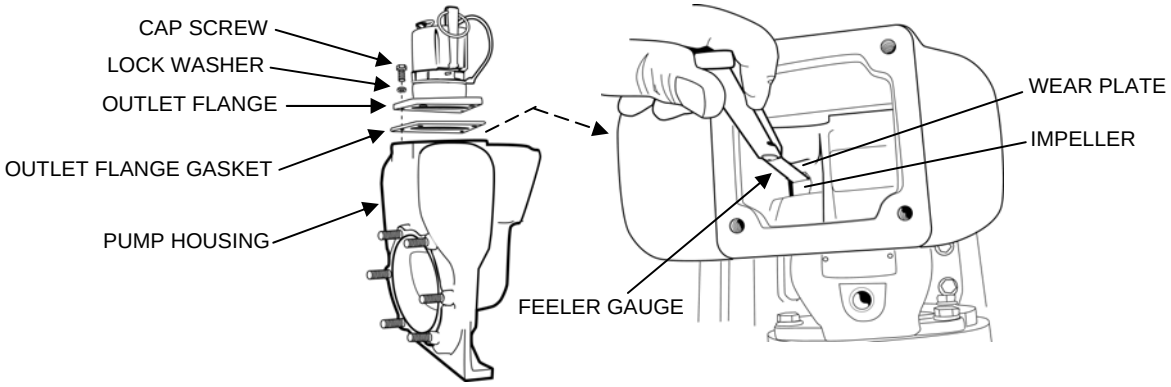

Figure 6. P-7 Pump Impeller Clearance Adjustment.

4. Complete the installation as follows:
    a. Apply sealing compound to the threads of the remaining four threaded studs extending from the pump housing through the adapter (WP 0079, Table 1, item 35). Install the nuts onto the studs.
    b. Remove the two nuts initially installed onto opposing studs. Apply sealing compound to the stud threads and reinstall the nuts (WP 0079, Table 1, item 35).
    c. Reinstall the pump outlet flange and gasket.
5. Connect the motor cable to the proper receptacle on the junction box.
6. Place the pump back into service and inspect it for proper rotation and leaks.

Product Water Distribution Hose Repair / Replacement:

Parts (TM 10-610-309-24P):
Hose assembly P02
Hose assembly P03
Hose assembly P04
Hose assembly P05
Hose assembly P06
Gaskets
Equipment Condition:
TWPS removed from service

Inspect the hoses and hose connectors for leaks, cracks, or other damage. Replace the entire hose assembly if damage is found. Check the female connectors of all hose assemblies for missing or damaged gaskets, and replace as necessary.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0058 00**
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REPAIR

P-7 and P-8 Pump Overhaul:

Parts (TM 10-4610-309-24P):
- Kit, Pump Overhaul
- Flapper Assembly
- Outlet Flange Gasket

Materials:
- Cloth, Abrasive (WP 0079, Table 1, item 15)
- Corrosion Preventive Compound (WP 0079, Table 1, item 17)
- Glycerin (WP 0079, Table 1, item 21)
- Sealing compound (WP 0079, Table 1, item 35)
- Clean, dry rags (WP 0079, Table 1, item 33)

Equipment Condition:
- Pump assembly removed from service and drained.

This section provides instructions for overhauling the P-7 or P-8 (Army TWPS only) pump by replacing the internal components. The pump should be overhauled if its flow rate has noticeably decreased, or if inspection of the pump during disassembly for some other maintenance task (such as engine/motor replacement) shows that the impeller or wear plate is damaged or badly corroded. Additional instructions in this section describe how to replace the pump inlet flapper assembly and the outlet flange gasket.

NOTE

Whenever the P-7 or P-8 pump is disassembled for any of the maintenance tasks in this work package, replace the drive sleeve, seal seat, seal assembly, and housing gasket regardless of their condition. These components are included in the seal repair kit. The pump overhaul kit includes these components plus the impeller, wear plate, and wear plate mounting screws and gaskets.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0058 00**
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REPAIR

P-7 and P-8 Pump Overhaul:

Parts (TM 10-4610-309-24P):
- Kit, Pump Overhaul
- Flapper Assembly
- Outlet Flange Gasket

Materials:
- Cloth, Abrasive (WP 0079, Table 1, item 10)
- Corrosion Preventive Compound (WP 0079, Table 1, item 12)
- Glycerin (WP 0079, Table 1, item 14)
- Sealing compound (WP 0079, Table 1, item 25)
- Clean, dry rags (WP 0079, Table 1, item 23)

Equipment Condition:
- Pump assembly removed from service and drained.

This section provides instructions for overhauling the P-7 or P-8 (Army TWPS only) pump by replacing the internal components. The pump should be overhauled if its flow rate has noticeably decreased, or if inspection of the pump during disassembly for some other maintenance task (such as engine/motor replacement) shows that the impeller or wear plate is damaged or badly corroded. Additional instructions in this section describe how to replace the pump inlet flapper assembly and the outlet flange gasket.

NOTE

Whenever the P-7 or P-8 pump is disassembled for any of the maintenance tasks in this work package, replace the drive sleeve, seal seat, seal assembly, and housing gasket regardless of their condition. These components are included in the seal repair kit. The pump overhaul kit includes these components plus the impeller, wear plate, and wear plate mounting screws and gaskets.

1. (P-8 Pump Skid only) Remove the fuel tank assembly from the skid as follows (see Figure 7):
   a. Close the fuel tank fuel cock.
   b. Uncouple the fuel supply and return line quick disconnect couplings.
   c. Lift the fuel tank assembly off the skid.

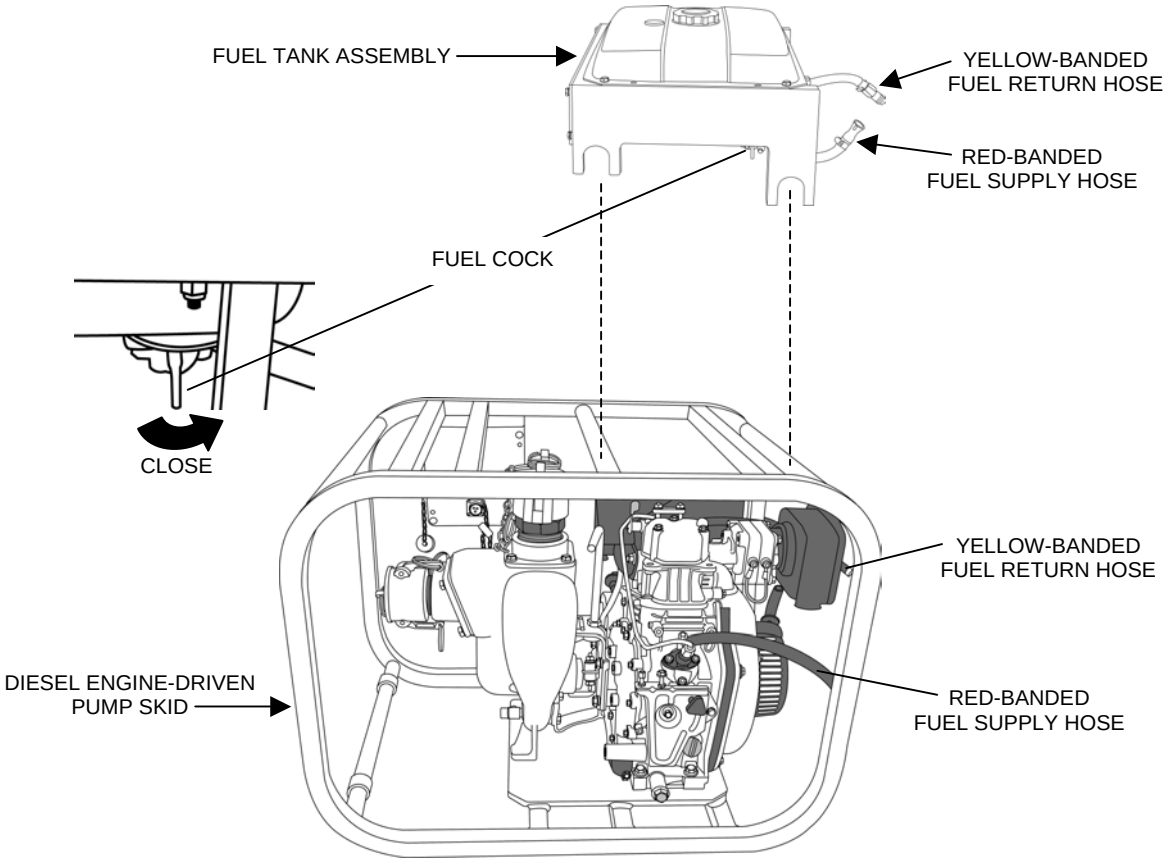

Figure 7. Extended Distribution Pump P-8 Skid Fuel Tank Assembly Removal.

2. Remove the pump from the diesel engine (P-8 Pump skid) or remove the pump from the motor (P-7 Pump skid) as follows (see Figure 8):
    a. Open the pump drain valve and drain any remaining water from the pump.
    b. Remove the six nuts that attach the pump housing to the adapter.
    c. Loosen and remove the pump housing and gasket. Discard the gasket.
    d. Remove and discard the coupling clamp assembly.
    e. Carefully pry the drive sleeve/impeller assembly off of the diesel engine (P-8) or electric motor (P-7) drive shaft. Discard the drive sleeve/impeller assembly.
    f. Remove the four cap screws, four lock washers, and four flat washers that attach the adapter to the diesel engine (P-8), or the four cap screws and four lock washers that attach the adapter to the electric motor (P-7) and remove the adapter.
    g. Push the seal seat out of the adapter and discard the seal seat.
    h. Remove and discard the two acorn nuts and two gaskets from the back of the pump housing.
    i. Remove and discard the two flat head screws and the wear plate.

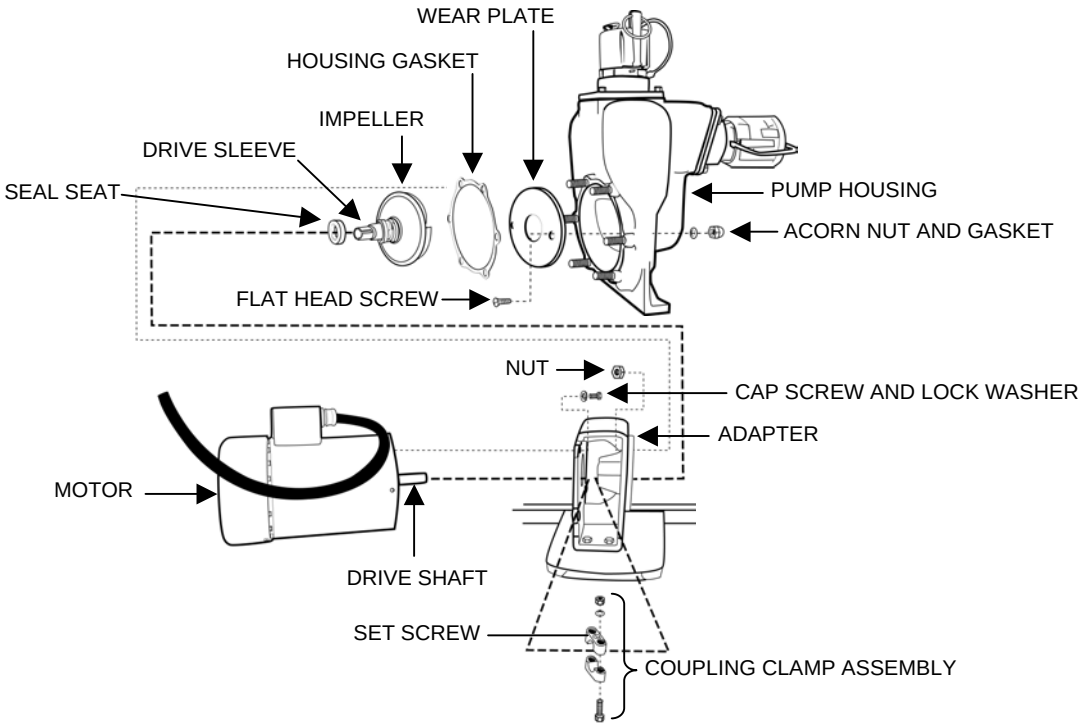

Figure 8. P-8 and P-7 Pump, Adapter, and Wear Plate Removal.

3. Assemble the pump with replacement parts as follows (see Figure 9):
    a. Insert the new wear plate into the pump housing and secure it to the housing with the new flat head screws and gaskets and the acorn nuts.
    b. Insert the new drive sleeve into the new impeller and secure it to the impeller using the impeller lock nut.
    c. Lubricate the inner diameter of the new seal assembly with glycerin or a comparable lubricant.
    d. With the rubber boot end of the seal assembly toward the impeller, twist and slide the seal assembly onto the drive sleeve.
    e. Clean the adapter bore and mounting faces.
    f. Clean the new seal seat and lubricate it with glycerin or a comparable lubricant.
    g. Insert the beveled end of the seal seat into the bore of the adapter and press it in until it is seated.

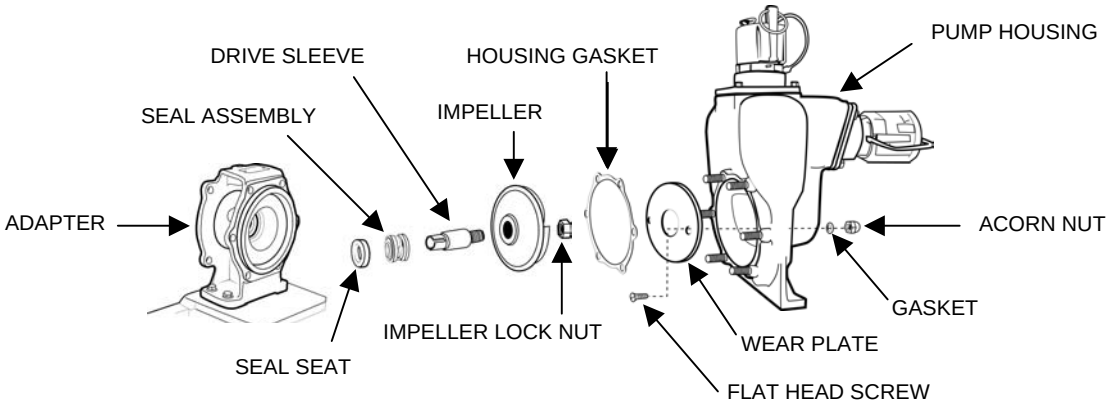

Figure 9. P7/P8 Pump Assembly.

4. Install the adapter and pump onto the diesel engine (P-8) or the electric motor (P-7) as follows (see Figure 10):
    a. Polish the engine/motor drive shaft with a fine abrasive cloth to remove any rust or corrosion.
    b. Attach the adapter to the engine (P-8) using the four cap screws, four lock washers, and four flat washers or attach the adapter to the motor (P-7) using the four cap screws and four lock washers.
    c. Lubricate the engine/motor drive shaft and the inside diameter of the new drive sleeve with corrosion preventive compound.
    d. Slide the new impeller and drive sleeve assembly onto the drive shaft.
    e. Install the coupling clamp assembly but do not tighten it.
    f. Place a new housing gasket between the adapter and the pump housing.
    g. Fit the pump onto the adapter and thread a nut on two opposing threaded studs to secure the pump to the adapter. Tighten the two nuts.

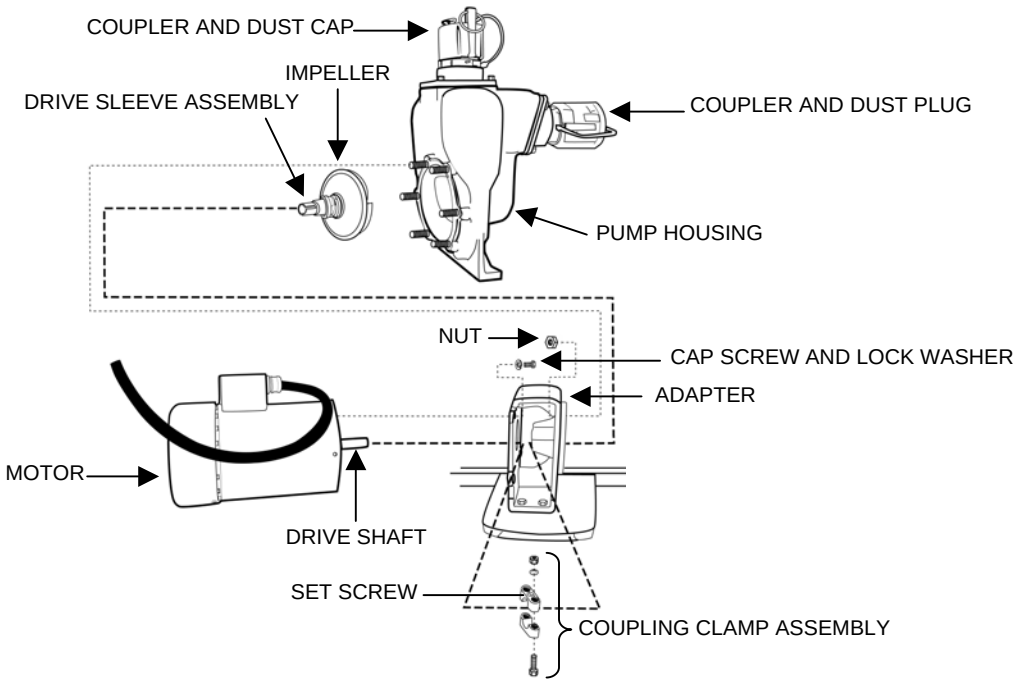

Figure 10. Pump P-7 Adapter and Pump Installation.

5. Set the gap between the impeller and the pump wear plate as follows (see Figure 11):
    a. Remove the four cap screws and four lock washers that secure the outlet flange to the pump housing.
    b. Carefully remove the pump flange to avoid damaging the gasket between the flange and the pump housing.
    c. If the gasket is damaged, replace it.
    d. Look through the outlet into the pump. Turn the impeller drive sleeve and impeller by hand until you see the impeller near the wear plate.
    e. Insert a 0.015 – inch feeler gauge between the impeller and wear plate. Move the impeller forward or backward as needed to provide a gap of 0.015 to 0.017-inch.
    f. Make sure the coupling clamp set screw, a drive sleeve slat, and the motor shaft keyway are aligned.
    g. Tighten the coupling clamp assembly to secure the impeller drive sleeve to the engine/motor drive shaft.
    h. Turn the drive shaft slowly to rotate the impeller and make sure that there is a minimum gap of 00.015-inch through the entire rotation of the impeller as follows:
        1) Turn the diesel engine (P-8) drive shaft by slowly pulling on the hand starter.
        2) Turn the electric motor (P-7) drive shaft by hand.
    i. Torque the coupling clamp nuts to 216 in.-lbs.
    j. Tighten the coupling clamp set screw into the drive shaft keyway.

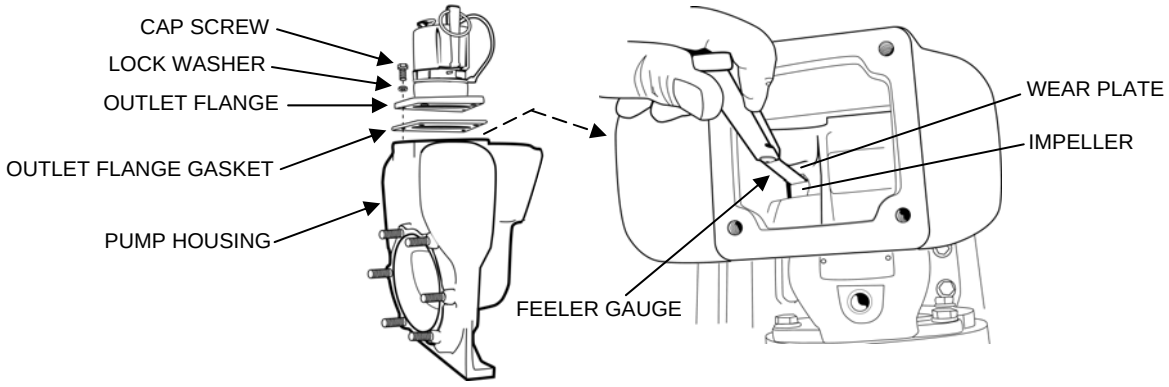

Figure 11. Pump Impeller Clearance Adjustment.

6. Complete the installation as follows:
    a. Apply sealing compound to the threads of the remaining four threaded studs extending from the pump housing through the adapter (WP 0079, Table 1, item 35). Install the nuts onto the studs.
    b. Remove the two nuts initially installed onto opposing studs. Apply sealing compound to the stud threads and reinstall the nuts (WP 0079, Table 1, item 35).
    c. Reinstall the pump outlet flange and gasket.
7. Connect the motor cable to the proper receptacle on the junction box.
8. Place the pump back into service and check it for leaks and proper operation.

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Inlet Flapper or Outlet Flange Gasket Replacement

Replace the inlet flapper assembly on the P-7 or P-8 pump as follows (see Figure 12):

1. Remove the four cap screws and four lock washers that attach the inlet flange to the pump housing.
2. Remove the inlet flange and the flapper assembly.
3. Clean the flange and pump housing surfaces that come in contact with the flapper assembly.
4. Install the new flapper assembly, making sure the flapper opens into the pump housing.
5. Reattach the inlet flange using the four cap screws and four lock washers.

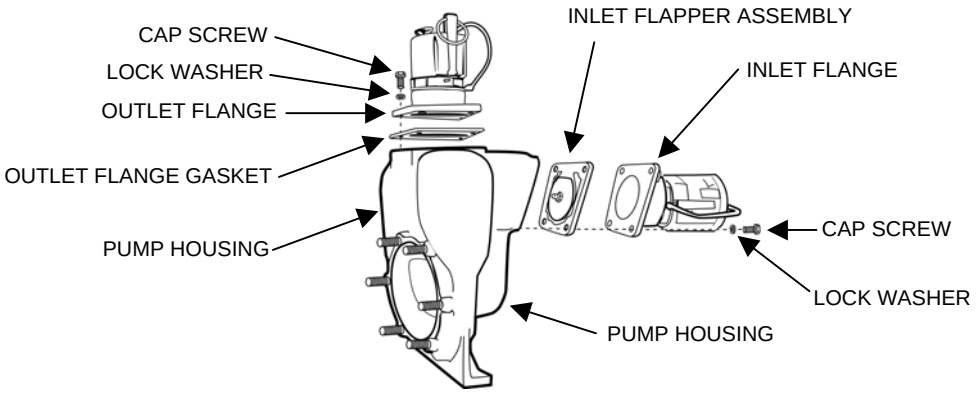

Figure 12. P-7/P8 Pump Inlet Flange Flapper Assembly and Outlet Flange Gasket Replacement.

Replace the outlet flange gasket on the P-7 or P-8 pump as follows (see Figure 12):

1. Remove the four cap screws and four lock washers that attach the outlet flange to the pump housing.
2. Remove the outlet flange and gasket.
3. Clean the flange and pump housing surfaces that come in contact with the gasket.
4. Install the new gasket.
5. Reattach the outlet flange using the four cap screws and four lock washers.
6. Place the pump back into service and inspect it for proper rotation and leaks.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) UNIT MAINTENANCE PROCEDURES OPERATING CONTROL SYSTEM TOP PANEL

0059 00

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

GENERAL:

This work package contains information and instructions for replacing components on the operating control panel top panel of the TWPS. The procedures covered in this work package include:

- Light Bulb Replacement
- Pilot Light Replacement
- Hour Meter Replacement
- Digital Display Replacement
- Rotary Switch Replacement
- Illuminated Push Button Replacement
- Push Button Replacement
- Selector Switch Replacement
- Emergency Stop Push Button Replacement
- Alarm Horn Replacement
- 10-Turn Potentiometer Replacement
- 1000 Ohm Potentiometer Replacement
- Computer Cable Assembly Replacement

REMOVE
In order to replace the components on the OCP (operator control panel), with the exception of light bulb replacement, it is necessary to open the control panel and remove the protective box covering the components at the back of the panel. Remove the protective box as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before opening the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before opening the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.

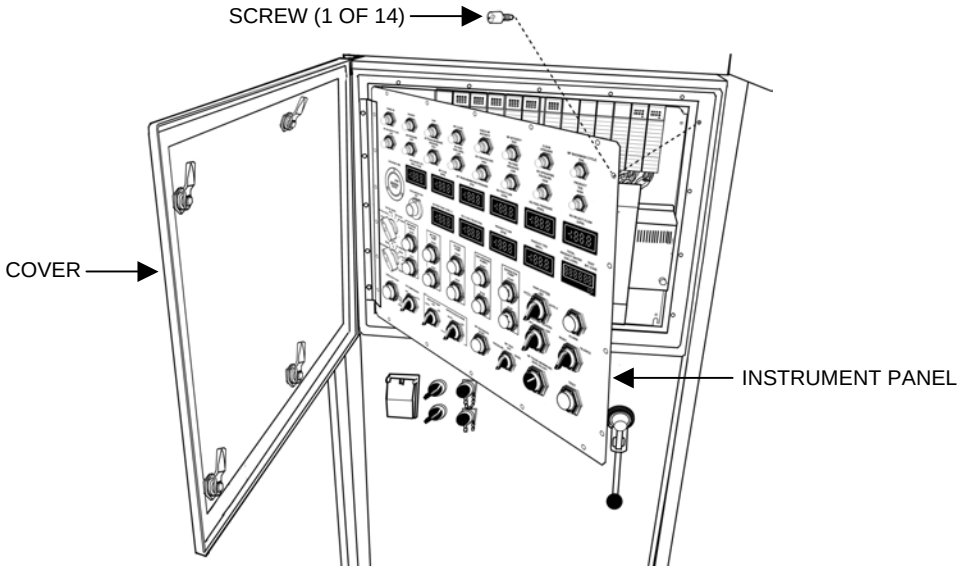

Figure 1. Opening the OCP Instrument Panel.

3. Remove the 24 nuts that secure the protective box to the back of the OCP instrument panel and lift the box off (see Figure 2).

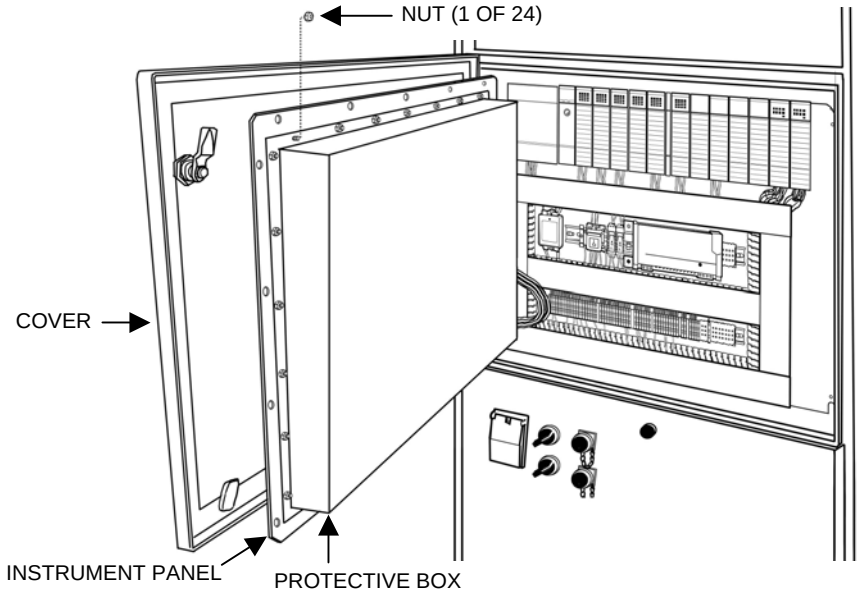

Figure 2. Box Removal from the Back of the OCP Instrument Panel.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

REPLACE

Light Bulb Replacement:

Parts (TM 10-610-309-24P):
Light bulb, green
Light bulb, red
Light bulb, amber
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a light bulb on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct color and type of light bulb before replacing the bulb.

1. Remove a light bulb from pilot light, emergency stop push button or selector switch as follows (see Figure 3):
   a. Open the OCP top panel; locate the light bulb to be replaced.
   b. Turn lens, push button knob or switch knob counterclockwise and remove.
   c. Push light bulb inward, turn counterclockwise and remove.

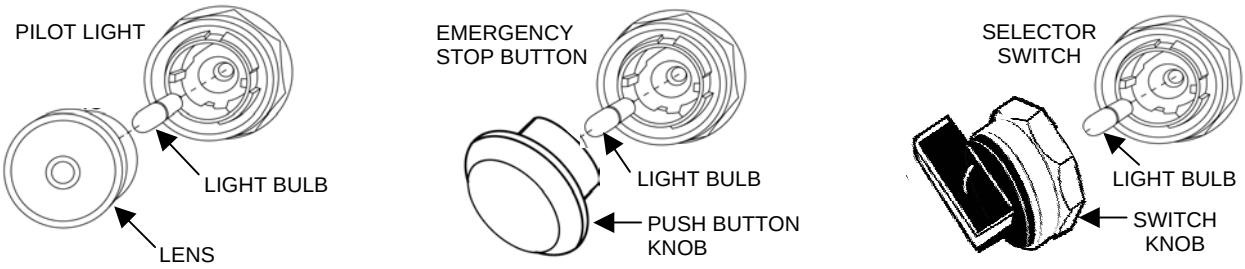

Figure 3. Light Bulb Replacement

2. Install a new light bulb as follows:
   a. Insert the new light bulb in its socket and turn clockwise
   b. Inspect lens for cracks and damage or missing seal. Replace if necessary.
   c. Insert the lens, button knob or switch knob in its socket over the light bulb and turn clockwise until secured.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

Pilot Light Replacement:

Parts (TM 10-610-309-24P):
- Pilot light, green
- Pilot light, red
- Pilot light, amber
- EMI gasket

Equipment Condition:
- Army TWPS: Generator off and TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Replace a pilot light on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct color pilot light before replacing the light.

1. Remove a pilot light as follows (see Figure 4):
   a. Open the OCP top panel, remove the protective box, locate the pilot light to be replaced.
   b. Tag the wires attached to the pilot light.
   c. Loosen the screw connections and remove the connecting wires.
   d. Remove the ring nut, locking washer, sealing washer and EMI gasket.
   e. Remove the pilot light from the control panel.

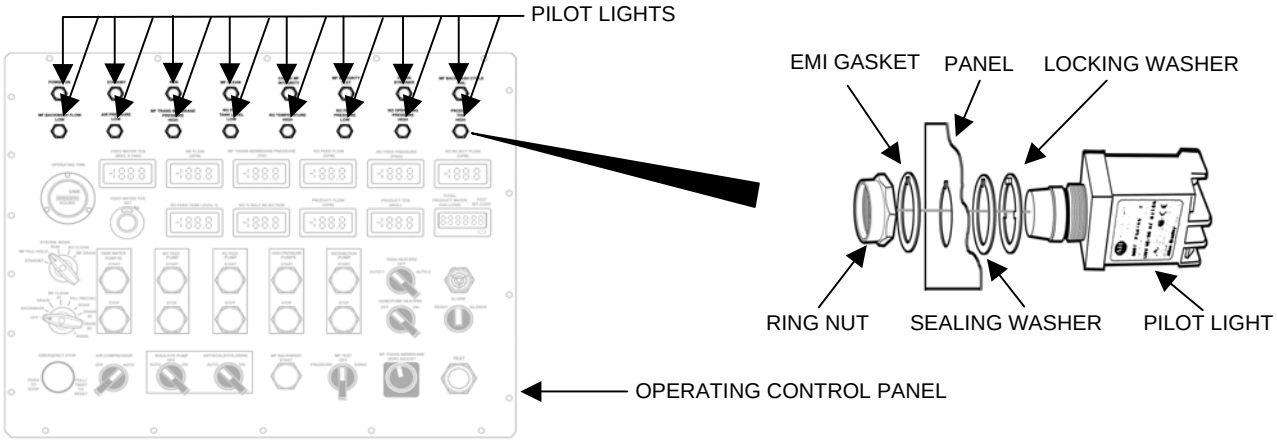

Figure 4. Pilot Light Assembly Removal.

2. Install a new pilot light as follows:
    a. Position the new pilot light, ring nut, locking washer; sealing washer and EMI gasket in the panel.
    b. Tighten the ring nut to secure the pilot light.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Reinstall the protective box, close and secure the operating control panel top panel.

Hour Meter Replacement:

Parts (TM 10-610-309-24P):
Hour meter
EMI gasket
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the hour meter on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the hour meter as follows (see Figure 5):
    a. Open the OCP top panel, remove the protective box and locate the hour meter.
    b. Tag the wires attached to the hour meter.
    c. Carefully pull the female connector wires from the hour meter blade terminals.
    d. Remove the three screws, washers, lock washers, and nuts that secure the hour meter to the panel and retain for reassembly.
    e. Remove the hour meter and EMI gasket from the control panel.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

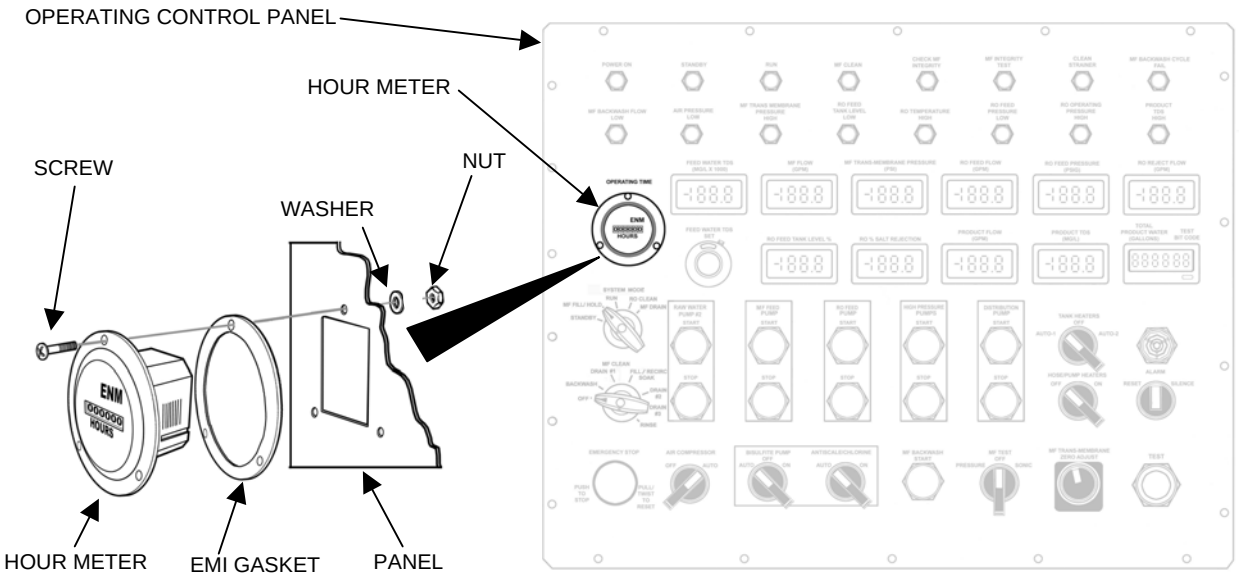

Figure 5. Hour Meter Assembly Replacement .

2. Install the new hour meter as follows:
    a. Position the new hour meter and EMI gasket in the panel.
    b. Secure the new hour meter to the panel using the three screws, washers, lock washer and nuts.
    c. Connect the connector wires to the blade terminals in accordance to the wire tags.
    d. Remove the wire tags if necessary.
    e. Reinstall the protective box, close and secure the operating control panel top panel.

Digital Display Replacement:

Parts (TM 10-610-309-24P)
Digital display
Digital display with reset
EMI gasket
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a digital display (current condition digital display) on the operating control panel top panel as follows:

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of display before replacing the display.

1. Remove a digital display as follows (see Figure 6):
   a. Open the OCP top panel, remove the protective box and locate the digital display to be replaced.
   b. Tag the wires attached to the digital display.
   c. Loosen the screw connections and remove the connecting wires.
   d. Remove the two mounting screws and nut fasteners at the rear of the digital display and remove the mounting clip.
   e. Remove the bezel from the rear of the digital display.
   f. Remove the digital display and EMI gasket from the control panel.

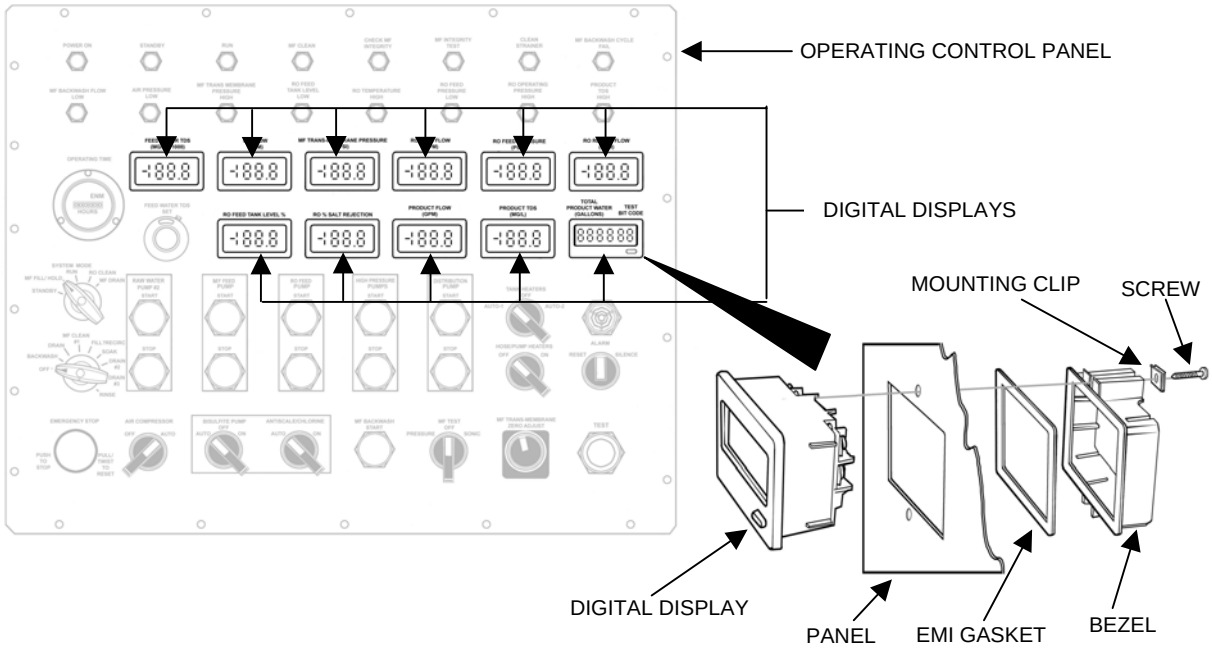

Figure 6. Digital Display Replacement.

2. Configure new digital display as follows:
   a. To set the digital display to the required 19.99mA current range, position the jumper over the top two pins on the second male header strip as indicated in Figure 7.

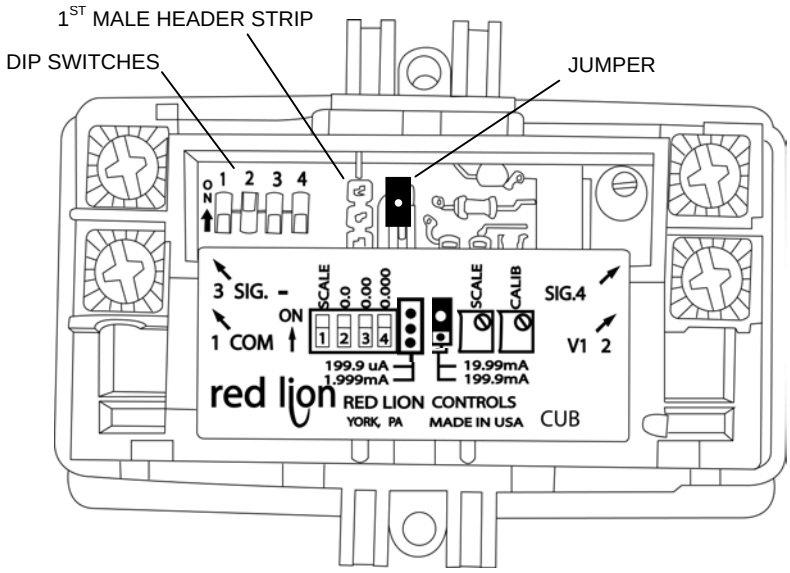

Figure 7.Digital Display Settings

   b. To display the proper decimal place, set dip switches 1 thru 4 in accordance with the associated display name labeled on the panel as called out in Table 1.

Table 1. Dip Switch Settings.

Display Name	Dip Switch			
	1	2	3	4
Feed Water TDS	OFF	ON	OFF	OFF
MF Flow	OFF	OFF	OFF	OFF
MF TMP	OFF	ON	OFF	OFF
RO Feed Flow	OFF	ON	OFF	OFF
RO Feed Pressure	OFF	OFF	OFF	OFF
RO Reject Flow	OFF	ON	OFF	OFF
RO Tank Level	OFF	ON	OFF	OFF
% Salt Rejection	OFF	ON	OFF	OFF
Product Flow	OFF	ON	OFF	OFF
Product TDS	OFF	OFF	OFF	OFF
Total Product Water	No Settings Required			

3. Install a new digital display as follows:
    a. Slide the nut fastener into the slot on the mounting clip and then insert the mounting screw through the nut on both sides of the mounting clip. The tip of the mounting screw should not project through the hole on clip.
    b. Slide the panel gasket over the rear of the new digital display to the back of the bezel.
    c. Position the digital display in the panel.
    d. Slide the mounting clip over the rear of the digital display until the clip is against the back of the panel.
    e. Hold the digital display in place while alternately tightening the two mounting screws to ensure uniform gasket pressure.
    f. Attach the wires to the screw connections in accordance to the wire tags.
    g. Tighten the screw connections to secure the wires.
    h. Remove the wire tags if necessary.
    i. Reinstall the protective box, close and secure the operating control panel top panel.

Rotary Switch Replacement:

Parts (TM 10-610-309-24P):
Rotary switch
Switch knob
Equipment Conduction:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a rotary switch on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove a rotary switch as follows (see Figure 8):
    a. Open the OCP top panel, remove the protective box and locate the rotary switch to be replaced.
    b. Tag the wires attached to the rotary switch.
    c. Loosen the screw connections and remove the connecting wires.
    d. Remove the switch knob.
    e. Remove mini screw from shaft attachment; slide attachment off rotary switch shaft.
    f. Remove the ring nut that secures the rotary switch to the panel.
    g. Remove the rotary switch from the control panel.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

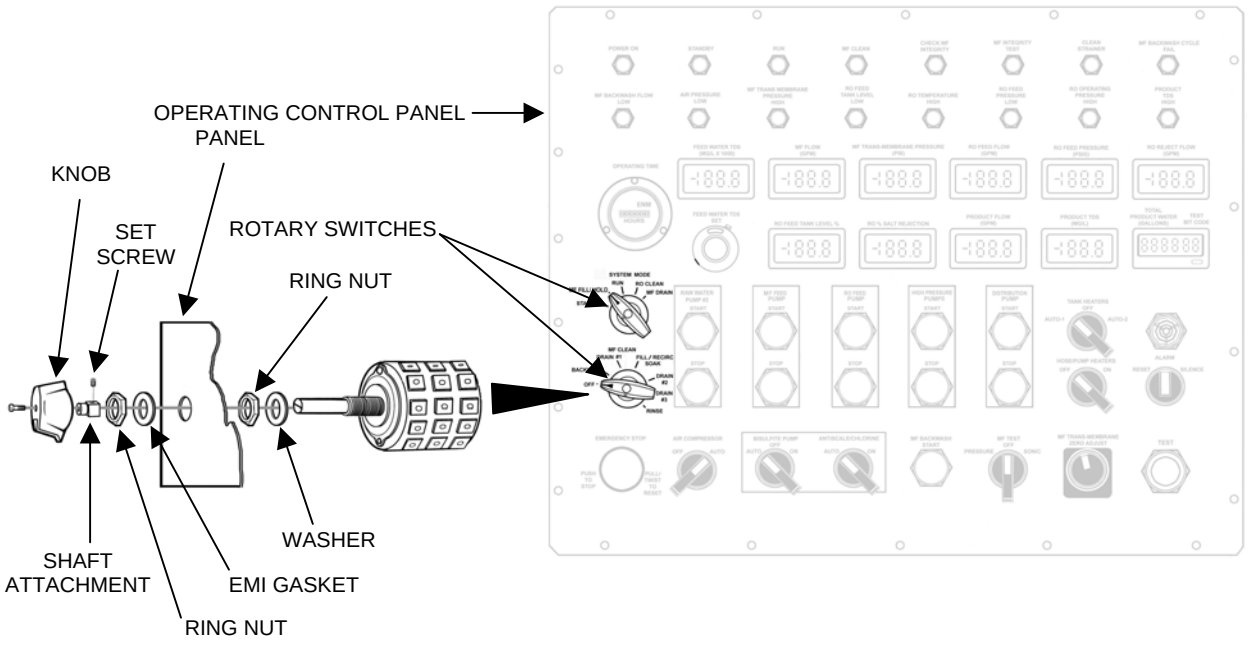

Figure 8. Rotary Switch Assembly Replacement.

2. Install a new rotary switch as follows:
    a. Position the new rotary switch in the panel with washer and back ring nut.
    b. Position the EMI gasket through the shaft to the panel.
    c. Tighten the front ring nut to secure the rotary switch to the panel.
    d. Slide the shaft attachment on the shaft and secure with mini screw.
    e. Install the new switch knob.
    f. Make any adjustments to knob and rotary switch to align with selections on panel.
    g. Attach the wires to the screw connections in accordance to the wire tags.
    h. Tighten the screw connections to secure the wires.
    i. Remove the wire tags if necessary.
    j. Reinstall the protective box, close and secure the operating control panel top panel.

Push Button Replacement:

Parts (TM 10-610-309-24P):
Push Button, illuminated, red
Push Button, illuminated, green
Gray Push Button
EMI gasket
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

Replace a push button on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct color illuminated push button before replacing a push button.

1. Remove a push button as follows (see Figure 9):
   a. Open the OCP top panel, remove the protective box and locate the push button to be replaced.
   b. Tag the wires attached to the push button.
   c. Loosen the screw connections and remove the connecting wires.
   d. Remove the ring nut that secures the push button to the panel.
   e. Remove the push button, sealing washer, rubber washer, locking washer and EMI gasket from the control panel.

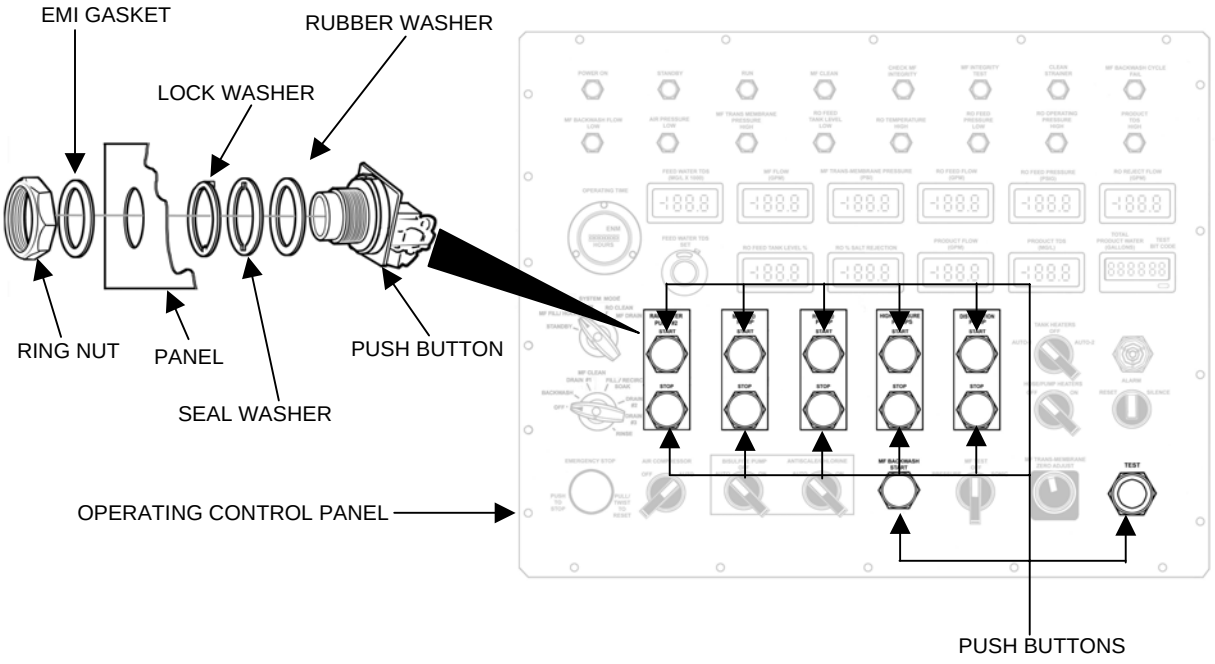

Figure 9. Push Button Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

2. Install a new push button as follows:
    a. Position the new push button, rubber washer, locking washer, sealing washer and EMI gasket in the panel.
    b. Tighten the ring nut to secure the push button switch to the panel.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Reinstall the protective box, close and secure the operating control panel top panel.

Selector Switch Replacement:

Parts (TM 10-610-309-24P):
Selector Switch, 3 position
Selector Switch, 2 position
Selector Switch, 2 position, spring return
EMI gasket
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a selector switch on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct type selector switch before replacing the switch.

1. Remove a selector switch as follows (see Figure 10):
    a. Open the OCP top panel, remove the protective box and locate the selector switch to be replaced.
    b. Tag the wires attached to the selector switch.
    c. Loosen the screw connections and remove the connecting wires.
    d. Remove the knob with the ring nut that secures the selector switch to the panel.
    e. Remove the selector switch, rubber washer, locking washer, sealing washer and EMI gasket from the control panel.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

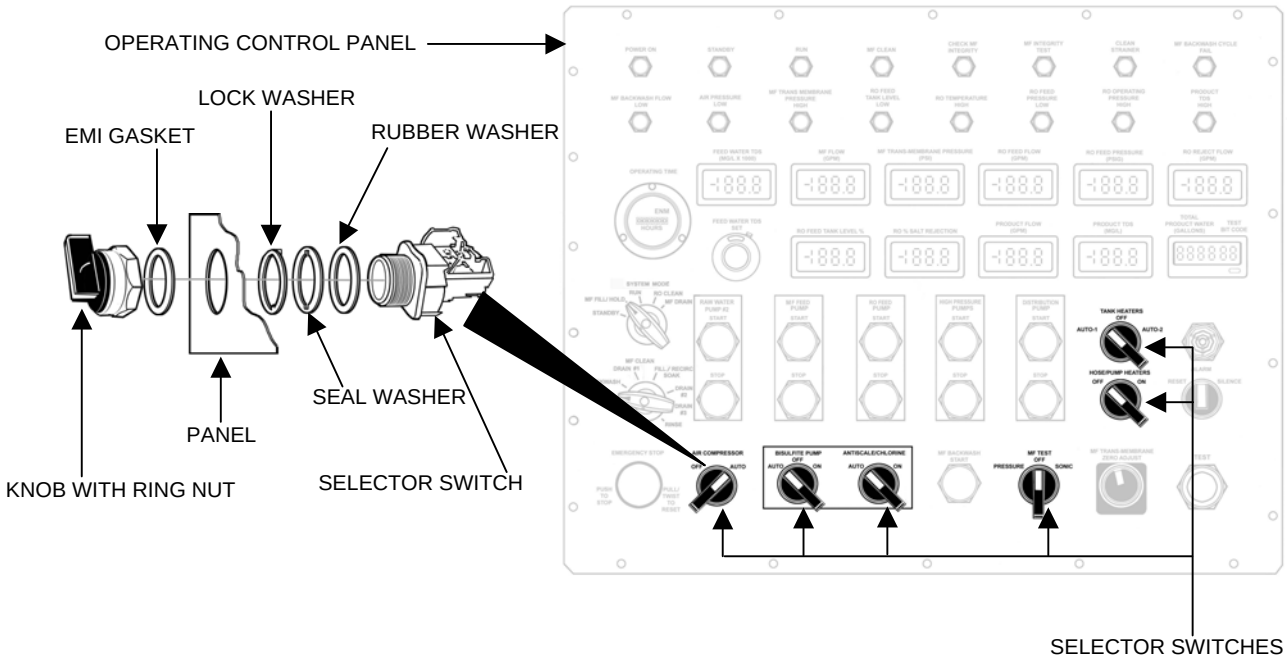

Figure 10. Selector Switch Replacement.

2. Install a new selector switch as follows:
    a. Position the new selector switch, rubber washer, locking washer, sealing washer and EMI gasket in the panel.
    b. Secure the selector switch to the panel using the ring nut with the knob.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Reinstall the protective box, close and secure the operating control panel top panel.

Emergency Stop Push Button Replacement:

Parts (TM 10-610-309-24P):
    Push Button, Emergency Stop
    EMI gasket
Equipment Condition:
    Army TWPS: Generator off and TWPS main breaker off
    Marine Corps TWPS: TWPS disconnected from power source

Replace the emergency stop push button on the operating control panel top panel as follows:

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UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the emergency stop push button as follows (see Figure 11):
    a. Open the OCP top panel, remove the protective box and locate the emergency stop push button.
    b. Tag the wires attached to the push button.
    c. Loosen the screw connections and remove the connecting wires.
    d. Remove the plastic mushroom cap from the front of the panel.
    e. Remove the ring nut that secures the push button to the panel.
    f. Remove the push button, rubber washers, locking washer, seal washer and EMI gasket from the control panel.

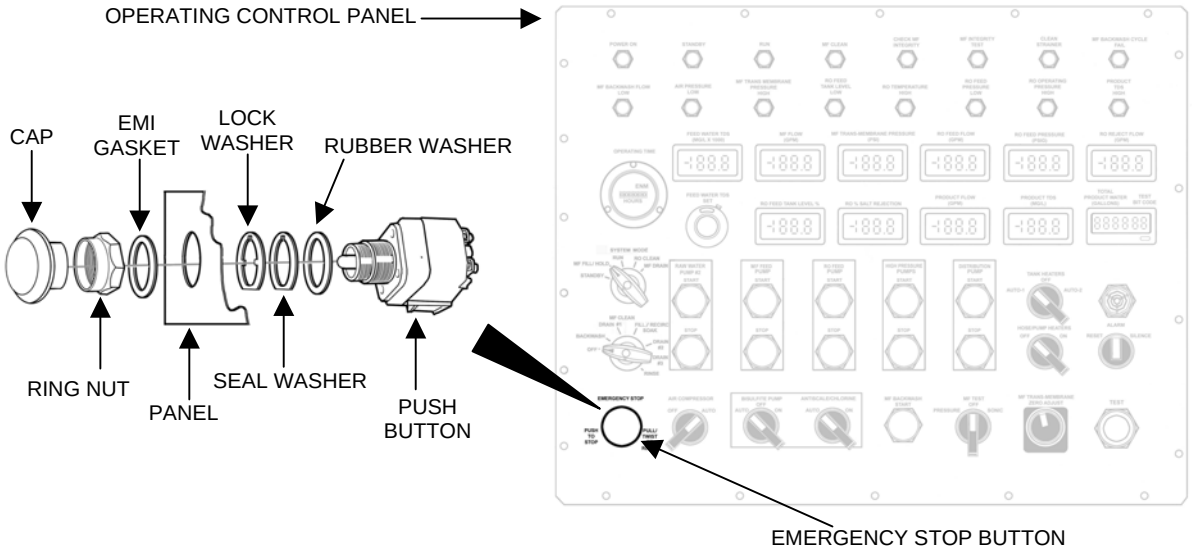

Figure 11. Emergency Stop Button Replacement.

2. Install the new emergency stop push button as follows:
    a. Position the new push button, rubber washers, locking washer and EMI gasket in the panel.
    b. Tighten the ring nut to secure the push button switch to the panel.
    c. Attach the plastic mushroom cap to the front of the switch.
    d. Attach the wires to the screw connections in accordance to the wire tags.
    e. Tighten the screw connections to secure the wires.
    f. Remove the wire tags if necessary.
    g. Reinstall the protective box, close and secure the operating control panel top panel.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

Alarm Horn Replacement:

Parts:
Alarm Horn (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the alarm horn on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the alarm horn as follows (see Figure 12):
   a. Open the OCP top panel, remove the protective box and locate the alarm horn.
   b. Tag the wires attached to the alarm horn.
   c. Loosen the screw connections and remove the connecting wires.
   d. Remove the plastic ring nut from the front of the alarm horn.
   e. Remove the alarm horn from the control panel.

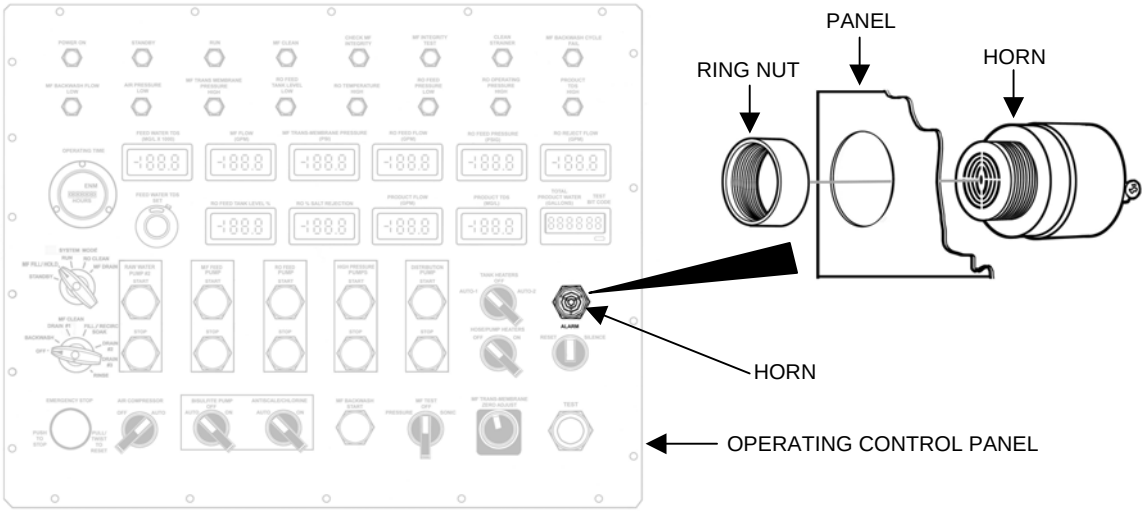

Figure 12. Alarm Horn Assembly Replacement.

2. Install the new alarm horn as follows:
    a. Position the alarm horn in the panel.
    b. Install and tighten the new plastic ring nut to secure the alarm horn to the panel. Do not over-tighten.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Reinstall the protective box, close and secure the operating control panel top panel.

10-Turn Potentiometer Replacement:

Parts (TM 10-610-309-24P):
Potentiometer, 10-turn, precision
Counting Dial
Material:
Soldering iron
Solder
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the precision 10-turn potentiometer on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the potentiometer as follows (see Figure 13):
    a. Open the OCP top panel, remove the protective box and locate the 10-turn potentiometer.
    b. Tag the wires attached to the potentiometer.
    c. Unsolder the wires from the solder lugs and remove the connecting wires.
    d. Loosen the setscrew in the knob of the counting dial.
    e. Remove the dial by gently pulling the dial while turning it clockwise.
    f. Remove the ring nut that secures the potentiometer to the panel.
    g. Remove the lock washer and key washer from the shaft.
    h. Remove the potentiometer from the control panel.

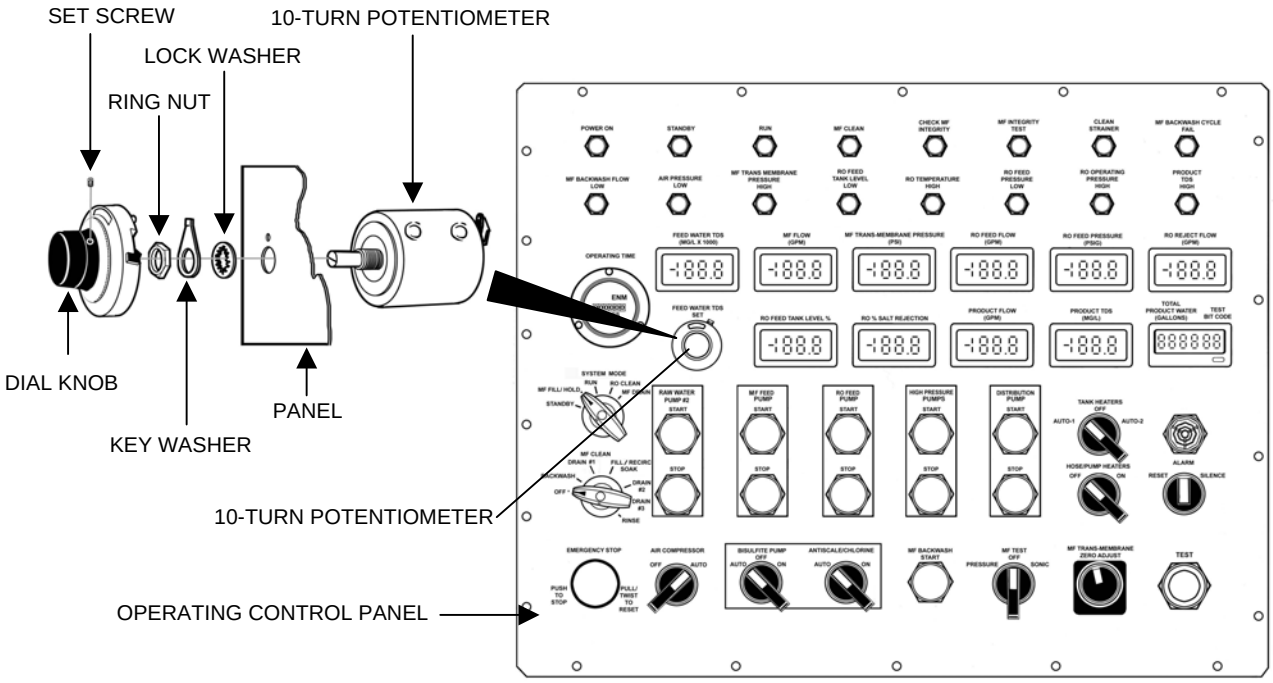

Figure 13. 10-Turn Potentiometer Assembly Replacement.

2. Install the new 10-turn potentiometer as follows:
    a. Position the potentiometer in the panel.
    b. Position the lock washer and key washer on the shaft.
    c. Install and tighten the ring nut to secure the potentiometer to the panel.
    d. Turn the potentiometer shaft counterclockwise to obtain minimum resistance or voltage ratio.
    e. Loosen the setscrew in the knob of the new counting dial.
    f. Set the counting dial to a “0.0” reading.
    g. While holding the outer ring of the dial, position the dial against panel.
    h. Tighten the knob set screw to secure it to the potentiometer shaft.
    i. Solder the wires to the solder lug connections in accordance to the wire tags.
    j. Remove the wire tags if necessary.
    k. Reinstall the protective box, close and secure the operating control panel top panel.

1000 Ohm Potentiometer Replacement:

Parts (TM 10-610-309-24P):
    Potentiometer, 1000 Ohm
    EMI Gasket
Equipment Condition:
    Army TWPS: Generator off and TWPS main breaker off
    Marine Corps TWPS: TWPS disconnected from power source

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

Replace the MF trans-membrane potentiometer on the operating control panel top panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

a. Remove the 1000 ohm potentiometer as follows (see Figure 14):
   a. Open the OCP top panel, remove the protective box and locate the 1000 ohm potentiometer.
   b. Tag the wires attached to the potentiometer.
   c. Loosen the screw connections and remove the connecting wires.
   d. Remove the ring nut that secures the potentiometer to the panel.
   e. Remove dial plate and EMI gasket from the front of the panel.
   f. Remove the potentiometer with dial nut, rubber washer, key washer, and locking washer from the back of the control panel.

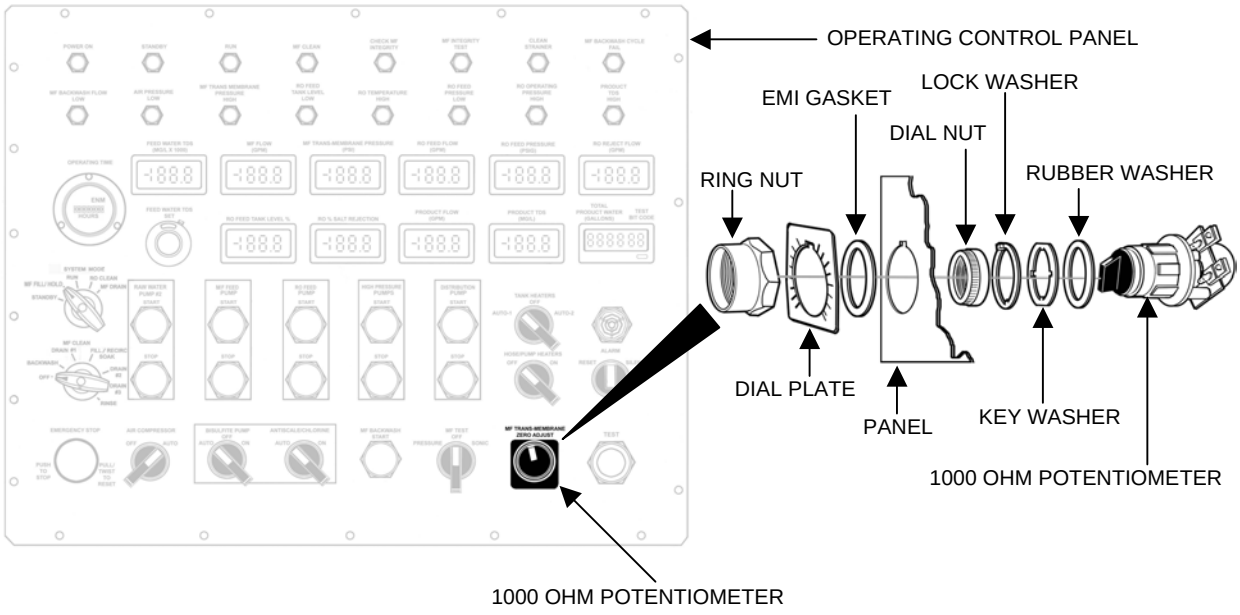

Figure 14. 1000 Ohm Potentiometer Assembly Replacement.

b. Install the new 1000 ohm potentiometer as follows:
    a. Position the rubber washer, locking washer and key washer with the dial nut on the new potentiometer.
    b. Insert the potentiometer through the back of the panel.
    c. Position the EMI gasket and dial plate on potentiometer.
    d. Secure the potentiometer to the panel using the ring nut
    e. Attach the wires to the screw connections in accordance to the wire tags.
    f. Tighten the screw connections to secure the wires.
    g. Remove the wire tags if necessary.
    h. Reinstall the protective box, close and secure the operating control panel top panel.

Computer Cable Assembly Replacement:

Parts (TM 10-610-309-24P):
OCP Computer Serial Port Cable Assembly
OCP Computer Program Port Cable Assembly
Gasket
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replacing the computer cable assembly as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of cable before replacing push button.

1. Remove computer cable as follows (see Figure 15):
    a. Locate the computer cable assembly on the outside of the OCP box.
    b. Remove the four screws washers and lock nuts securing the cable connector to the OCP box and retain for reassembly.
    c. Remove the dust cap and retain for reassembly.
    d. Open the OCP top panel to the sub panel.
    e. Open the processor module compartment door.
    f. Remove the wire duct covers below and left of the processor module.
    g. Disconnect the wiring harness of the cable assembly to be removed from the processor module.
    h. Carefully pull the cable assembly through the OCP box and remove the cable assembly.
    i. Remove gasket from OCP Box.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0059 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM TOP PANEL

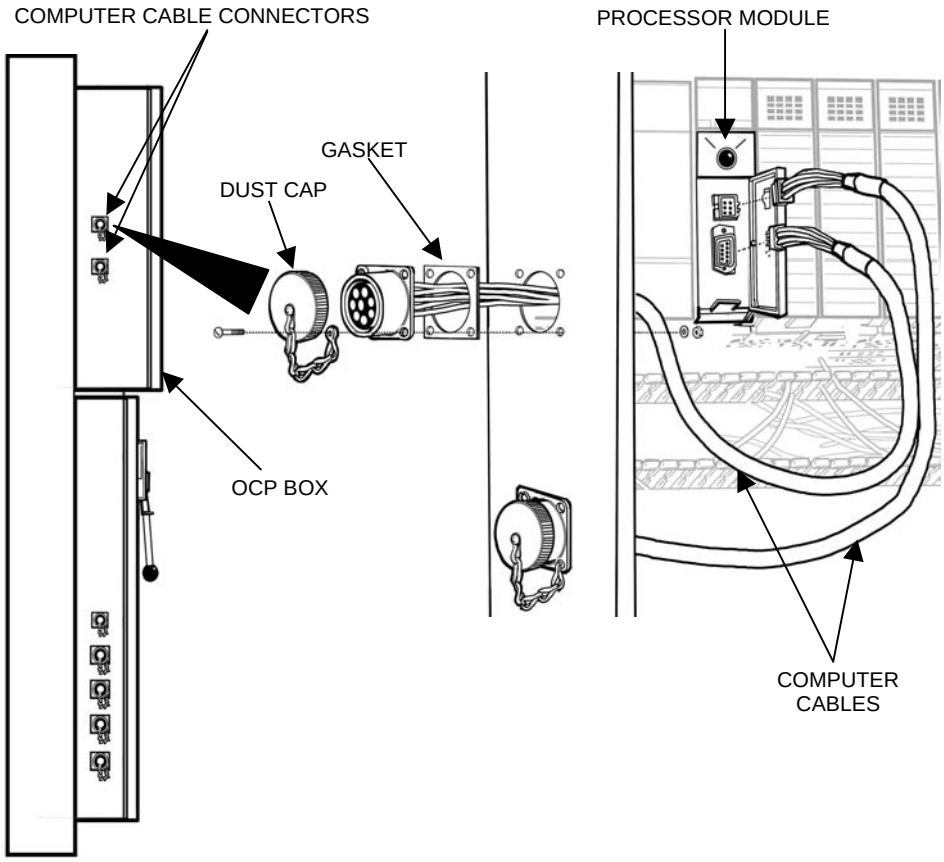

Figure 15. Computer Cable Assembly Replacement.

2. Install new computer cable assembly as follows:
    a. Position the new gasket through the harness end of the new cable assembly up to the connector end of the cable assembly.
    b. Insert the harness end of the cable assembly through the connector hole of the OCP box and feed up to the processor module.
    c. Align the gasket and the connector with screw holes on the OCP box.
    d. Position the end of dust cover chain on one of screw holes with the connector and gasket.
    e. Secure the connector, gasket and dust cover chain to the OCP box using the four screws, washers and lock nuts.
    f. Connect the harness end of the cable to the connector of the processor module.
    g. Close processor module compartment door.
    h. Replace wire duct covers.
    i. Close sub panel door
    j. Close OCP top panel.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) UNIT MAINTENANCE PROCEDURES OPERATING CONTROL SYSTEM SUB PANEL

0060 00

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

GENERAL:

This work package contains information and instructions for replacing components in the operating control panel sub-panel. If you are unable to return a component or assembly to workable condition by following the procedure, notify Direct Support (DS) Maintenance. The procedures covered in this work package include:

- 13-Slot Chassis Power Supply Replacement
- PLC Processor and Memory Module Replacement
- AC Input Module Replacement
- Relay Output Module Replacement
- Triac Output Module Replacement
- Analog Output Module Replacement
- Analog Input Module Replacement
- 13-Slot Chassis Replacement
- 3-Pole Relay Replacement
- Time Delay Relay Replacement
- Power Line Filter Replacement
- Electric Heater Replacement
- Solid State Relay Replacement
- Circuit Breaker Replacement
- Instrumentation Power Supply Replacement
- DC Terminal Replacement
- AC Terminal Replacement
- Ground Terminal Replacement

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

REPLACE

13-Slot Chassis Power Supply Replacement:

Parts:
Power Supply, 13-Slot Chassis (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the 13-slot chassis power supply on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.

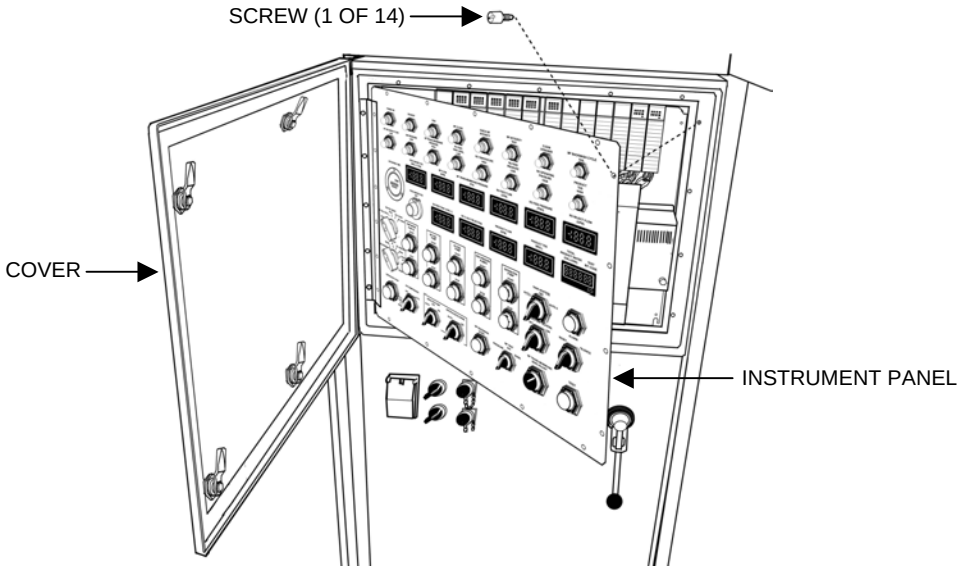

Figure 1. Opening the OCP Instrument Panel.

3. Remove the power supply as follows (see Figure 2):
    a. Locate the power supply mounted on the left side of the 13-slot chassis.
    b. Remove the wire duct cover below the 13-slot chassis.
    c. Open the compartment door of the power supply.
    d. Tag the wires connected to the power supply.
    e. Disconnect the wires connected to the power supply.
    f. Remove the two screws that secure the power supply to the 13-slot chassis and retain for reassembly.
    g. Remove the power supply from the 13-slot chassis.

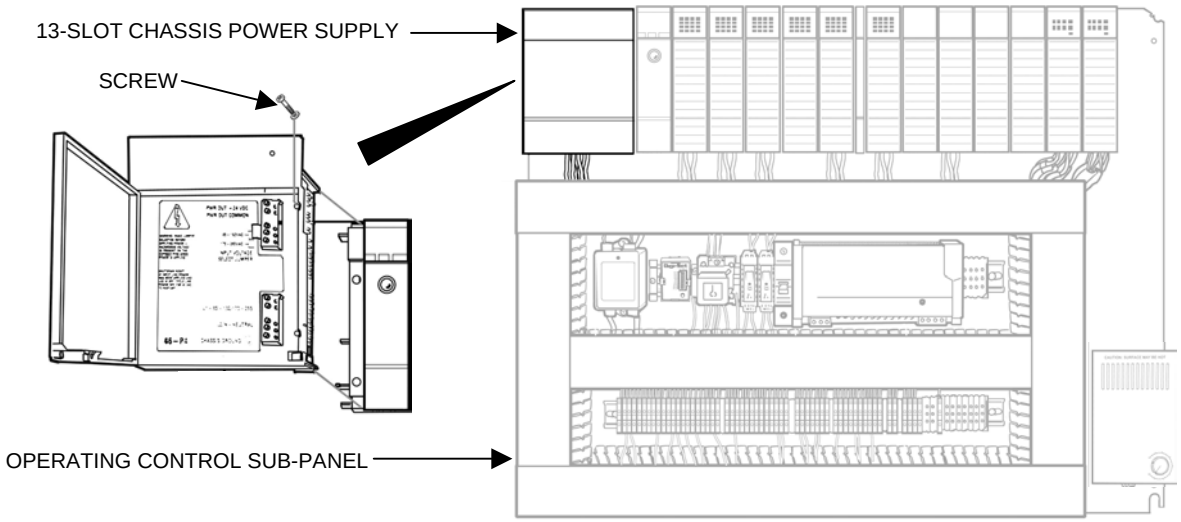

Figure 2. 13-Slot Chassis Power Supply Removal.

4. Install the new power supply as follows:
    a. Position the new power supply on the 13-slot chassis and press the power supply terminals into the 13-slot chassis slots.
    b. Secure the power supply to the chassis using the two screws.
    c. Connect the wires to the power supply in accordance with the wire tags.
    d. Remove the wire tags if necessary.
    e. Close the power supply compartment door.
    f. Reinstall the wire duct cover.
    g. Close and secure the OCP instrument panel using the 14 screws.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

PLC Processor Module and Memory Module Replacement:

Parts:
PLC processor (TM 10-610-309-24P)
Memory module (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the PLC processor module and/or the memory module inside the processor as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Locate the processor inside the 13-slot chassis that is to be replaced.
4. Remove the processor and memory module as follows (see Figure 3):

CAUTION

Electronic components are sensitive to electrical static. Discharge any electrical static before handling. Failure to do so may damage the components.

a. Touch any metal portion of the TWPS chassis to discharge any electrical static.
b. Open the compartment door of the processor.
c. Pull the upper terminal block with its connected wiring off the processor module.
d. Loosen the two screws that hold the lower terminal block in place then pull the lower terminal block off the processor module.
e. With one hand on each end of the processor, press the release tabs and evenly pull the processor out of the 13-slot chassis.
f. Locate the memory module on the processor.
g. Gently pull the memory module from the processor.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

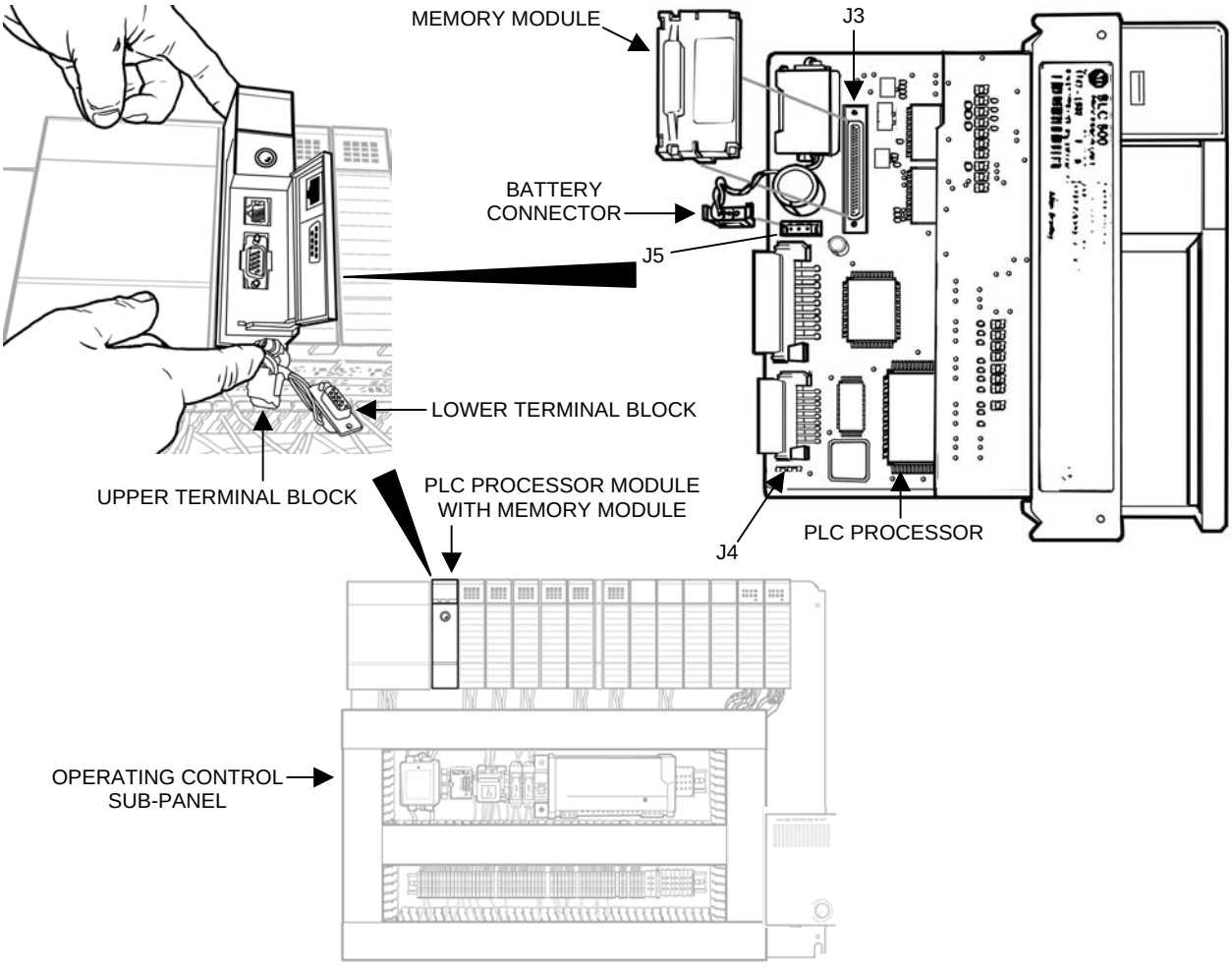

Figure 3. PLC Processor Module and Memory Module Replacement.

5. Install a new processor and/or memory module as follows:
    a. Connect the battery connector wire to J5 of the new processor.
    b. Place the jumper on pins 2 and 3 of J4 of the processor.
    c. Position the new memory module on J3 of the processor and press in place.
    d. Position the processor in the 13-slot chassis and press into place.
    e. Press the lower terminal block with its connected wiring onto the new processor module and secure it with the two screws.
    f. Press the upper terminal block with its connected wiring onto the new processor module.
    g. Close the processor compartment door.
    h. Close and secure the OCP instrument panel using the 14 screws.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

AC Input Module, Relay Output Module, or Triac Output Module Replacement:

Parts (TM 10-610-309-24P):
- AC input module
- Relay output module
- Triac output module

Equipment Condition:
- Army TWPS: Generator off and TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Replace the AC input module, the relay output module, or the triac output module on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of module before replacing.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove AC input module, relay output module, or triac output module as follows (see Figure 4):
   a. Locate the AC input module, relay output module, or triac output module inside the 13-slot chassis that is to be replaced.

CAUTION

Electronic components are sensitive to electrical static. Discharge any electrical static before handling. Failure to do so may damage the components.

   b. Touch any metal portion of the TWPS chassis to discharge any electrical static.
   c. Open the compartment door of the module.
   d. Loosen the top and bottom screws that hold the terminal block in place, then pull the terminal block with its connected wiring off the module.
   e. With one hand on each end of the module, press the release tabs and evenly pull the module out of the 13-slot chassis.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

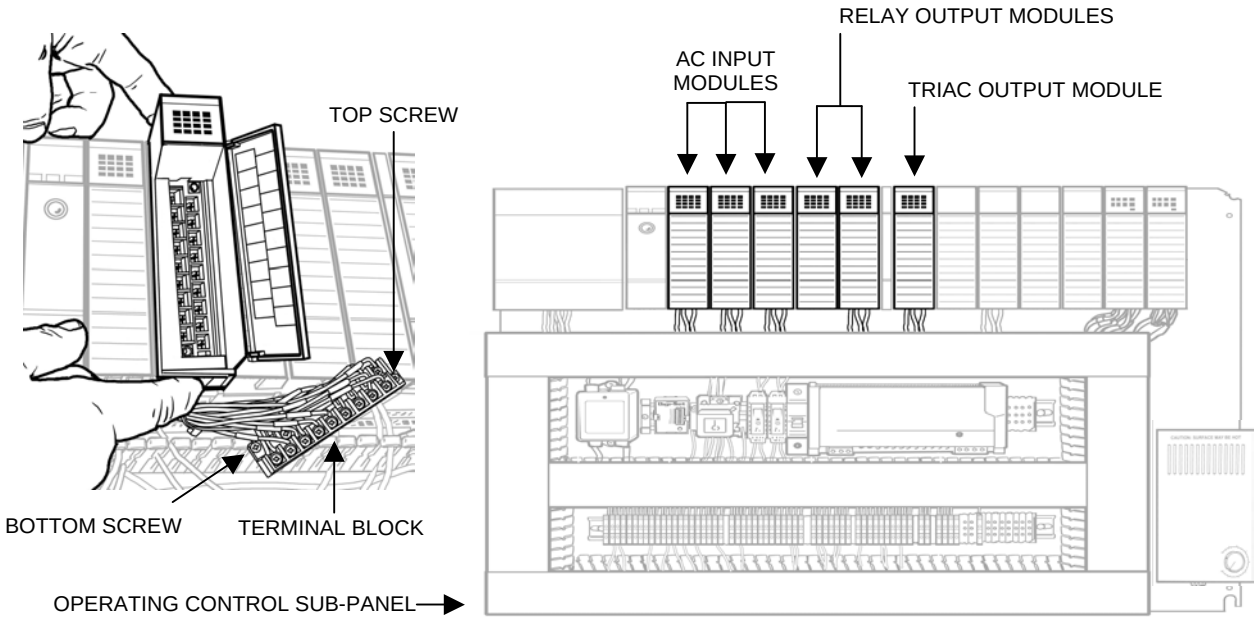

Figure 4. AC Input Module, Relay Output Module, or Triac Output Module Replacement.

4. Install a new AC input module, relay output module, or triac output module as follows:
    a. Position the new module in the 13-slot chassis and press into place.
    b. Press the terminal block with its connected wiring onto the new module and secure it with the two screws.
    c. Close the module compartment door.
    d. Close and secure the OCP instrument panel using the 14 screws.

Analog Output Module Replacement:

Parts:
Analog output module (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the analog output module on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove an analog output module as follows (see Figure 5):
    a. Locate the analog output module inside the 13-slot chassis that is to be replaced.

CAUTION

Electronic components are sensitive to electrical static. Discharge any electrical static before handling. Failure to do so may damage the components.

    b. Touch any metal portion of the TWPS chassis to discharge any electrical static.
    c. Open the compartment door of the module.
    d. Pull the lower terminal block with its connected wiring off the module.
    e. With one hand on each end of the module, press the release tabs and evenly pull the module out of the 13-slot chassis.

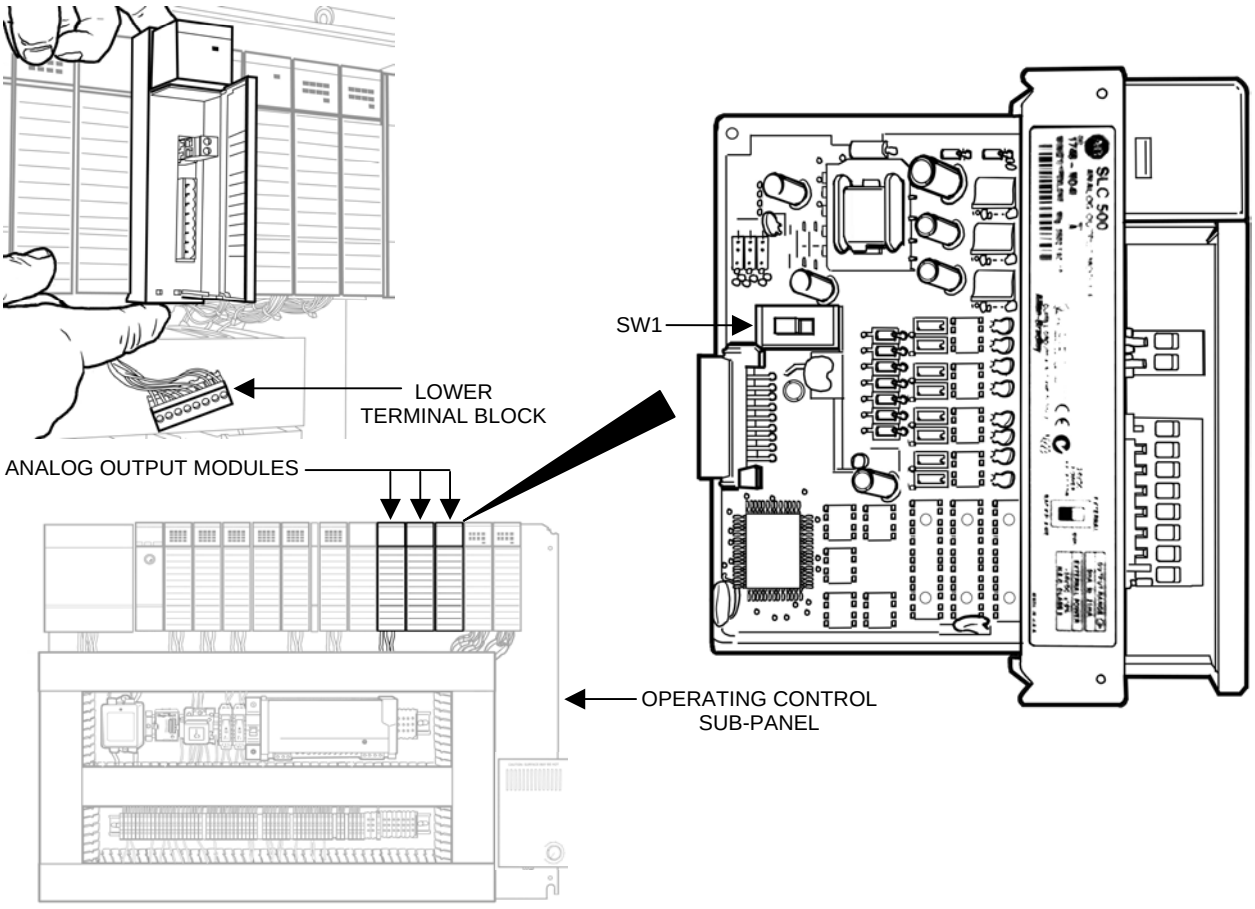

Figure 5. Analog Output Module Replacement.

4. Install a new analog output module as follows:
    a. On the new module, set SW1 to the “BACKPLANE” position.
    b. Position the new module in the 13-slot chassis and press into place.
    c. Press the terminal block with its connected wiring onto the new module.
    d. Close the module compartment door.
    e. Close and secure the OCP instrument panel using the 14 screws.

Analog Input Module Replacement:

Parts:
Analog input module (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the analog input module on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove the analog input module as follows (see Figure 6):
    a. Locate the analog input module inside the 13-slot chassis that is to be replaced.

CAUTION

Electronic components are sensitive to electrical static. Discharge any electrical static before handling. Failure to do so may damage the components.

    b. Touch any metal portion of the TWPS chassis to discharge any electrical static.
    c. Open the compartment door of the module.
    d. Loosen the top and bottom screws that hold the terminal block in place, then pull the terminal block with its connected wiring off the module.
    e. With one hand on each end of the module, press the release tabs and evenly pull the module out of the 13-slot chassis.

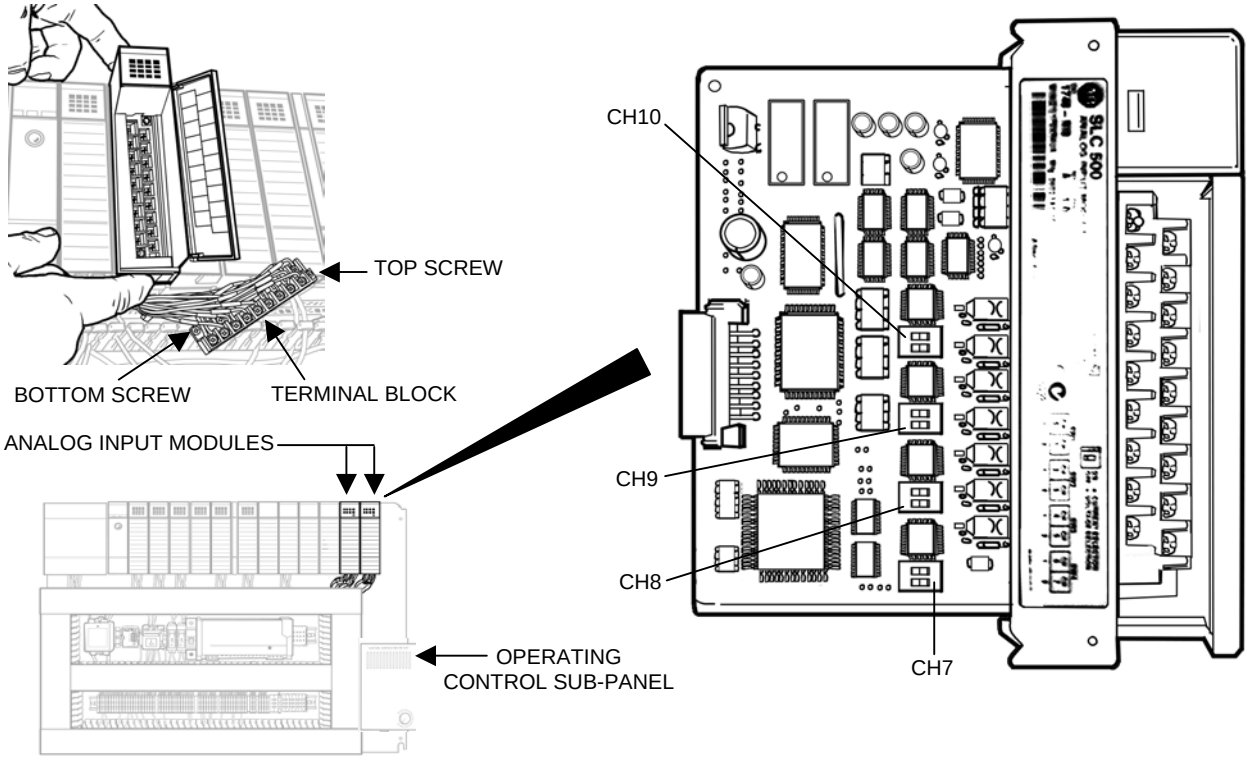

Figure 6. Analog Input Module Replacement.

4. Install a new analog output module as follows:
   a. On the new module, set the jumper switches CH7, CH8, CH9 and CH10 to the settings illustrated in Figure 7 for installation in slot 11 or slot 12.

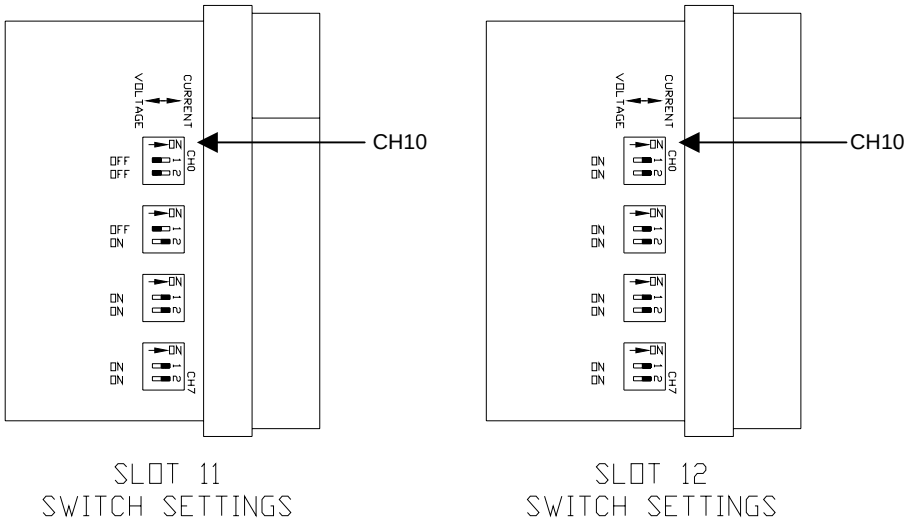

Figure 7. Analog Output Module Switch Settings.

b. Position the new module in the 13-slot chassis and press into place.
c. Press the terminal block with its connected wiring onto the new module and secure it with the two screws.
d. Close the module compartment door.
e. Close and secure the OCP instrument panel using the 14 screws.

13-Slot Chassis Replacement:

Parts:
13-Slot Chassis (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the 13-slot chassis on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 8).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.

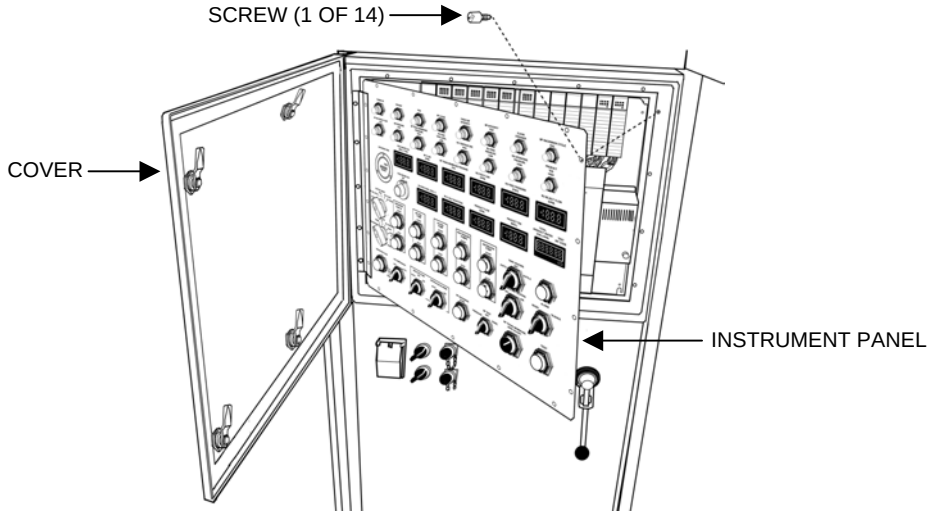

Figure 8. Opening the OCP Instrument Panel.

3. Remove the 13-slot chassis as follows (see Figure 9):
    a. Remove the 13 slot chassis power supply. Refer to **13-Slot Chassis Power Supply Replacement.**
    b. Remove PLC Processor Module. Refer to **PLC Processor Replacement** and **Memory Module Replacement.**
    c. Remove AC input modules and relay output modules. Refer to **AC Input Module Replacement** or **Relay Output Module Replacement**.
    d. Remove analog output modules. Refer to **Analog Output Module Replacement**.
    e. Remove analog input modules. Refer to **Analog Input Module Replacement**.
    f. Remove the four screws from the tabs at the bottom of the 13-slot chassis.
    g. Lift up the 13-slot chassis to clear the four screws in the keyhole brackets at the top of the chassis.
    h. Remove 13-slot chassis from the sub panel.

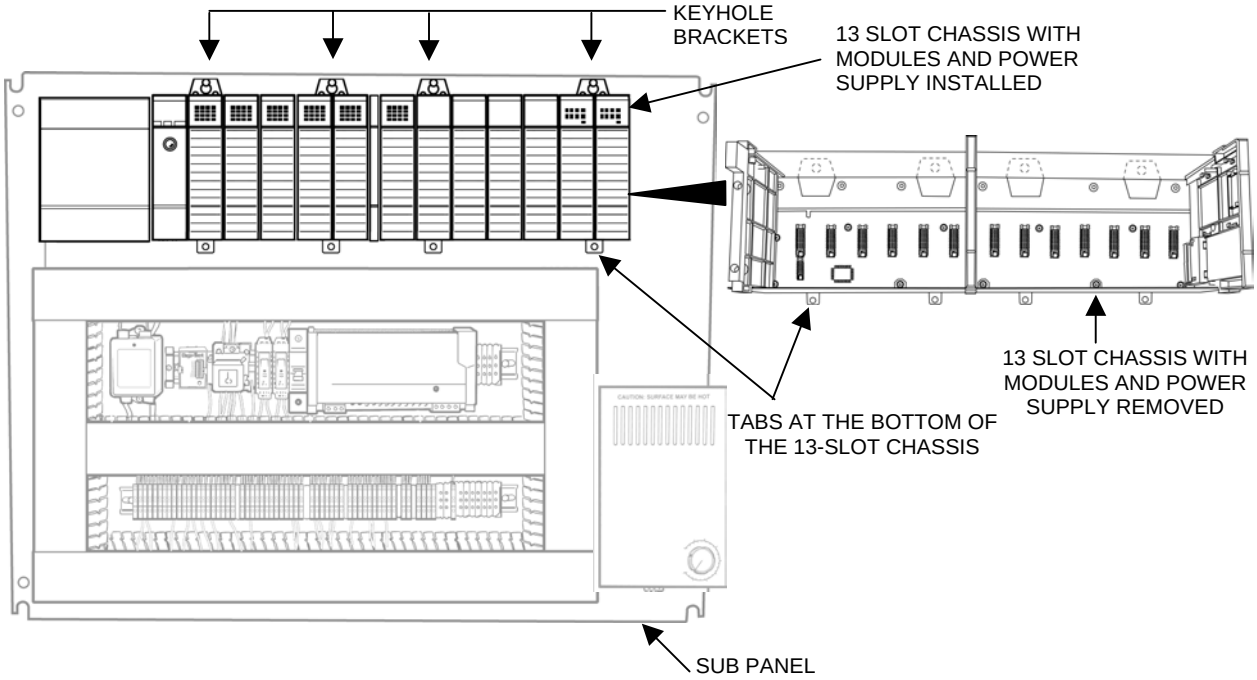

Figure 9. 13-Slot Chassis Replacement.

4. Install the new 13-slot chassis as follows:
    a. Position the 13-slot chassis on the sub panel by placing the chassis keyhole brackets over the four screws at the top of the panel.
    b. Slide the chassis down to secure the keyhole brackets with the screws.
    c. Reinstall the four screws at the bottom of the 13-slot chassis.
    d. Reinstall the 13 slot chassis power supply. Refer to **13-Slot Chassis Power Supply Replacement**.
    e. Reinstall the PLC Processor Module. Refer to **PLC Processor and Memory Module Replacement**.

f. Reinstall the AC input modules and relay output modules. Refer to **AC Input Module Replacement** or **Relay Output Module Replacement**.
g. Reinstall the analog output modules. Refer to **Analog Output Module Replacement**.
h. Reinstall the analog input modules. Refer to **Analog Input Module Replacement**.

3-Pole Relay Replacement:

Parts:
Relay, 3-pole (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the 3-pole relay on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove the 3-pole relay as follows (see Figure 10):
   a. Locate the 3-pole relay.
   b. Carefully pull the 3-pole relay out of the relay socket.

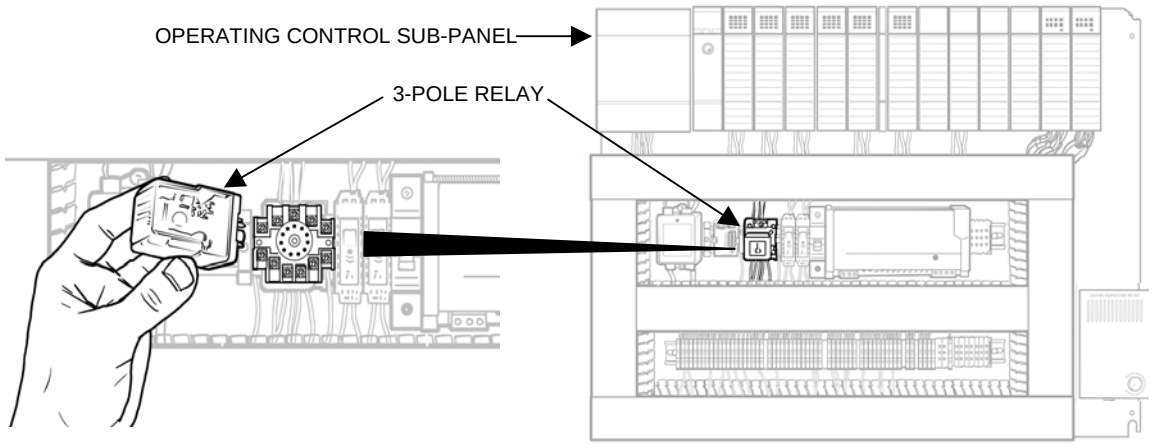

Figure 10. 3-Pole Relay Removal.

4. Install a new 3-pole relay as follows:
    a. Align the new 3-pole relay pins with the relay socket.
    b. Carefully push the 3-pole relay completely into the socket.
    c. Close and secure the OCP instrument panel using the 14 screws.

Time Delay Relay Replacement:

Parts:
Relay, Time Delay (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the time delay relay on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove the time delay relay as follows (see Figure 11):
    a. Locate the time delay relay.
    b. Un-clip the brackets at the top of the relay.
    c. Carefully pull the time delay relay out of the relay socket.

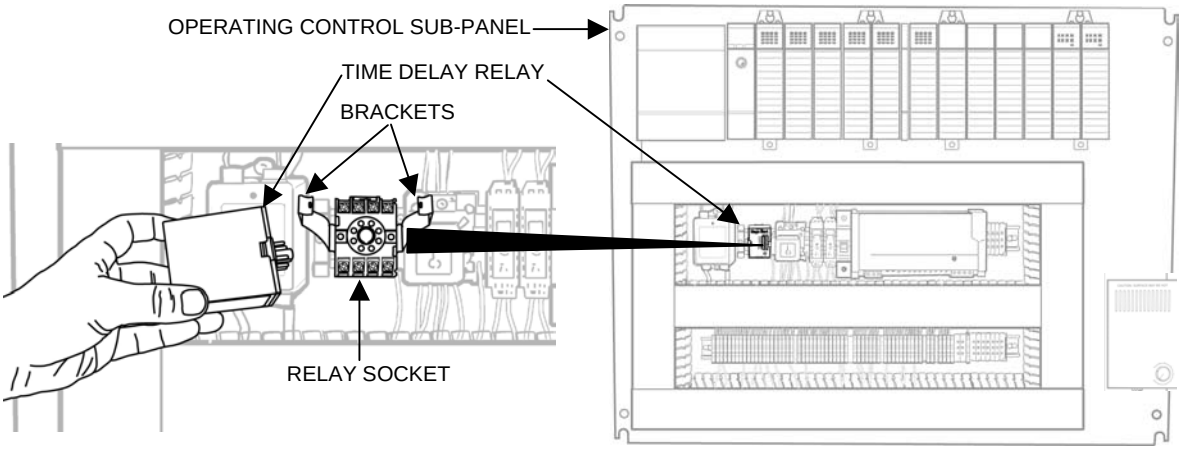

Figure 11. Time Delay Relay Removal.

4. Install a new time delay relay as follows:
    a. On the new time delay relay, set the jumper switches to the settings illustrated in Table 1 to obtain a 2 second time delay.

Table 1. Time Delay Relay Settings

Time	Setting
0.1	OFF
0.2	OFF
0.4	ON
0.8	OFF
1.6	ON
3.2	OFF
6.4	OFF
12.8	OFF
25.6	OFF
51.2	OFF

    b. Align the new time delay relay pins with the relay socket.
    c. Carefully push the time delay relay completely into the socket.
    d. Clip the brackets onto the relay.
    e. Close and secure the OCP instrument panel using the 14 screws.

Power Line Filter Replacement:

Parts:
Power Line Filter (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the power line filter on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove the power line filter as follows (see Figure 12):
    a. Locate the power line filter.
    b. Remove the two screws, flat washers and tooth washers that secure the power line filter to the sub-panel and retain for reassembly.

c. Tag the wires attached to the power line filter.
d. Carefully pull the connecting wires from the male terminals of the power line filter.
e. Remove the power line filter.

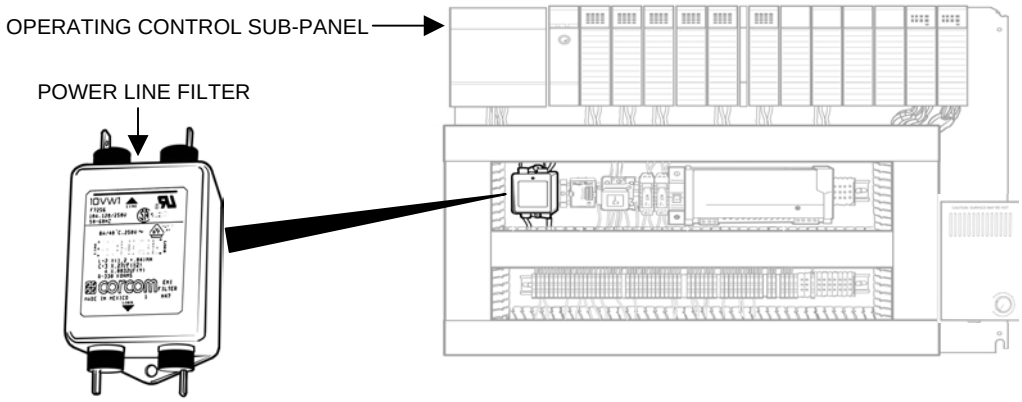

Figure 12. Power Line Filter Removal.

4. Install new power line filter as follows:
   a. Position the new power line filter in the operating control sub-panel.
   b. Attach the connecting wires to the power line filter in accordance to the wire tags.
   c. Secure the power line filter to the sub-panel using the two screws, flat washers and tooth washers.
   d. Remove the wire tags if necessary.
   e. Close and secure the OCP instrument panel using the 14 screws.

Electric Heater Replacement:

Parts:
Electric Heater (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replacing the electric heater on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.

3. Remove electric heater as follows (see
4. Figure 13):
    a. Locate the electric heater.
    b. Remove the four screws and tooth washers that secure the electric heater to the sub-panel and retain for reassembly.
    c. Carefully lift the electric heater from panel.
    d. With a small flat tip screwdriver, press in the tension release slots to remove wires from terminal at bottom of electric heater.

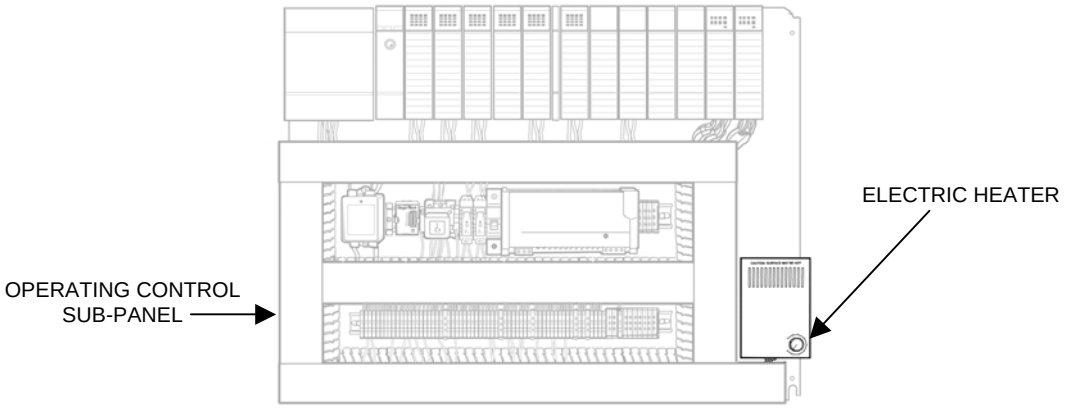

Figure 13. Electric Heater Removal.

5. Install new electric heater as follows:
    a. Position the new electric heater in the terminal block connection at the bottom of the electric heater.
    b. Secure the electric heater to the sub-panel using the four screws and tooth washers.
    c. Close and secure the OCP instrument panel using the 14 screws.

Solid State Relay Replacement:

Parts:
Solid State Relay (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the solid-state relay of the Operating Control Panel Sub-Panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove the solid state relay as follows (see Figure 14):
    a. Locate the solid-state relay.
    b. Tag the wires connected to the solid-state relay.
    c. Using a flat tip screwdriver, insert it into the DIN rail holding clip at the bottom of the solid-state relay. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail and then lift up on the solid-state relay to remove from the DIN rail.
    d. Loosen the screw connections and remove the connecting wires

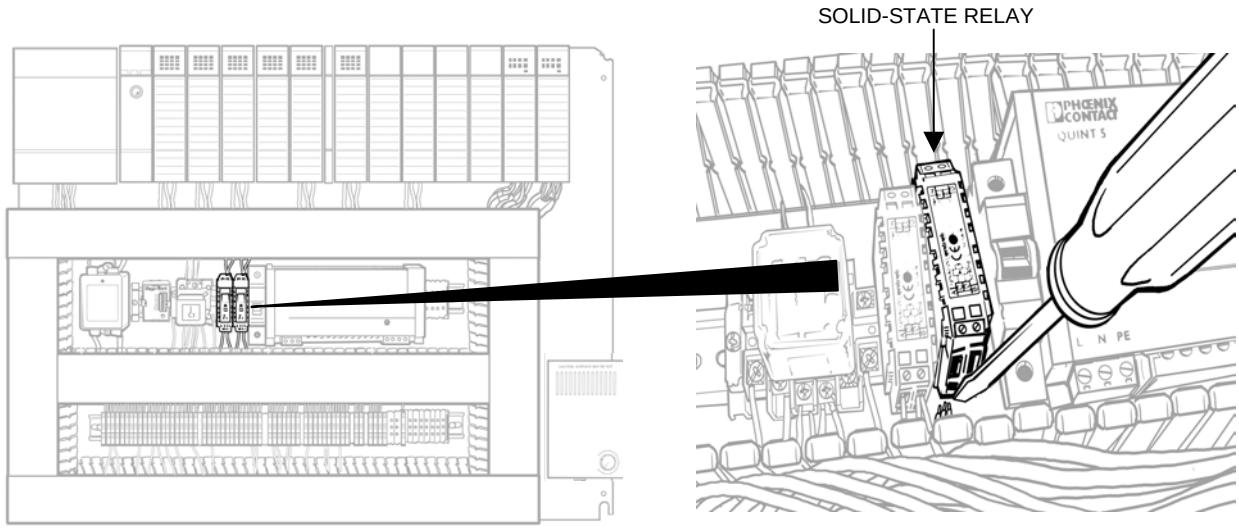

Figure 14. Solid State Relay Removal.

4. Install a new solid state relay as follows:
    a. Insert the wires into the screw connections in accordance to the wire tags on the new solid state relay.
    b. Position the new solid-state relay on the DIN rail.
    c. Carefully pull the built-in clamp of the component with a small flat tip screwdriver while pressing the component on the DIN rail.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Close and secure the OCP instrument panel using the 14 screws.

Circuit Breaker Replacement:

Parts:
Circuit Breaker (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

Replace the circuit breaker of the Operating Control Panel Sub-Panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove the circuit breaker as follows (see Figure 15):
    a. Locate the circuit breaker.
    b. Tag the wires connected to the circuit breaker.
    c. Using a flat tip screwdriver, insert it into the DIN rail holding clip at the bottom of the circuit breaker. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail and then lift up on the circuit breaker to remove from the DIN rail.
    d. Loosen the screw connections and remove the connecting wires.

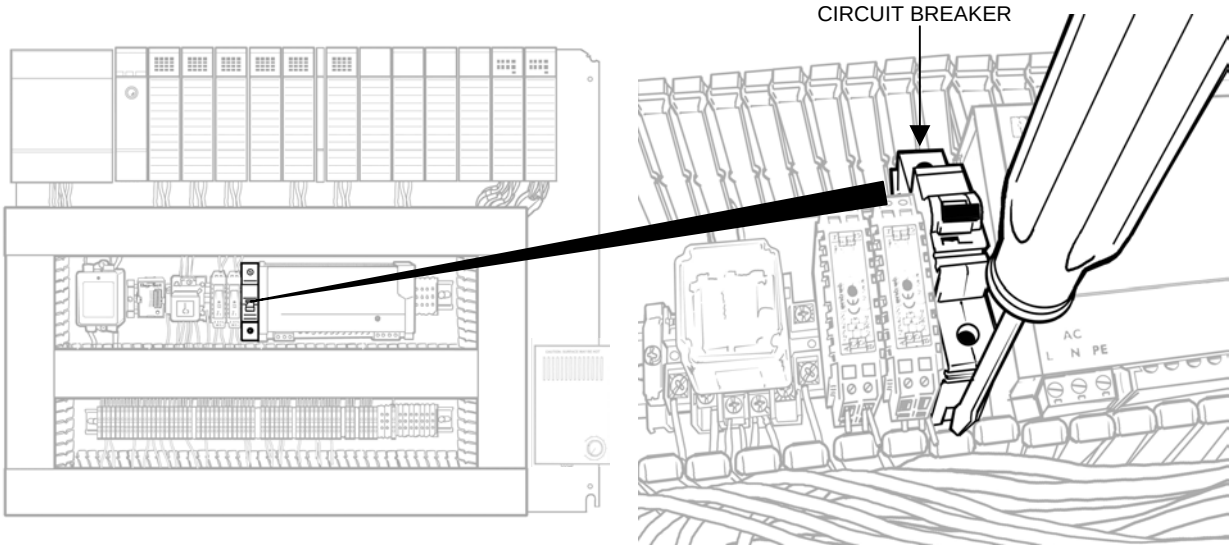

Figure 15. Circuit Breaker Removal.

4. Install a new circuit breaker as follows:
    a. Insert the wires into the screw connections in accordance to the wire tags on the new circuit breaker.
    b. Position the new circuit breaker on the DIN rail.
    c. Tighten the screw connections to secure the wires.
    d. Remove the wire tags if necessary.
    e. Close and secure the OCP instrument panel using the 14 screws.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

Instrumentation Power Supply Replacement:

Parts:
Power Supply, Instrumentation (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the instrumentation power supply of the Operating Control Panel Sub-Panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove the instrumentation power supply as follows (see Figure 16):
    a. Locate the instrumentation power supply.
    b. Tag the wires connected to the instrumentation power supply.
    c. Pry down on the top terminal blocks on the left and right side of the power supply to disconnect the power supply.
    d. Gently pry down on the built-in clamp of the instrumentation power supply with a small flat tip screwdriver while lifting up on the instrumentation power supply to remove from the DIN rail.

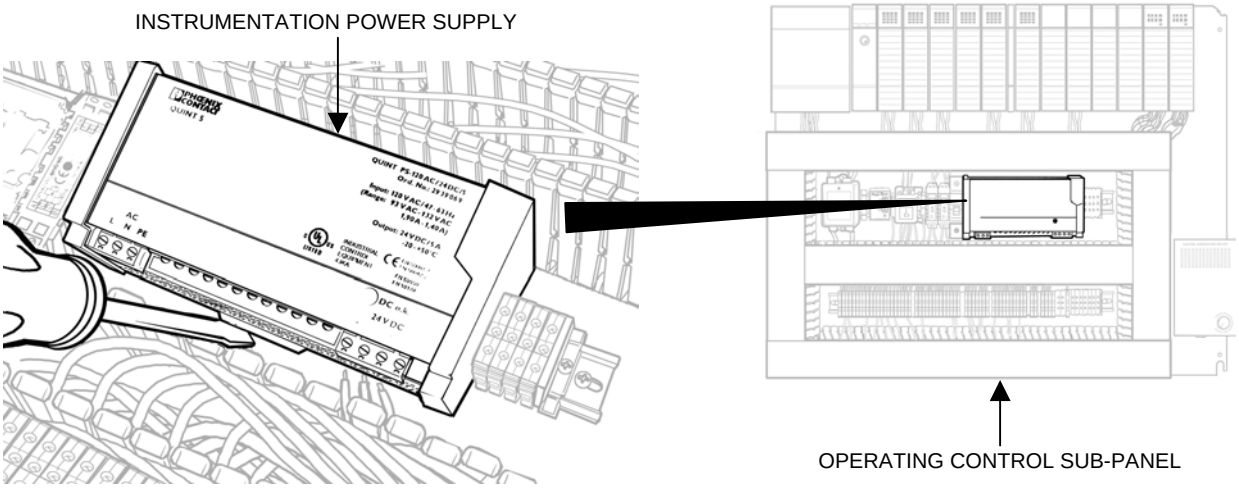

Figure 16. Instrumentation Power Supply Removal.

4. Install a new the instrumentation power supply as follows:
    a. Position the instrumentation power supply on the DIN rail.
    b. Press down on the lower part of the power supply to engage the DIN rail clip.
    c. Reconnect the two terminal blocks to the bottom of the power supply.
    d. Close and secure the OCP instrument panel using the 14 screws.

AC or DC Terminal Replacement:

Parts:
AC Terminal (TM 10-610-309-24P)
DC Terminal (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace an AC or DC terminal on the operating control panel sub-panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of terminal before replacing.

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove AC terminals (blue) or DC terminals (gray) as follows (see Figure 17):
    a. Locate the AC or DC terminal.
    b. Tag the wires connected to the terminal.
    c. Loosen the screw connections and remove the connecting wires.
    d. Gently pry down on the tab at the bottom of the terminal while lifting up on the terminal to remove from the DIN rail.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

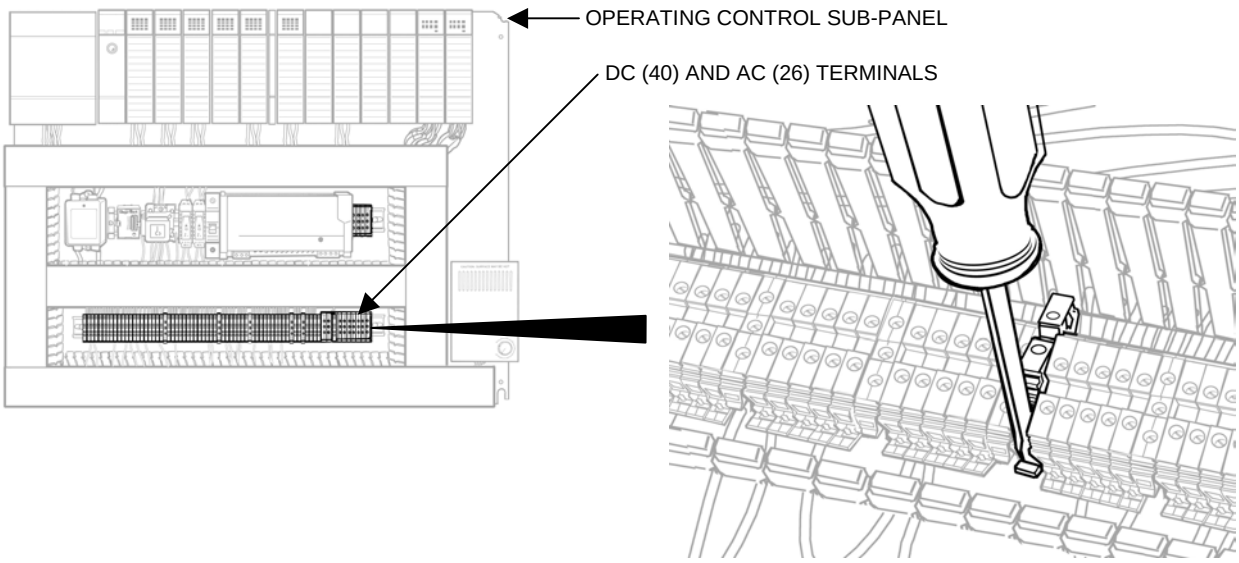

Figure 17. AC or DC Terminal Removal.

4. Install the new AC or DC terminal as follows:
    a. Position the new AC or DC terminal on the DIN rail and snap into place.
    b. Insert the wires in the screw connections in accordance to the wire tags.
    c. Tighten the screw connections to secure the wires.
    d. Remove the wire tags if necessary.
    e. Close and secure the OCP instrument panel using the 14 screws.

Ground Terminal Replacement:

Parts:
Ground Terminal (TM 10-610-309-24P)
Equipment Condition:
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the ground terminal on the operating control panel sub-panel as follows:

1. Open the cover to the OCP (see Figure 1).
2. Remove the 14 screws that secure the OCP and swing the instrument panel open.
3. Remove ground terminal (green/yellow) as follows (see Figure 18):
    a. Locate the ground terminal.
    b. Tag wires connected to the terminal.
    c. Loosen the screw connections and remove the wires.
    d. Loosen the center screw on the ground terminal and then lift the terminal off the DIN rail.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0060 00**
UNIT MAINTENANCE PROCEDURES
OPERATING CONTROL SYSTEM SUB PANEL

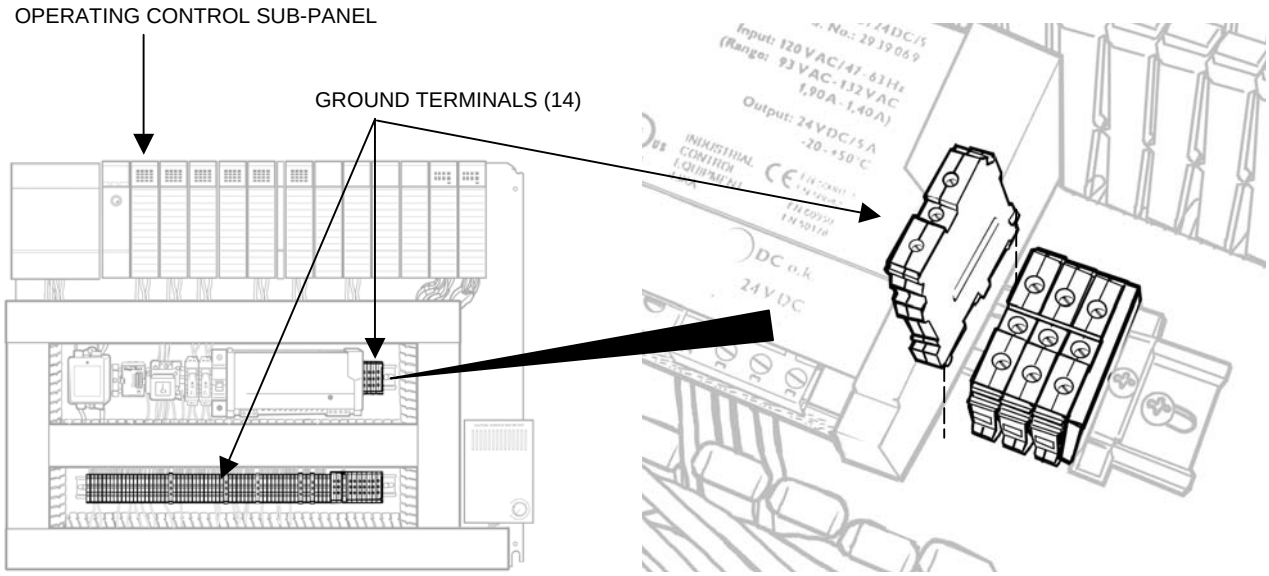

Figure 18. Ground Terminal Removal.

4. Install the new ground terminal as follows:
    a. Position the ground terminal onto the DIN rail.
    b. Tighten the center screw on the ground terminal to secure to the DIN rail.
    c. Insert the wires in the screw connections in accordance to the wire tags.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Close and secure the OCP instrument panel using the 14 screws.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) UNIT MAINTENANCE PROCEDURES FEED FLOW CONTROL PANEL

0061 00

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

GENERAL:

This work package contains information and instructions for replacing components in the air system feed flow control panel of the TWPS. If you are unable to return a component or assembly to workable condition by following the repair procedure, replace the complete panel assembly. The procedures covered in this work package include, in order:

- Air System Bleed Down Procedures
- Feed Flow Control Panel Assembly Replacement
- Pressure Regulating Valve PRV-904 Replacement
- IP Transducer FY-102 Replacement
- Three Way Solenoid Valve XV-912 Replacement
- Feed Control Selector Valve V-914 Replacement
- Pressure Gauge 0-30 psig PI-904 Replacement

All feed flow control panel repair procedures in this work package, can be performed on the TWPS.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

AIR SYSTEM BLEED DOWN PROCEDURES

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Bleed the air system as follows:

1. Make sure TWPS is in Standby Shutdown without Draining Down (WP 0017).
2. Bleed the air system as follows (see Figure 1 for valve location):
    a. Stop the air compressor by switching the Air Compressor control at the OCP to OFF.
    b. Close Air Receiver Tank Shut-Off Valve V-907.
    c. Make sure that Low Pressure Air Shut Off Valve V-909 is open.
    d. **Slowly** open Low Pressure Air Vent Valve V-910 to bleed the air from the air system.

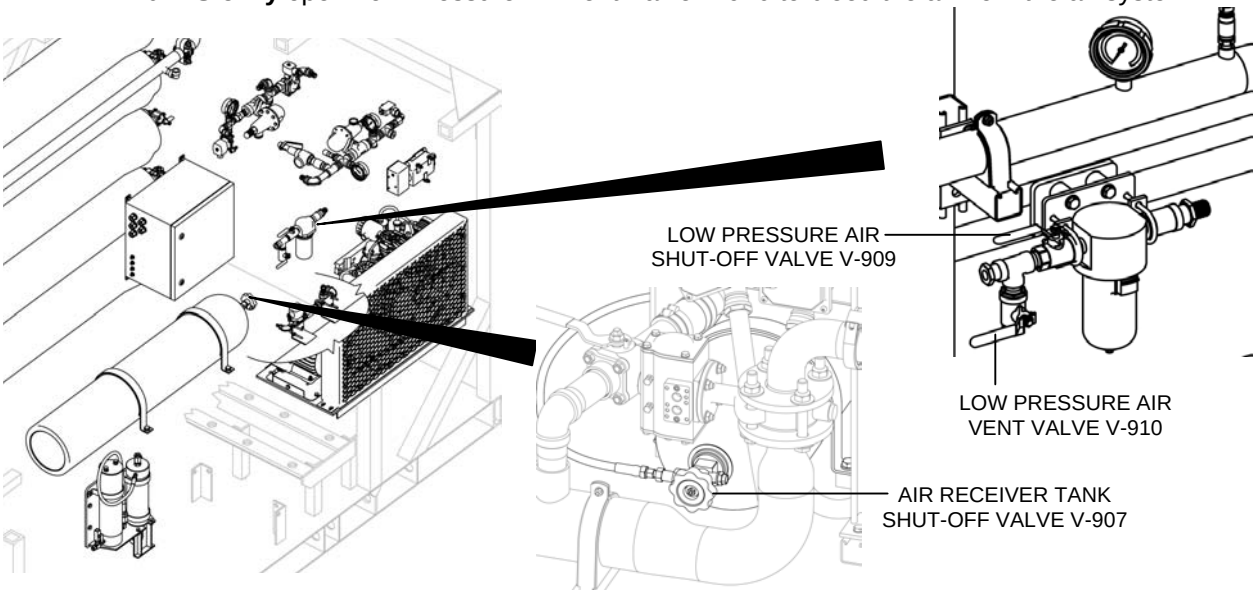

Figure 1. Valves for Bleeding the Air System.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

REPLACE

Feed Flow Control Panel Assembly Replacement:

Parts:
Feed Flow Control Panel Assembly (TM 10-4610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

Replace the feed flow control panel assembly as follows:

1. Bleed the air system. Refer to **AIR SYSTEM BLEED DOWN PROCEDURES**.
2. Remove the feed flow control panel assembly from the TWPS as follows (see Figure 2):

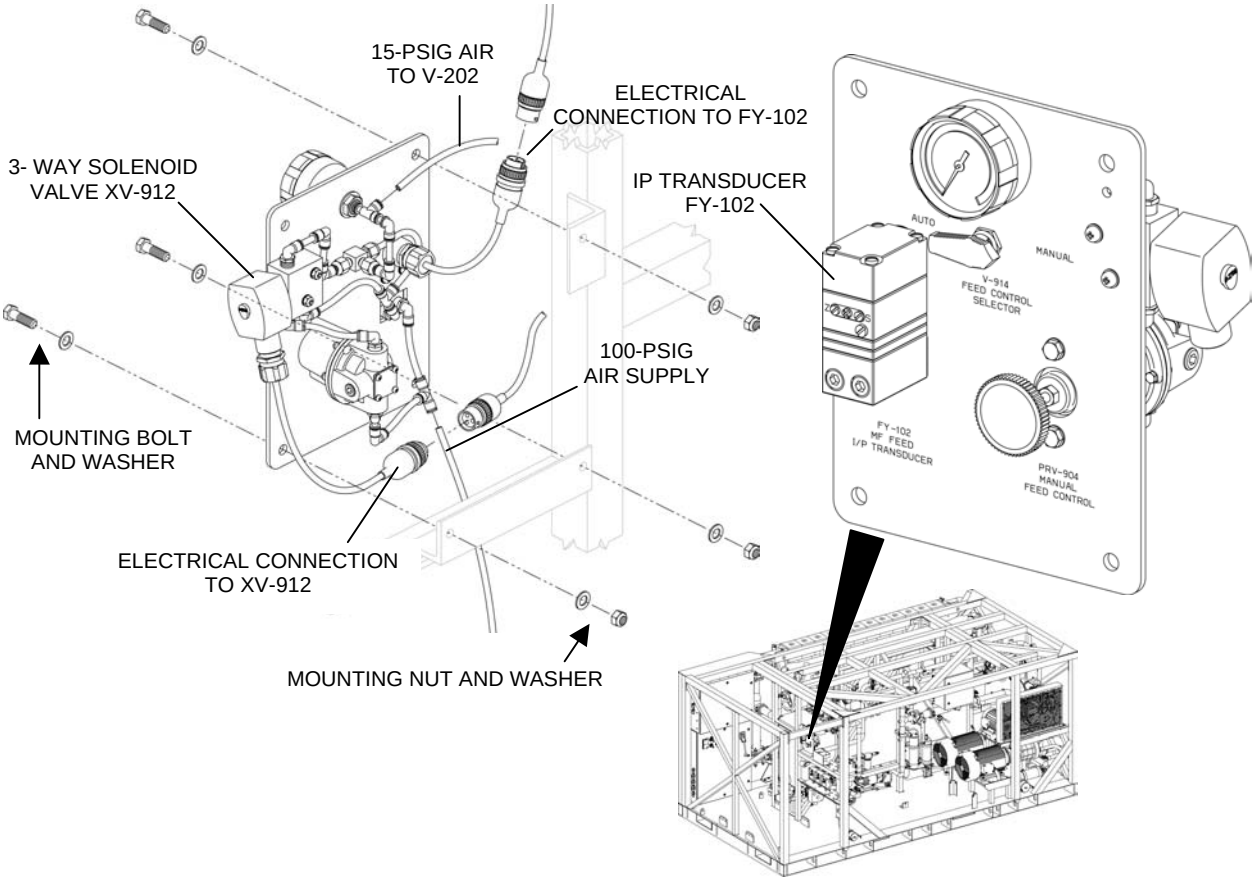

Figure 2. Feed Flow Control Panel Removal.

   a. Disconnect the air hose that supplies 100-psig air to the Feed Flow Control Panel.
   b. Disconnect the air hose that supplies 15-psig air to Filtrate Flow Control Valve V-202.
   c. Disconnect and tag the electrical connection from Transducer FY-102.
   d. Disconnect and tag the electrical connection from 3-Way Solenoid Valve XV-912.
   e. Remove the bolts, nuts, and washers that secure the feed flow control panel assembly to the TWPS.

2. Install the new feed flow control panel as follows (see Figure 2):
   a. Install the feed flow control panel assembly to the TWPS using 4 bolts and nuts and 8 washers.
   b. Reconnect the electrical connection to Transducer FY-102.
   c. Reconnect the electrical connection to 3-Way Solenoid Valve XV-912.
   d. Reconnect the 15-psig air hose.
   e. Reconnect the 100-psig air hose.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

Pressure Regulating Valve PRV-904 Replacement:

Parts:
Pressure Regulating Valve PRV-904 (TM 10-4610-309-24P)
Material:
Antiseizing tape (WP 0079, Table 1, item 30, 31)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Pressure Regulating Valve PRV-904 as follows:

1. Remove Pressure Regulating Valve PRV-904 from the feed flow control panel assembly as follows (see Figure 3):
    a. Bleed the air system. Refer to **AIR SYSTEM BLEED DOWN PROCEDURES**.
    b. Disconnect the upper and lower tubes from the regulating valve.
    c. Unscrew the lock nut that holds the adjusting knob in place; remove and retain the knob.
    d. Remove the two bolts, lock washers, and flat washers that hold the pressure-regulating valve to the panel assembly and remove the pressure-regulating valve.
    e. Remove the two tubing adapters from the regulating valve and clean the threads.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

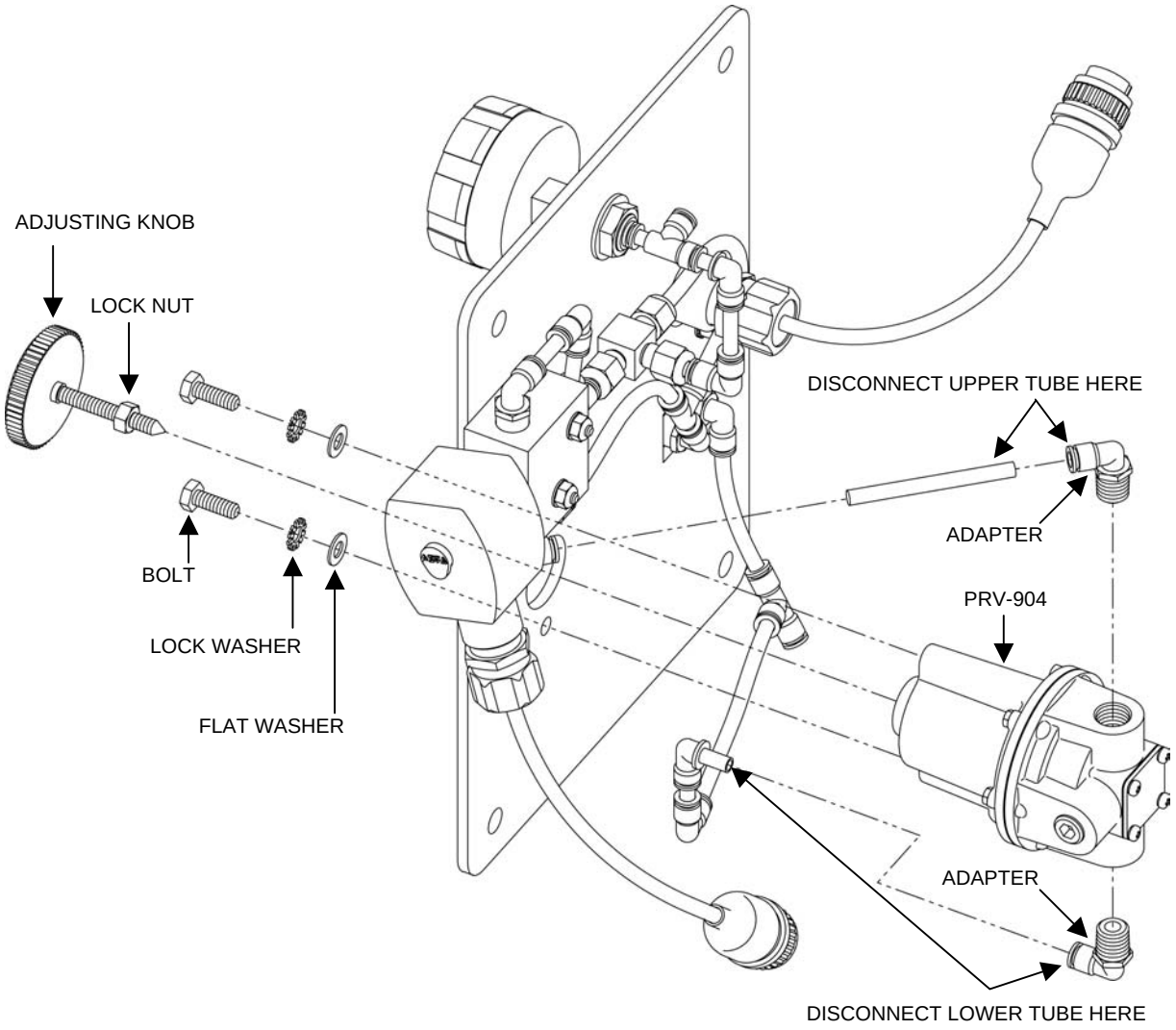

Figure 3. Pressure Regulating Valve PRV-904.

2. Install the new pressure regulating valve onto the feed flow control panel assembly as follows:
    a. Apply antiseizing tape to the threads of the two tubing adapters removed from the old valve.
    b. Install the tubing adapters into the new pressure-regulating valve.
    c. Mount the regulator valve bracket to the control panel; then install the two screws that secure the regulator to the front of the panel.
    d. Install the adjusting knob to the stem of the regulating valve and secure the locknut.
    e. Connect the tubes that were disconnected from the old valve to the same adapters in the new valve.
3. Check the feed flow control panel assembly for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

IP Transducer FY-102 Replacement:

Parts:
IP Transducer FY-102 (TM 10-4610-309-24P)
Material:
Antiseizing tape (WP 0079, Table 1, item 30, 31)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace IP Transducer FY-102 as follows:

1. Remove the IP Transducer FY-102 from the feed flow control panel assembly as follows (See Figure 4):
    a. Bleed the air system. Refer to **AIR SYSTEM BLEED DOWN PROCEDURES**.
    b. Disconnect the IP Transducer FY-102 electrical connection.
    c. Disconnect the two tubing connections from the IP transducer.
    d. Remove the two screws, lock washers, and flat washers that hold the IP transducer to the panel assembly and remove the transducer.
    e. Remove the two tubing adapters from the IP transducer and clean the threads.

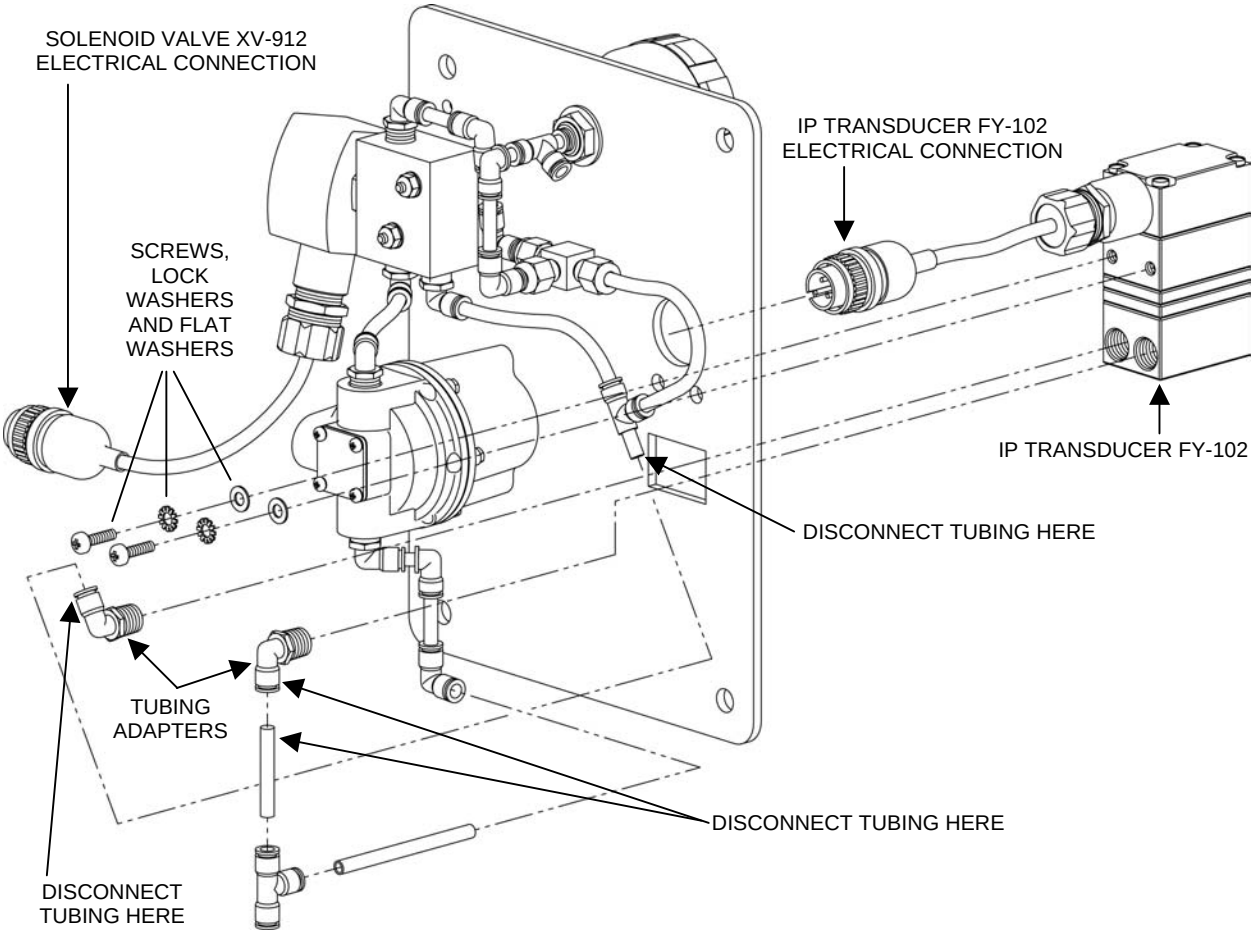

Figure 4. IP Transducer FY-102.

2. Install the IP transducer into the feed flow control panel assembly as follows:
    a. Apply antiseizing tape to the adapter threads.
    b. Install the adapters in the new IP transducer in the same positions as they were in the old transducer. Do not over-tighten.
    c. Mount the IP transducer to the panel assembly, then install and tighten the two screws, lock washers, and flat washers.
    d. Connect the tubes that were disconnected from the old transducer to the same adapters in the new transducer.
    e. Reconnect the electrical connection to IP Transducer FY-102.
3. Check the feed flow control panel for proper operation and leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

Three-Way Solenoid Valve XV-912 Replacement:

Parts:
Three-Way Solenoid Valve XV-912 (TM 10-4610-309-24P)
Materials:
Antiseizing tape (WP 0079, Table 1, item 30, 31)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace 3-Way Solenoid Valve XV-912 as follows:

1. Remove 3-Way Solenoid Valve XV-912 from the feed flow control panel assembly as follows (see Figure 5):
   a. Bleed the air system. Refer to **AIR SYSTEM BLEED DOWN PROCEDURES**.
   b. Disconnect the solenoid electrical connection.
   c. Disconnect the tubing from the three tubing adapters on the solenoid valve.
   d. Remove the 2 lock nuts, 2 flat washers, and 2 screws that hold the 3-way valve to the control panel and remove the solenoid valve.
   e. Remove the three tubing adapters from the old solenoid valve and clean the threads.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

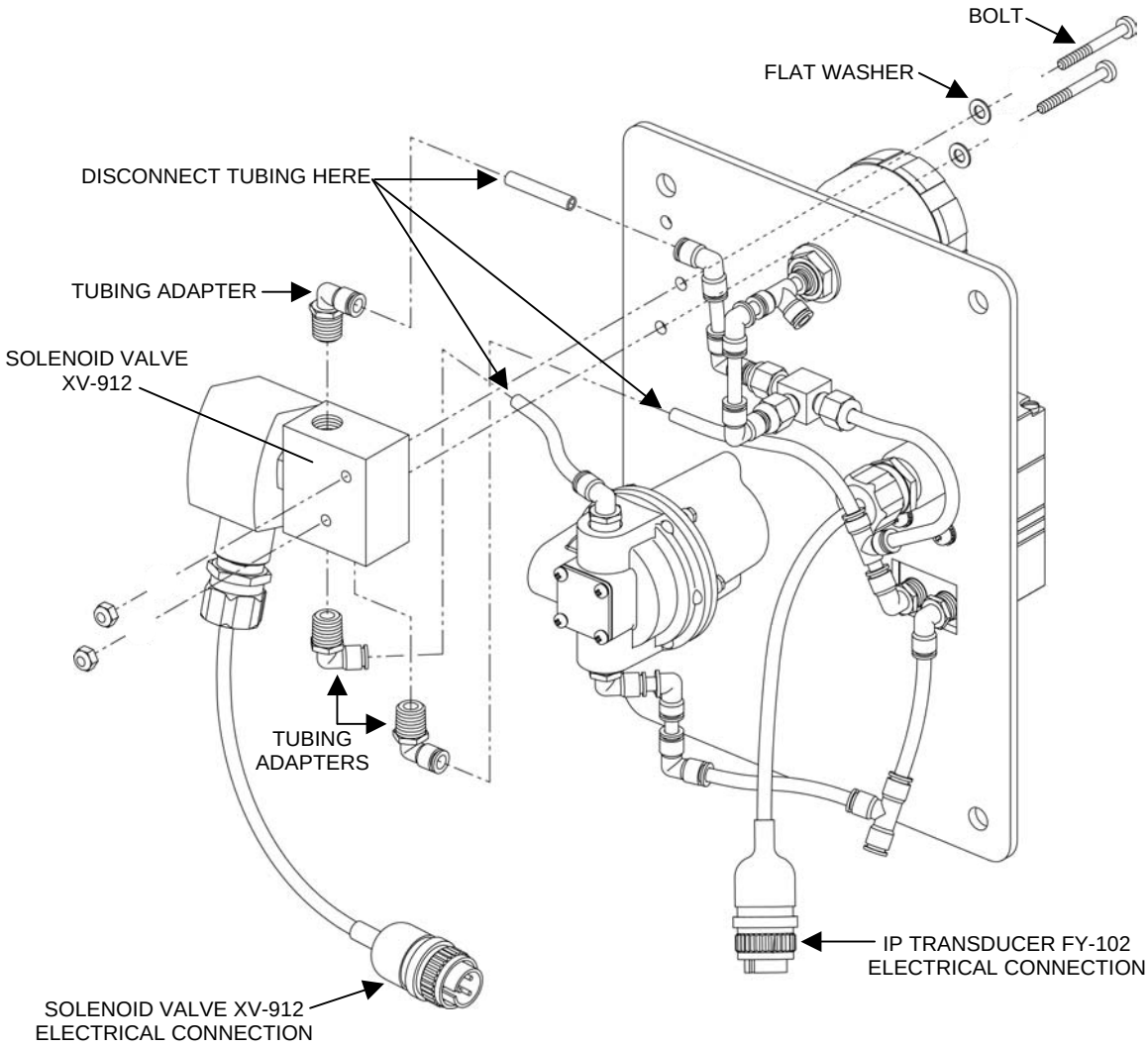

Figure 5. Three Way Solenoid Valve XV-912.

2. Install the three way solenoid valve onto the feed flow control panel assembly as follows:
    a. Apply antiseizing tape to the adapter threads.
    b. Install the adapters into the new solenoid valve in the same position they were in the old solenoid valve. Do not over-tighten.
    c. Mount the 3-way solenoid valve onto the feed flow control panel assembly using the 2 lock nuts, 2 flat washers, and 2 screws.
    d. Connect the 3 tubes that were disconnected from the old solenoid valve to the same adapters in the new solenoid valve.
    e. Reconnect the electrical connection to 3-Way Solenoid Valve XV-912
3. Check the feed flow control panel for proper operation and leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

Feed Control Selector Valve V-914 Replacement:

Parts:
Feed Control Selector Valve V-914 (TM 10-4610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Feed Control Selector Valve V-914 as follows:

1. Remove Feed Control Selector Valve V-914 from the feed flow control panel assembly as follows (see Figure 6):
    a. Bleed the air system. Refer to **AIR SYSTEM BLEED DOWN PROCEDURES**.
    b. Position the selector valve in the manual feed position.
    c. Disconnect the tubing from the selector valve.
    d. Loosen the setscrew on the selector knob and remove the selector knob.
    e. Remove the flat nut that holds the selector valve to the feed flow control panel and remove the selector valve.
    f. Loosen the ferrules on the selector valve and remove and retain the tubes from the valve.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

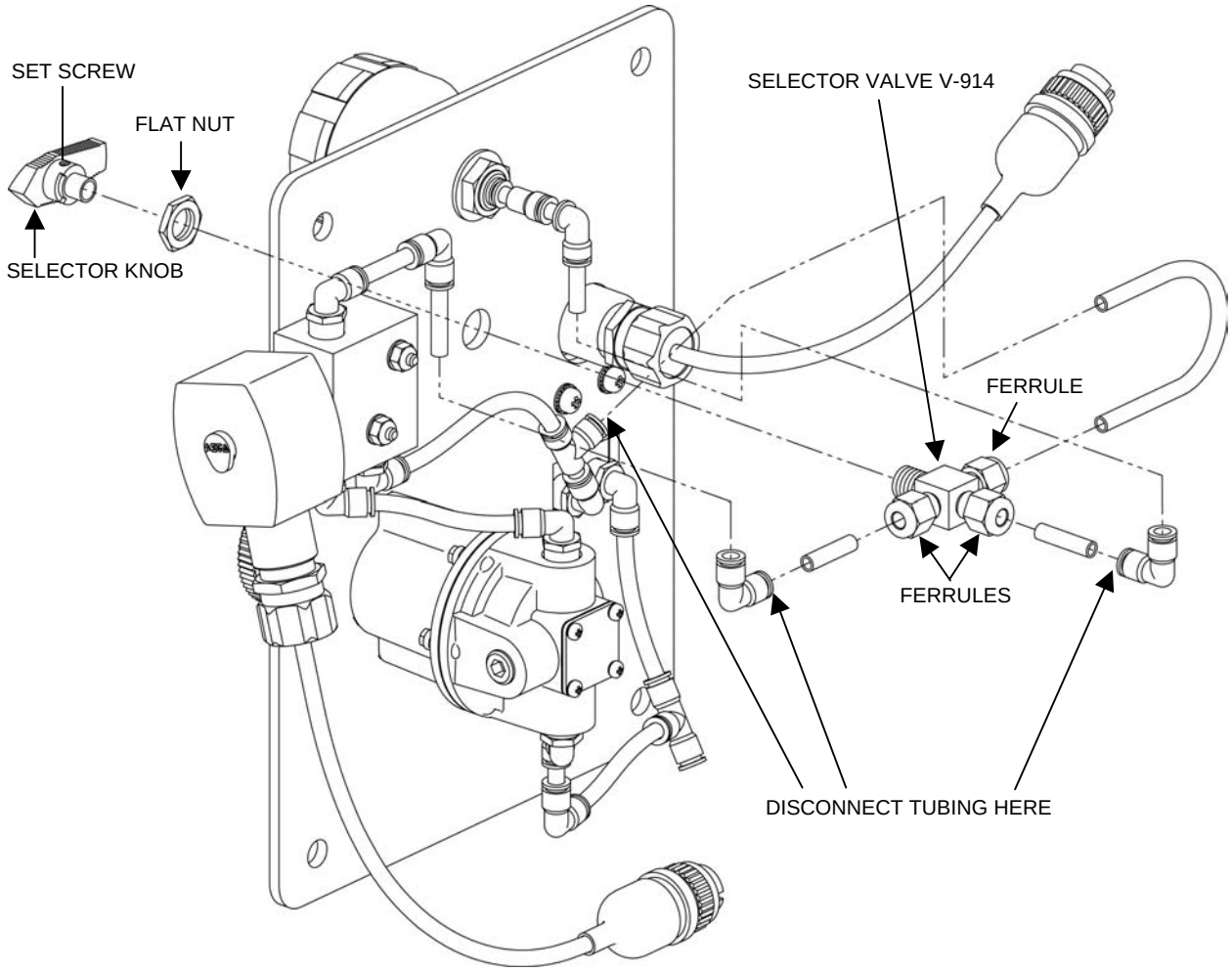

Figure 6. Feed Control Selector Valve V-914.

2. Install the new Feed Control Selector Valve V-914 to the feed flow control panel assembly as follows:
    a. Loosen the ferrules on the new selector valve. Insert the tubes that were removed from the old selector valve in the same ferrules in the new selector valve. Tighten the ferrules to secure the tubes. Do not over-tighten.
    b. Insert the selector valve through the panel and secure it to the panel with the flat nut.
    c. Install the selector knob to the selector stem and secure it with the setscrew. Make sure the knob is positioned in the manual feed position.
    d. Connect the 3 tubes that were disconnected earlier to their appropriate locations.
3. Check the feed flow control panel for proper operation and leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

Pressure Gauge 0-30 psig PI-904 Replacement:

Parts:
Pressure Gauge 0-30 psig PI-904 (TM 10-4610-309-24P)
Material:
Antiseizing tape (WP 0079, Table 1, item 30, 31)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

WARNING

The TWPS must be in Shutdown and the TQG and TWPS main breaker must be off (Army) or the TWPS disconnected from its power source (Marine Corps) prior to performing maintenance on the TWPS Air System. Failure to observe this warning can result in injury to personnel and damage to equipment.

High pressure. The air system contains air pressure up to 1800 psig. The air system must be bled prior to performing maintenance on components of the air system. Failure to observe this warning can result in injury to personnel and damage to equipment.

Replace Pressure Gauge PI-904 as follows:

1. Remove Pressure Gauge PI-904 from the feed flow control panel assembly as follows (see Figure 7):
    a. Bleed the air system. Refer to **AIR SYSTEM BLEED DOWN PROCEDURES**.
    b. Disconnect the tube from the panel mount connector.
    c. Remove the nut that holds the pressure gauge to the feed flow control panel and remove the pressure gauge.
    d. Remove the panel-mount connector from the gauge and clean the threads of the connector.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0061 00**
UNIT MAINTENANCE PROCEDURES
FEED FLOW CONTROL PANEL

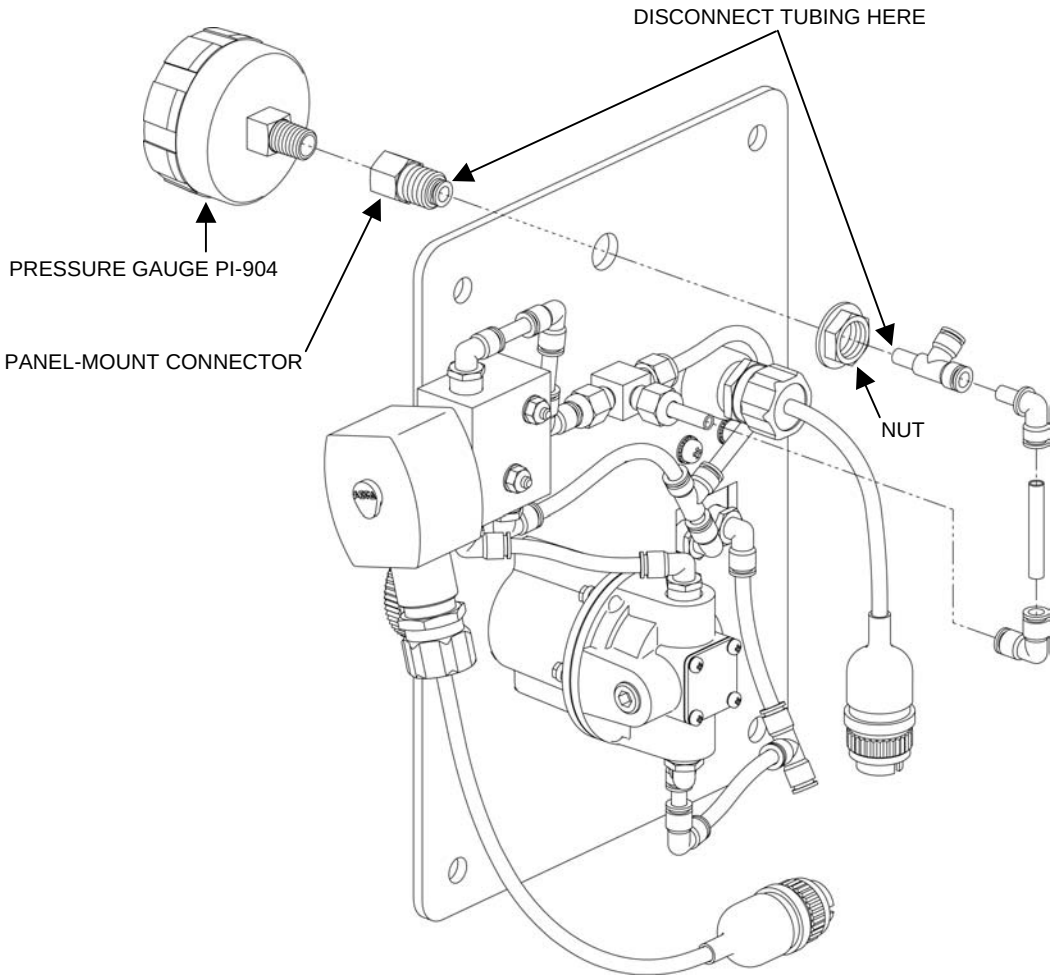

Figure 7. Pressure Gauge PI-904.

2. Install the new pressure gauge in the feed flow control panel assembly as follows:
    a. Apply antiseizing tape to the new pressure gauge threads and the panel-mount connector threads.
    b. Install the panel mount connector onto the threads of the new pressure gauge.
    c. Mount the new pressure gauge to the feed flow control panel assembly and secure it with the nut.
    d. Connect the tube that was disconnected from the pressure gauge to the connector on the new pressure gauge.
3. Check the feed flow control panel for proper operation and leaks.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) UNIT MAINTENANCE PROCEDURES CONTROL INSTRUMENTS

0062 00

THIS SECTION COVERS:
Replace, Check, Configure

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One Maintainer
Equipment Condition
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

GENERAL:

This work package contains information and instructions for replacing common control instruments in a number of systems on the TWPS. The procedures covered in this work package include:

Panel-Mounted Flow Transmitter Replacement and Configuration:
- MF Feed Flow Transmitter FT-101
- RO Reject Flow Transmitter FT-401
- Product Flow Transmitter FT-501

Tee Mounted Flow Sensor Replacement:
- MF Feed Flow Element FE-101
- RO Reject Flow Element FE-401
- Product Flow Element FE-501

Flow Loop Status Check

Panel-Mounted Conductivity Transmitter Replacement and Configuration:
- Conductivity Indicating Transmitter CIT-501

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

Conductivity Sensor Replacement:
- Product Conductivity Element CE-501A
- Product Conductivity Element CE-501B

MF and RO System Indicator Replacement:
- MF Feed Pressure Indicator PI-101
- MF Filtrate Pressure Indicator PI-201
- RO Feed Tank Temperature Indicator TI-202
- RO Feed Pressure Indicator PI-202
- HPP Discharge Pressure Indicator PI-303
- RO Feed Pressure Indicator PI-304
- RO Reject Pressure Indicator PI-401
- RO Product Pressure Indicator PI-501

MF and RO Transmitter Replacement:
- MF Feed Pressure Transmitter PT-101
- MF Filtrate Pressure Transmitter PT-102
- RO Feed Tank Level Transmitter LT-201
- RO Feed Pressure Transmitter PT-201
- RO Feed Pressure Transmitter PT-302
- RO Feed (Filtrate) Temperature Transmitter TT-201

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

REPLACE

Panel-Mounted Flow Transmitter Replacement:

Parts:
GLI model Pro-Series Model F3 (TM 10-4610-309-24P)
Tools:
Electrical Tool Box
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replacing any of the three panel-mounted flow transmitters listed below as follows:
- MF Feed Flow Transmitter FT-101
- RO Reject Flow Transmitter FT-401
- Product Flow Transmitter FT-501

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before disconnecting and connecting transmitter electrical connections. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the transmitter. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the flow transmitter from the instrument/solenoid panel box as follows (see Figure 1):
   a. Hold the flow transmitter and remove the four screws on the front of the transmitter.
   b. Disconnect the DC input supply cable from the back of the transmitter (see Figure 2).
   c. Disconnect the sensor cable from the back of the transmitter (see Figure 2).
   d. Remove the flow transmitter, transmitter panel mount gasket and retainer plate from the transmitter panel.

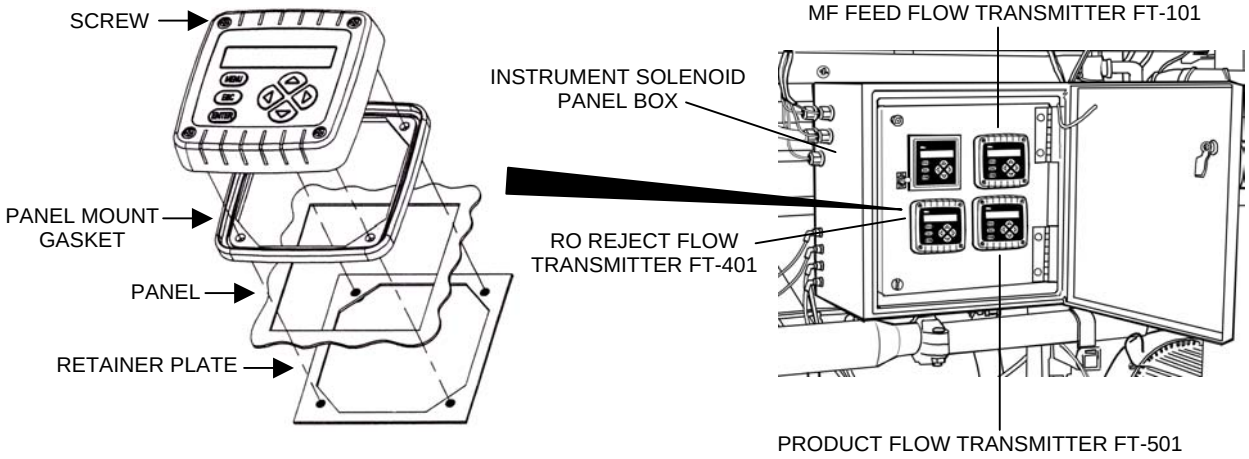

Figure 1. Flow Transmitter Removal.

2. Install the new flow transmitter to the instrument/solenoid panel as follows (see Figure 2):
   a. Put the DC input supply cable and sensor cable through the back of the retainer plate, transmitter panel, and the transmitter panel mount gasket.

NOTE

The terminal color code label on the back of the flow transmitter may not match the colors of the wires that are to be connected to the terminals. Follow the instructions below when connecting wiring to the flow transmitter terminals.

   b. Connect the sensor cable wiring to the new transmitter as follows:
      1. Black wire to terminal 1 of TB2.
      2. Red wire to terminal 2 of TB2.
      3. Shielded ground wire to terminal 3 of TB2.
   c. Connect the two wire DC input supply cable as follows:
      1. DC+ Positive to terminal 1 of TB1 (black wire)
      2. DC- Negative to terminal 4 of TB1 (red wire)
      3. Jumper across terminals 2 and 3 of TB1.
   d. Mount the transmitter to the transmitter panel using the four screws supplied with the transmitter.

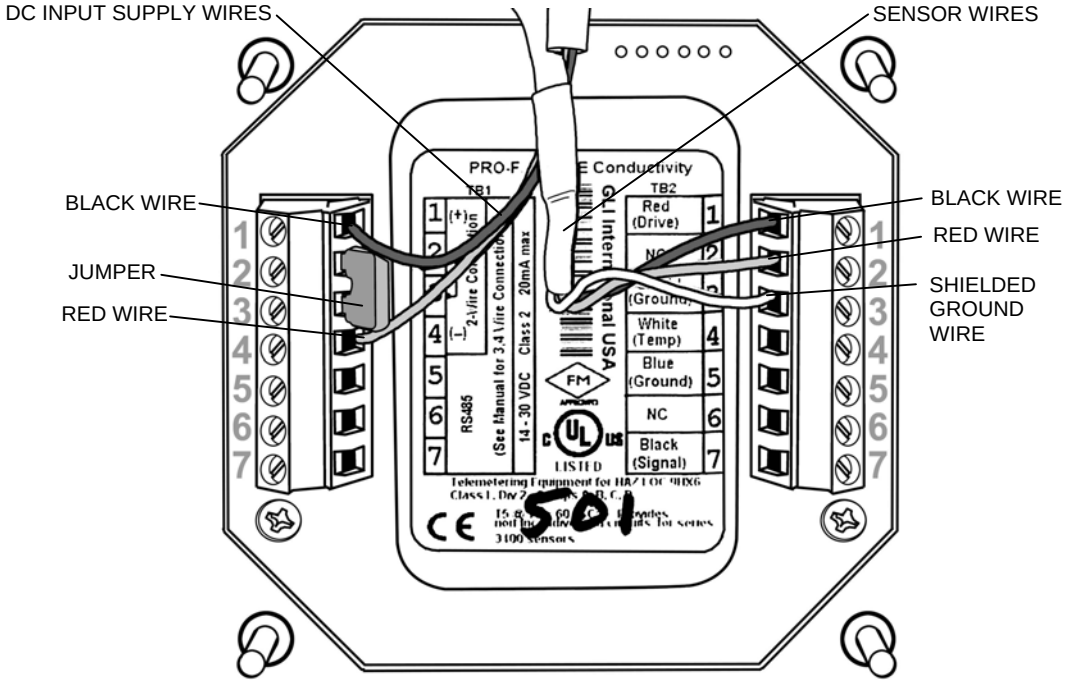

Figure 2. Flow Transmitter Wiring Terminal Designations.

3. Configure the flow transmitter with its associated sensor. Refer to **Flow Transmitter Configuration**.
4. Run the TWPS unit and check the transmitter for proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

Panel-Mounted Flow Transmitter Configuration:

NOTE

The transmitter and the sensor that feeds information to the transmitter are configured using the following keys on the face of the transmitter (see Figure 3):

- **Enter key: Pressing this key does two things: It displays submenu and edit/selection screens, and it enters (saves) configuration values/selections.**
- **ESC key: Pressing this key always takes the display up on level in the menu tree. The ESC key can also "abort" the procedure to change a value or selection.**
- **Left and right arrow keys: Depending on the type of displayed screen, these keys do the following:**
  - **Measure Screen: At the Measure screen the left and right arrow keys change the readout (in a continuous loop sequence) to show different measurements.**
  - **Menu Screen: At the Menu screen the left and right arrow key are non-functional.**
  - **Edit/Selection Screens: At the Edit/Selection screens the left and right arrow keys move the cursor left or right in order to select digit for adjustment with up and down arrow keys.**
- **Up and down arrow keys: Depending on the type of displayed screen, these keys do the following:**
  - **Measure Screen: At the Measure screen the up and down arrow keys are non-functional.**
  - **Menu Screen: At the Menu screen the up and down arrow keys move the display up or down between other same-level menu screens.**
  - **Edit/Selection Screens: At the Edit/Selection screens the up and down arrow keys adjust the selected digit value up or down, or move up or down between choices.**

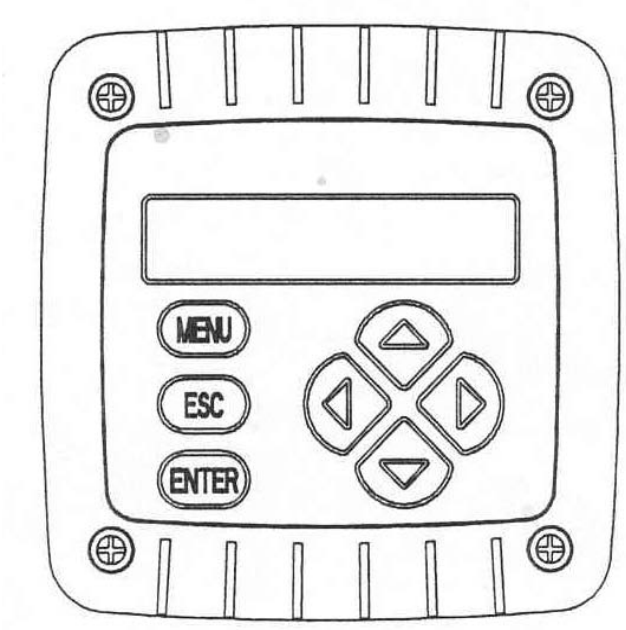

Figure 3. Transmitter Keypad.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

Configure a flow transmitter with its sensor as follows:

1. Select the language to operate the transmitter:
    a. Press the **MENU** key to display a **"MAIN MENU"** screen.
    b. If the "**MAIN MENU/CONFIGURE"** screen is not showing, use the **up** and **down** arrow keys to display it.
    c. Press the **ENTER** key to display **Configure/Set Output**.
    d. Press the **down** arrow key until **Configure/Language** screen appears.
    e. This setting is factory default set to **English** so no entry is required.
2. Configure the sensor:
    a. Set the Multiplier (for displayed flow rate).
        1) With the **Configure/Language** screen displayed, press **down** arrow key once to display **Configure/Sensor**.
        2) Press the **ENTER** key to display **Sensor/Set Multiplier**.
        3) Press **ENTER** key again to display a screen like **Set Multiplier/(x100).**
        4) Use the **up** and **down** arrow keys **to select "x1"**.
        5) With **"x1"** selected press **ENTER** key to enter selection.
    b. Set the Decimal (for displayed flow rate).
        1) With the **Sensor/Set Multiplier** screen displayed, press the **down** arrow key once to display **Sensor/Set Decimal**.
        2) Press the **ENTER** key to display a screen like **Set Decimal/xxx.x**. Use the **up** and **down** arrow keys to select **"xxx.x".**
        3) With **"xxx.x"** selected press the **ENTER** key to enter this selection.
    c. Set the Filter Time.
        1) With the **Sensor/Set Decimal screen** displayed, press the **down** arrow key once to display **Sensor/Set Filter**.
        2) Press the **ENTER** key to display a screen like **Set Filter/0 Seconds**.
        3) Use the **up** and **down** arrow keys to adjust the displayed value to the desired filter time of **two (2) seconds** and press the **ENTER** key to enter the value.
    d. Select the Flow Units (for displayed flow rates).
        1) With the **Sensor/Set Filter** screen displayed, press the **down** arrow key once to display **Sensor/Flow Units**.
        2) Press the **ENTER** key to display a screen like **Flow Units/US GAL/MIN**.
        3) This setting is factory default to **US GAL/MIN.**
        4) Press the **ENTER** key to accept this selection.
    e. Select the Volume Units (for displayed volume).
        1) With the **Sensor/Flow** Units screen displayed, press the **down** arrow key once to display **Sensor/Volume Units**.
        2) Press the **ENTER** key to display a screen like **Volume Units/US GALLONS**.
        3) This setting is factory default to **US GALLONS.**
        4) Press the **ENTER** key to accept this selection
    f. Select the Enter Note (top line of Measurement screen).
        1) With the **Sensor/Volume Units** Screen displayed, press the **down** arrow key **three times** to display **Sensor/Enter Note.**
        2) Press the **ENTER** key to display **Enter Note/Flow**.
        3) This setting is factory default to **Flow.**
        4) Press the **ENTER** key to accept this selection

g. Select the Sensor Type.
    1) With the **Sensor/Enter Note** screen displayed. Press the **down** key once to display **Sensor/Select Sensor**.
    2) Press the **ENTER** key to display a screen like **Select Sensor/GLI PIPE MOUNT**.
    3) Use the **up** and **down** arrow keys to select the type of sensor and mounting arrangement for the transmitter according to the service as follows:
        a) FT-101: **GLI PIPE MOUNT**
        b) FT-401: **GLI PVDF T**
        c) FT-501: **GLI PVDF T**
    4) With the appropriate choice displayed, press the **ENTER** key to enter this selection.

h. Set the Sensor Data.

NOTE

If a sensor is replaced, always enter the new sensor's related configuration data. If the entered data does not match the sensor being used, measurement readings will be inaccurate. After selecting/entering sensor type, the Sensor/Select Sensor screen re-appears.

1) Press the **down** arrow key once to display **Sensor/Set Sensor**. Pressing the **ENTER** key displays **Set Sensor/Set Pipe ID** (for FT-101) or **Tee Size** (for FT-401 and FT-501)
2) **For FT-101 only.** With the **Set Sensor/Set Pipe ID** screen displayed, press the **ENTER** key to display a screen like **Set Pipe ID/(3.000 in.).** Use the arrow keys to adjust the display value to **3.314 in.** and press **ENTER** key to enter the value. (Right/left keys moves the curser. Up/down keys change the value of the number at the curser.)
3) **For FT-401 and FT-501.** With the **Set Sensor/Set Pipe ID** screen displayed, press the **ENTER** key to display a screen like **Set Pipe ID/(3.000 in.).** Use the up/down arrow keys to adjust the display value to **2.0 in.** and press **ENTER** key to enter the value.

3. Configuring the Analog Output:
    a. Set the Parameter (representation)
        1) Press the **MENU** key to display a **"MAIN MENU"** screen.
        2) If the **MAIN MENU/Configure** screen is not showing use the **up** and **down** arrow keys to display it.
        3) Press the **ENTER** key to display **Configure/Set Output.**
        4) Press the **ENTER** key again to display **Set Output/Set Parameter.**
        5) Press the **ENTER** key again to display a screen like **Set Parameter/(Flow).**
        6) Use the **up** and **down** arrow keys to select desired choice **"FLOW"** press the **ENTER** key to enter this selection.
    b. Set the 4mA and 20mA Values (range expand)
        1) With the **Set Output/Set Parameter** screen displayed, press the **down** arrow key once to display **Set Output/Set 4mA Value**.
        2) Press the **ENTER** key to display a screen like **Set 4mA Value/(0.0 x 1GPM)**. Use the **arrow** keys to set a displayed value of **"ZERO"** at which 4mA is desired, and press the **ENTER** key to enter this value.

3) After the **Set Output/Set 4mA Value** screen re-appears, press the **down** arrow key once to display **Set Output/Set 20ma Value**.
4) Press **ENTER** key to display a screen like **Set 20mA Value**. Use the **arrow** keys to set the display value as listed below. Press the **ENTER** key to enter the value.
   a) FT-101: **225**
   b) FT-401: **55**
   c) FT-501: **30**

c. Set the Fail Level Mode (off, 4 mA or 20 mA).
   1) Press the **down** arrow key twice to display **Set Output/Set Fail Level**.
   2) Press the **ENTER** key to display **Set Fail Level/(OFF).** Use the **up** and **down** arrow keys to select **"OFF"** as the desired choice, then press the **ENTER** key to enter this selection.

4. Set the Passcode (feature enabled or disabled).
   a. Press the **MENU** key to display the **MAIN MENU** screen.
   b. If the **MAIN MENU/Configure** screen is not showing, use the **up** and **down** arrow keys to display it.
   c. Press the **ENTER** key to display **Configure/Set Output**.
   d. Press the **down** arrow key once to display **Configure/Set Passcode**.
   e. Press the **ENTER** key to display **Set Passcode/Disabled**.
   f. The desired choice is **"Disabled",** Press the **ENTER** key to enter this selection.
   g. Press **Menu** and then **Esc** to return to the normal display screen.
5. The F3 Transmitter configuration is now complete.

Tee-Mounted Flow Sensor Replacement:

Parts:
Tee-Mount Flow Sensor F1A11 (TM 10-4610-309-24P)
Tools:
Electrical Tool Box
Material:
Valve seal lubricant (WP 0079, Table 1, item 18)
Five Gallon Bucket
Tie Wraps (BII)
Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace any of the three tee-mounted flow sensors listed below as follows:
- MF Feed Flow Element FE-101
- RO Reject Flow Element FE-401
- Product Flow Element FE-501

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on flow sensors. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on flow sensors. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure that the pipe connection where the flow sensor is to be removed has been depressurized and drained.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove a tee-mounted flow sensor as follows:

NOTE
Place a container under the sensor to catch any residual water.

a. Remove the locking pin holding the sensor in place, then remove the sensor from the process pipe (see Figure 4 for the location of the flow sensors).

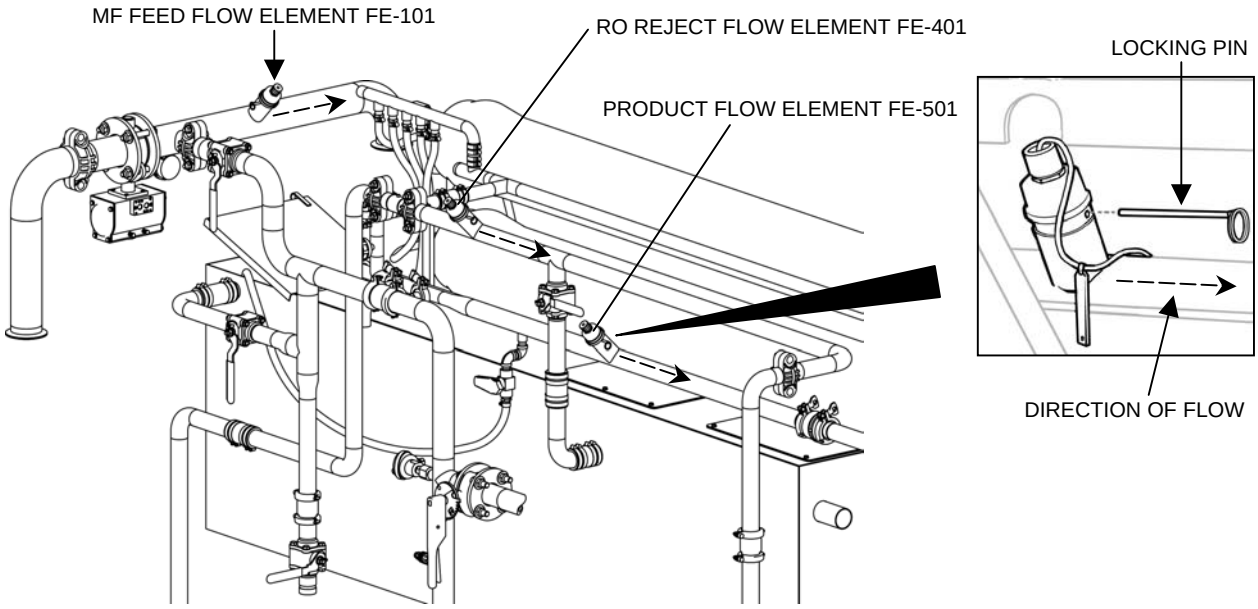

Figure 4. Tee-Mounted Flow Sensors.

3. Mark the sensor cable routing from the sensor to the transmitter in the Instrument/Solenoid Panel Box (see Figure 5 for the sensor and box locations).
    a. Cut the tie wraps that secure the sensor cable along it routing from the sensor to the transmitter.
    b. Unscrew the ring nut from the panel box that the cable runs through.
    c. Disconnect the transmitter sensor cable from the back of panel mounted flow transmitter. Refer to **REPLACE** and **Panel-Mounted Flow Transmitters**.
    d. Pull the wiring through the panel box and remove the sensor and its cabling.

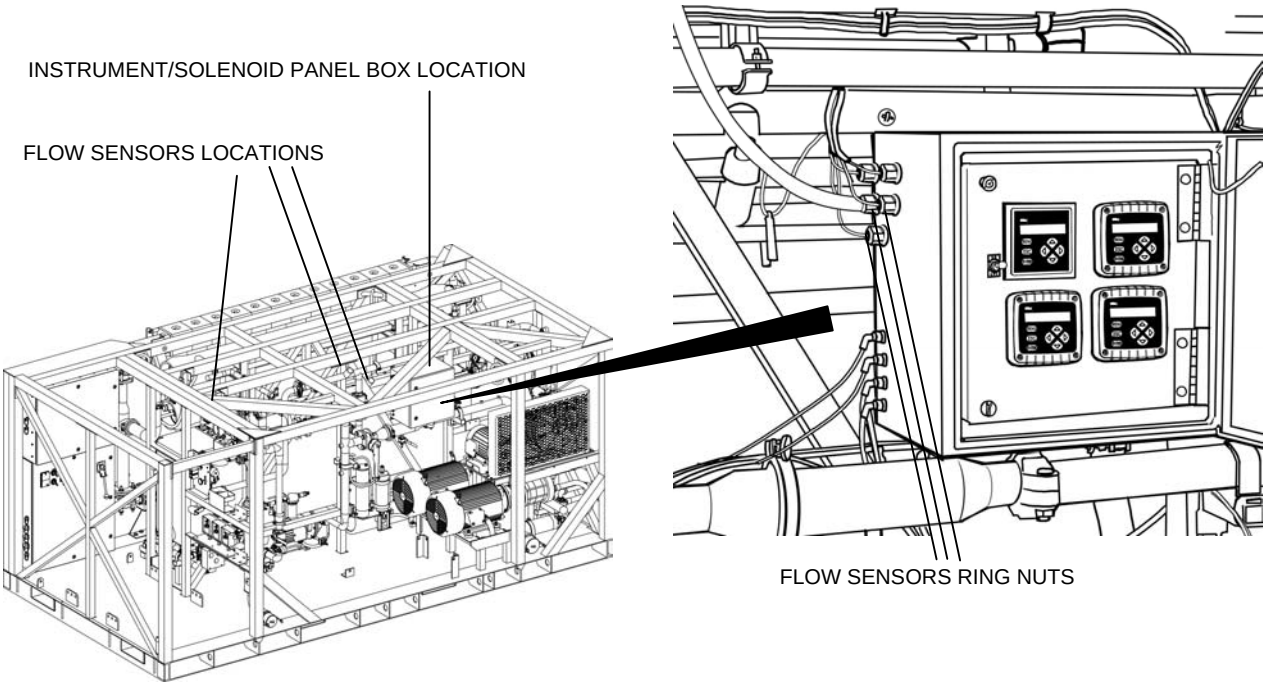

Figure 5. Flow Sensor and Instrument/Solenoid Panel Box Location.

4. Clean the area where the sensor mounts and inspect for any condition that could cause leakage.
5. Install the new flow sensor as follows:
    a. Place a small amount of valve seal lubricant on the two O-rings on the sensor to make installation into the tee mount easier.
    b. Install the sensor into the tee mount.
    c. Install the locking pin.
    d. Route the sensor cable along the cabling run that was marked earlier during removal and secure the sensor cable and other cabling in the run with tie wraps.
    e. Feed the cabling through the ring nut and panel box.
    f. Connect the new sensor cable to the transmitter. Refer to **REPLACE** and **Panel-Mounted Flow Transmitters**.
6. Run the TWPS and check for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

Flow Loop Status Check:

NOTE

The flow transmitter is designed so that you can check the operating status of the transmitter and the sensor. When the transmitter detects a "FAIL" diagnostic condition it will flash the "WARNING CHECK STATUS" message on the screen. By performing the flow loop status check, you can determine if the problem is with the transmitter or the sensor.

Perform the flow loop status check as follows:

1. Press the **MENU** key to display a **"MAIN MENU"** screen.
2. If the "**MAIN MENU TEST/MAINT"** screen is not showing, use the **up** and **down** arrow keys to display it.
3. Press the **ENTER** key to display **TEST/MAINT STATUS**.
4. Press the **ENTER** key again.
    a. If **STATUS: ANALYZER OK** appears, the transmitter is operating properly.
    b. If **FAIL** appears, replace the transmitter. Refer to **Panel-Mounted Flow Transmitter Replacement and Configuration**.
5. Press the **ENTER** key again.
    a. If **STATUS: SENSOR OK** appears, the sensor is operating properly.
    b. If **FAIL** appears, replace the sensor. Refer to **Tee-Mounted Flow Sensor Replacement**.
6. Press the **ESC** key or the **ENTER** key again to end status checking.

Panel-Mounted Conductivity Transmitter Replacement:

Parts:
GLI Model C33 Conductivity Analyzer (TM 10-4610-309-24P)
Tools:
Electrical Tool Box
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replacing Conductivity Indicating Transmitter CIT-501 as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the transmitter. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the transmitter. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the conductivity indicating transmitter from the instrument/solenoid panel box as follows (see Figure 6):
    a. Disconnect the AC power supply wiring module (TB1) from the back of the transmitter.
    b. Disconnect the sensor shield wiring module (TB2) from the back of the transmitter.
    c. Disconnect the sensor A and B wiring module (TB3) from the back of the transmitter.
    d. Disconnect the relay wiring module (TB4) from the back of the transmitter.
    e. Remove the two screws that hold the transmitter to the transmitter panel and pull the transmitter out the front of the panel.

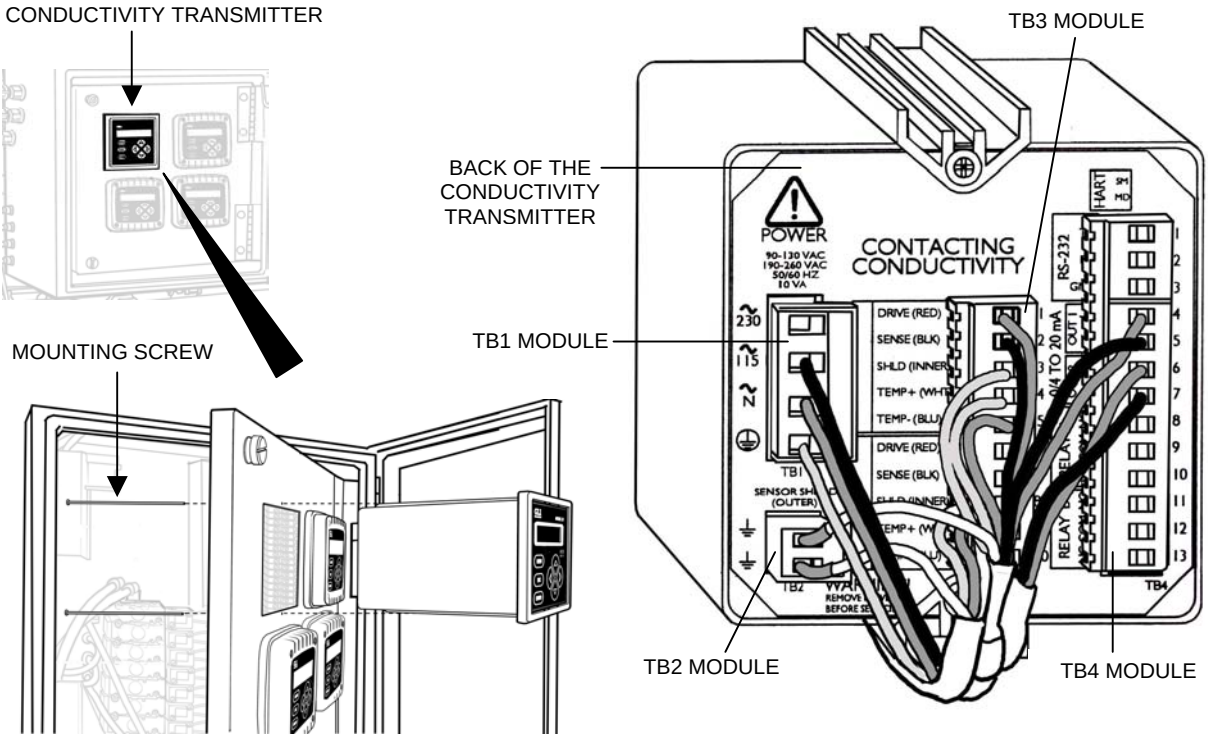

Figure 6. Panel-Mounted Conductivity Transmitter Removal.

2. Install the new conductivity transmitter to the transmitter panel as follows (see Figure 6):
    a. Insert the new conductivity transmitter in the panel and secure it with the two screws.
    b. Connect the relay wiring module to the TB4 terminals on the back of the new transmitter.
    c. Connect the sensor A and B wiring module to the TB3 terminals on the back of the new transmitter.
    d. Connect the sensor shield wiring module to the TB2 terminals on the back of the new transmitter.
    e. Connect the AC power supply wiring module to the TB1 terminals on the back of the new transmitter.
3. Configure the conductivity indicating transmitter and sensors A and B. Refer to **Conductivity Transmitter Configuration**.
4. Run the TWPS unit and check the transmitter for proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

Panel-Mounted Conductivity Transmitter Configuration:

NOTE

The user interface consists of a two-line LCD display and keypad with MENU, ENTER, ESC, Left and Right and Up and Down Keys (see Figure 7).

The MEASURE Screen is normally displayed. Pressing the MENU Key temporarily replaces the MEASURE screen with the top-level MAIN Menu-CALIBRATE branch selection screen. Using the keypad, you can then display other screens to calibrate, configure or test the Transmitter.

If the keypad is not used within 30 minutes, except during calibration or while using specific Transmitter test/maintenance functions, the display will automatically return to the MEASURE screen.

To display the MEASURE screen at any time, press the MENU key once and then the ESC key once.

The Conductivity Transmitter KEY Pad:

- **MENU Key:**
  - **Pressing this key when the MEASURE screen is displayed shows the MAIN MENU-CALIBRATE screen. Then, to display the CONFIGURE or top-level main branch screen press the Down- key.**
  - **Pressing the MENU-key when a menu screen is displayed always shows the top-level screen in that branch.**
  - **(Pressing the MENU-key also "aborts" the procedure to change values or selections).**
- **ENTER key: Pressing this key does two things:**
  - **It displays submenu and edit/selection screens.**
  - **It enters (saves) configuration values/selections.**
- **ESC key:**
  - **Pressing this key always takes the display up one level in the menu tree.**
  - **The ESC key can also "abort" the procedure to change a value or selection.**
- **Left and Right arrow keys: Depending on the type of displayed screen, these keys do the following:**
  - **Measure Screen: At the Measure screen the left and right arrow keys change the readout (in a continuous loop sequence) to show different measurements.**
  - **Menu Screen: At the Menu screen the left and right arrow key are non-functional.**
  - **Edit/Selection Screens: Coarse adjusts the displayed numerical value.**
- **Up and down arrow keys: Depending on the type of displayed screen, these keys do the following:**
  - **Measure Screen: At the Measure screen the up and down arrow keys are non-functional.**
  - **Menu Screen: At the Menu screen the up and down arrow keys move up or down between other same-level menu screens.**
  - **Edit/Selection Screens: At the Edit/Selection screens the up and down arrow keys "Fine" adjust the displayed numerical value (holding key down changes value faster), or moves up or down between choices.**

- **Measure Screen:**
  - **The measure screen can show seven different readout versions.**
  - **The standard readout used for our configuration is shown in Figure 7.**
  - **When the measure value is beyond the Transmitter's measuring range, series of "+" or "-" screen symbols appear respectively indicating that the value is above or below range.**

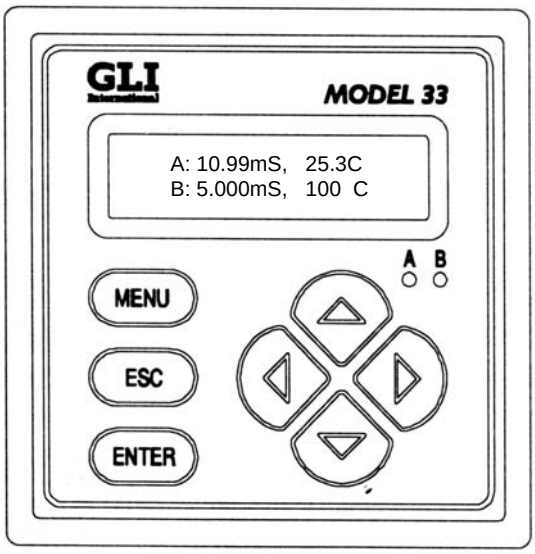

Figure 7. CIT-501 Conductivity RO Product Measure Screen Standard Configuration.

Configure the transmitter as follows:

1. Select the language to operate the transmitter:
   a. Press the MENU key to display a "MAIN MENU" screen.
   b. If the "MAIN MENU/CONFIGURE" screen is not showing, use the Up and Down arrow keys to display it.
   c. Press the ENTER key to display Configure/Set Output 1.
   d. Press the Down arrow key until Configure/Language screen appears.
   e. Press ENTER key to display a language like English.
   f. Use the Up or Down key to select "English" as the language.
   g. Press the ENTER key to enter the language selected.

NOTE

All listed sensor configuration instructions are for Sensor A. Configure Sensor B in the same way and with same values as Sensor A, except as listed in configuration step.

2. Select Measurement
   a. With the **Configure/Language** screen displayed, press the **Down key** once to display **Configure/Sensor A** (Press **Down Key** twice to display **Configure/Sensor B**).

b. Press **ENTER key** to display **Sensor A/Select Measure.**
c. Press **ENTER key** again to display a screen **Select Measure/(Conductivity)**.
d. Use the **Up** or **Down key** to select desired measurement **"Conductivity".**
e. Press the **ENTER key** to enter the selected measurement.

3. Select Display Format
   a. With the **Sensor A/Select Measure** screen displayed, press the **Down key** once to display **Sensor A/Display Format**.
   b. Press the **ENTER key** to display a screen like **Display Format/(200.0 us/cm).**
   c. Use the **Down** or **Up keys** to select a Display format .
      1) Conductivity For Sensor A ENTER: 200.0 us/cm
      2) Conductivity For Sensor B ENTER 2000 us/cm
   d. Press **ENTER key** to enter the selected display format.
4. Select Temperature Compensation
   a. With the **Sensor A/Display Format** screen displayed, press the **Down key** once to display **Sensor A/T-Compensation**.
   b. Press **ENTER key** to display a screen like **T-Compensation/Linear**.
   c. Use the **Down** and **Up keys** to select "**LINEAR**".
   d. Then press the **ENTER key** to enter the selection.
5. Select Config Linear
   a. With the **Sensor A/T-Compensation** screen displayed press the **Down key** until **Sensor A/Config Linear** screen appears.
   b. Press **ENTER key** to display **Config Linear/Set Slope**.
   c. Press **ENTER key** again to display a screen like **Set Slope/(2.00 %/°C)**.
   d. Use **Arrow keys** to adjust to a desired slope of **"2.00 %/ °C".**
   e. Press **ENTER key** to enter the slope.
   f. After the **Config Linear/Set Slope** screen re-appears, press the **Down key** once to display **Config Linear/Set Ref Temp**.
   g. Press **ENTER key** to display a screen like **Set Ref Temp/(25.0 °C)**.
   h. Use the **Arrow keys** to adjust to the desired reference temperature of **"25.0 °C".**
   i. Press the **ENTER key** to enter the reference temperature.
   j. After the **Config Linear/Set Ref Temp** screen re-appears, press **ESC key** once to return to the **Sensor A/Config Linear** Screen.
6. Select Cell K
   a. With the **Sensor A/Config Linear** screen displayed, press the **Down key** until **Sensor A/Cell Constant** screen appears.
   b. Press **ENTER key** to display **Cell Constant/Select Cell K**.
   c. Press **ENTER key** again to display a screen like **Select Cell K/ (0.05000)**.
   d. Use the **Down** and **Up keys** to select the nominal cell category that corresponds to the sensor's **GLI Certified "K" Value**.
      1) For **Sensor A** Enter **"0.05000"**
      2) For **Sensor B** Enter **"10"**
   e. Press **ENTER key** to enter the selected nominal cell category.
   f. After the **Cell Constant/Select Cell K** screen re-appears, press the **Down key** once to display **Cell Constant/Set Cell K**.
   g. Press **ENTER key** to display a screen like **Set Cell K/ (0.05000)**.
   h. Use the **Up** or **Down Arrow keys** to adjust the display value to **EXACTLY MATCH** the sensor's GLI certified "K" value listed on the Sensor cable.
   i. Press **ENTER key** to enter the certified "K" value.

j. After the **Cell Constant/Set Cell K** screen re-appears, press **ESC key** once to return to the **Sensor A/Cell Constant** screen.

7. Set Filter Time
   a. With the **Sensor A/Cell Constant** screen displayed, press the **Down key** once to display **Sensor A/Set Filter**.
   b. Press the **ENTER key** to display a screen like **Set Filter/(0S)**.
   c. Use the **Arrow keys** to adjust to the desired filter time of **"2S".**
   d. Press **ENTER key** to enter the filter time.
8. Select Pulse Suppress (ON/OFF)
   a. With the **Sensor A/Set Filter** screen displayed, press the **Down key** once to display **Sensor A/Pulse Suppress**.
   b. Press the **ENTER key** to display a screen like **Pulse Suppress/ (ON)**.
   c. Use the **Down** and **Up keys** to select the pulse suppress mode of **"ON".**
   d. Press the **ENTER key** to enter pulse suppress mode.
9. Select Temp Element Type
   a. With the **Sensor A/Pulse Suppress** Screen displayed press the **Down key** twice to display **Sensor A/Temp Element**.
   b. Press **ENTER key** to display **Temp Element/Select Type**.
   c. Press **ENTER key** again to display a screen like **Select Type/(PT1000)**.
   d. Use the **Down** and **Up keys** to select **PT1000** as the type of temperature element used with the sensor to compensate the measurement.
   e. Press **ENTER key** to enter the selected temperature element.
10. Set T Factor (Sensor's GLI-certified "T" factor)
   a. With the **Temp Element/Select Type** screen displayed, press the **Down key** once to display **Temp Element/Set T Factor**.
   b. Press **ENTER key** to display a screen like **Set T Factor/(1000.0 OHMS)**.
   c. Use the **Arrow keys** to adjust the displayed value to **EXACTLY MATCH** the sensor's GLI certified T Factor listed on the cable
   d. Press **ENTER key** to enter certified T Factor.
   e. After the **Temp Element/Set T Factor** screen re-appears, press **ESC key** twice to return to the **Configure/Sensor A** screen.
11. Set °C or °F (temperature display format)
   a. With the **Configure/ Sensor A** screen displayed, press **UP key ONLY** twice until the **Configure/Set °C or °F** screen appears.
   b. Press **ENTER key** to display a screen like **Set °C or °F/(°C)**.
   c. Use the **Down and Up keys** to select the display temperature units **(°F)**.
   d. Press **ENTER key** to enter the selected display temperature units.
12. Set Parameter (These instructions configure Output 1. Configure Output 2 in the same way.)
   a. With the **Configure/Set °C or °F** screen displayed, press the **UP key ONLY** until **Configure/Set Output 1** appears.
   b. Press **ENTER key** to display **Set Output 1/Set Parameter**.
   c. Press **ENTER key** again to display a display screen like **Set Parameter/(Sensor A)**.
   d. Use the **Up** and **Down keys** to select the parameter the output will represent.
      1) **Output 1** Parameter **Sensor A**
      2) **Output 2** Parameter **Sensor B**
   e. Press **ENTER key** to enter the selected parameter.
13. Set 0/4mA and 20mA Values (range expand)
   a. With the **Set Output 1/Set Parameter** screen displayed, press **Down key** once to display **Set Output 1/Set 4mA Value**.

b. Press **ENTER key** to display a screen like **Set 4mA Value/ (0.0 uS/cm)**.
c. Use the **Arrow keys** to set the value for which **0/4mA** is desired.
    1) For **Output 1 Sensor A** enter **0.0 uS/cm**
    2) For **Output 2 Sensor B** enter **0.0 uS/cm**
d. Press **ENTER key** to enter the desired value selected.
e. After the **Set Output 1 Set 4mA Value** screen re-appears, press **Down key** once to display **Set Output 1/Set 20mA Value**.
f. Press **ENTER key** to display a screen like **+++.+ uS/cm**.
g. Use **Arrow keys** (**Left** key **decreases** value and **Right** key **increases** value) to set value at which **20mA** is desired.
    1) For **Output 1 Sensor A** enter **100 uS/cm**
    2) For **Output 2 Sensor B** enter **2000 uS/cm**
h. Press **ENTER key** to enter the desired value selected.

14. Set Filter Time
    a. With the **Set Output 1/Set 20mA Value** Screen displayed Press **Down key** Twice to display **Set Output 1/Set Filter**.
    b. Press **ENTER key** to display a screen like **Set Filter/(0S)**.
    c. Use **Arrow keys** to adjust to a filter time of **"2S".**
    d. Press **ENTER key** to enter the selected filter time.
15. Set Scale 0mA/4mA(low end point
    a. With the **Set Output 1/Set Filter** screen displayed, press **Down key** once to display **Set Output 1/Scale 0mA/4mA**.
    b. Press **ENTER** key to display a screen like **Scale 0mA/4mA/(4mA)**.
    c. Use the **Down** and **Up keys** to select the minimum value of **"4mA"** for the analog output
    d. Press **ENTER key** to enter the selected minimum value.
16. Return to Measure Screen - Press the **MENU key** once and then the **ESC key** once.
17. Configuration Complete.

Conductivity Sensor Replacement:

Parts (TM 10-4610-309-24P):
    GLI Model 3455-Series Sanitary (CIP) Flange Style Conductivity Sensor
    Gasket
Material:
    Five Gallon Bucket
    Tie Wraps
Tools:
    Electrical Tool Box
Equipment Condition:
    TWPS in Standby Shutdown With Drain-Down
    Army TWPS: Generator off and TWPS main breaker off
    Marine Corps TWPS: TWPS disconnected from power source

Replace either or both of the conductivity elements (sensors) listed below as follows:
- Product Conductivity Element CE-501A
- Product Conductivity Element CE-501B

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the conductivity elements. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the transmitter. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure that the piping connection where the sensor is to be removed has been depressurized and drained.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the sensor as follows:

NOTE
Place a bucket under the sensor to catch any liquid still in the piping system.

a. Remove the sanitary clamp and gasket that secure the sensor in the process pipe and pull the sensor out of the pipe (see Figure 8 for the location of the conductivity sensors).
b. Inspect the gasket for damage and replace if necessary.

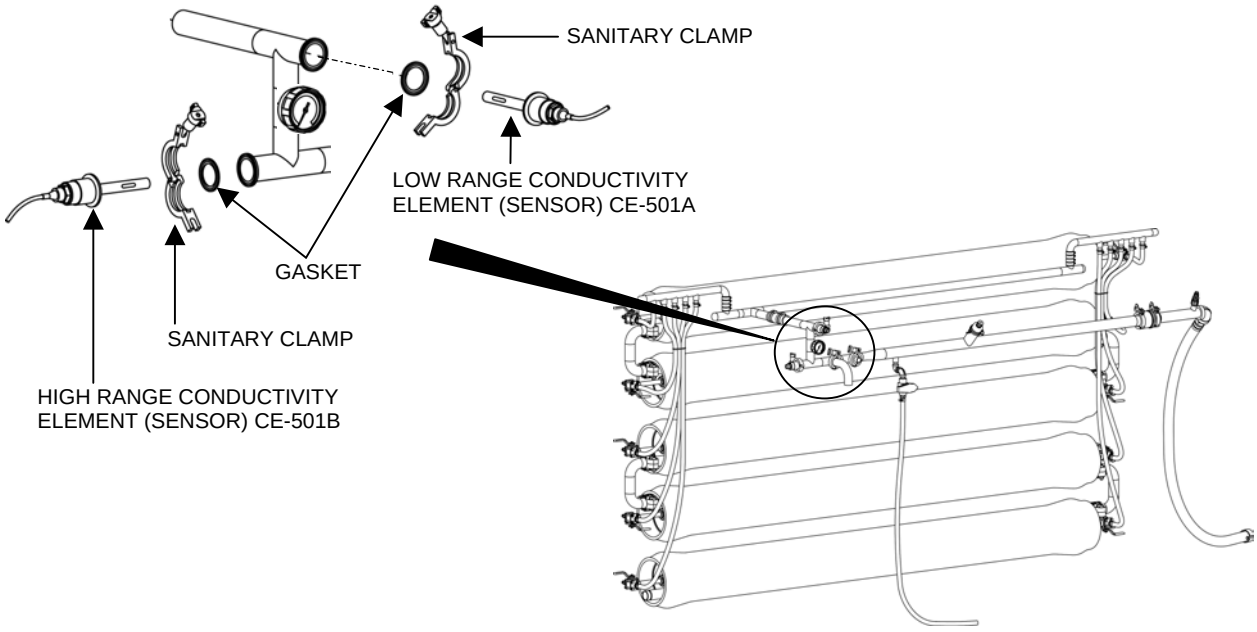

Figure 8. Conductivity Sensors Location.

c. Mark the sensor cable routing from the sensor to the transmitter in the Instrument/Solenoid Panel Box (see Figure 9 for the sensor and box locations).
d. Cut the tie wraps that secure the sensor cable along its routing from the sensor to the transmitter.
e. Unscrew the ring nut from the panel box that the cable runs through.

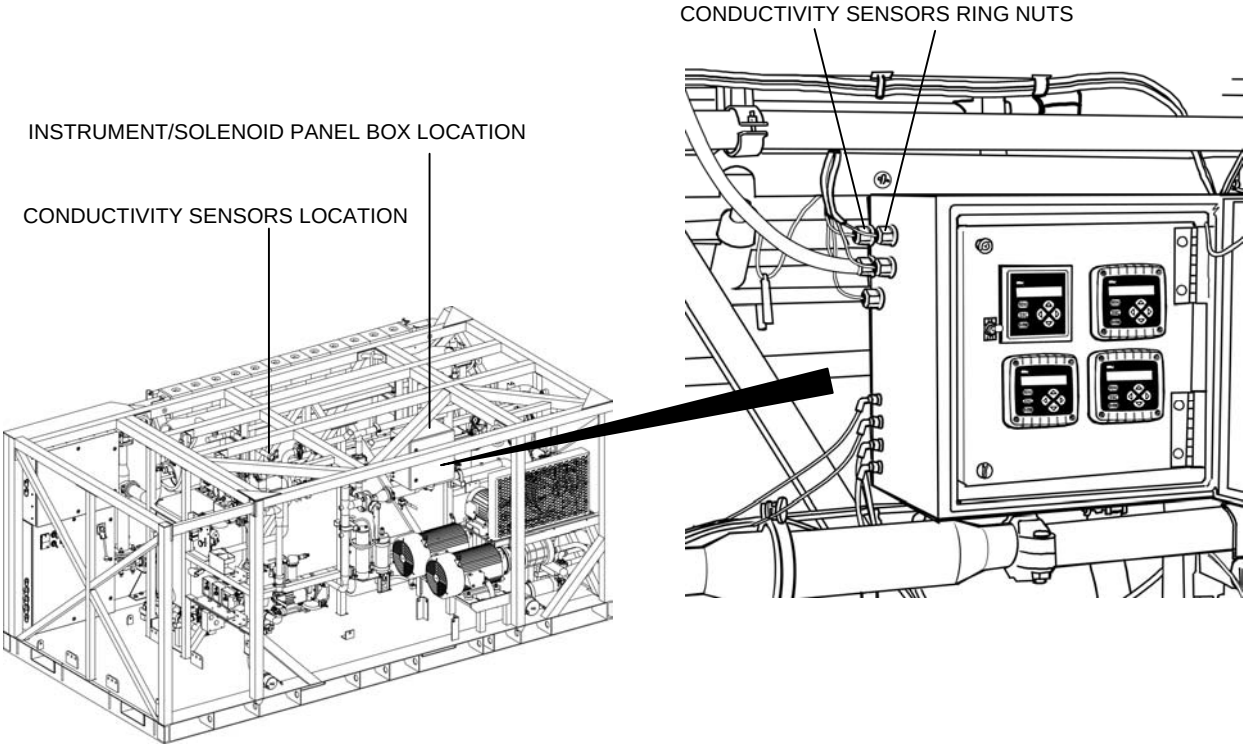

Figure 9. Conductivity Sensors and Instrument/Solenoid Panel Box Location.

f. Disconnect the sensor outer shield wire from module TB2 and the sensor red, black, inner shield, white, and blue wires from module TB3 at the back of the conductivity transmitter CIT-501 (see Figure 10).
g. Pull the wiring through the panel box and remove the sensor and its cabling.

3. Clean the area where the sensor mounts and inspect for any condition that could cause leakage.
4. Install the new conductivity sensor as follows:
   a. Position the gasket on the piping flange.
   b. Insert the new sensor into the piping and position it against the gasket.
   c. Secure the sensor and gasket to the flange using the sanitary clamp and tighten.
   d. Rout the sensor cabling back through the cabling run that was marked earlier during removal and secure the sensor cabling and the other cabling in the run with tie wraps.
   e. Feed the sensor cabling through the ring nut and panel box.

5. Connect the sensor wiring to the back of the transmitter as follows (see Figure 10):

CAUTION

Both conductivity sensors have two shield wires. One of the two shield wires has shrink tube near the end of the wire. This shield wire is the outer sensor shield wire and must be connected to the terminal at the TB2 module. If the two shield wires are not connected to their proper terminals, the conductivity sensor and transmitter may not function properly.

a. Outer shield wire (stranded wire with clear sheathing and a shrink tube near the end of the wire) to the open terminal on module TB2.
b. Red sensor wire to the TB3 module terminal labeled DRIVE (RED).
c. Black sensor wire to TB3 module terminal labeled SENSE (BLK).
d. Inner shield wire (stranded wire with clear sheating without a shrink tube) to the TB3 module terminal labeled SHLD (INNER).
e. White wire to the TB3 module terminal labeled TEMP+(WHT).
f. Blue wire to the TB3 module terminal labeled TEMP-(BLU).

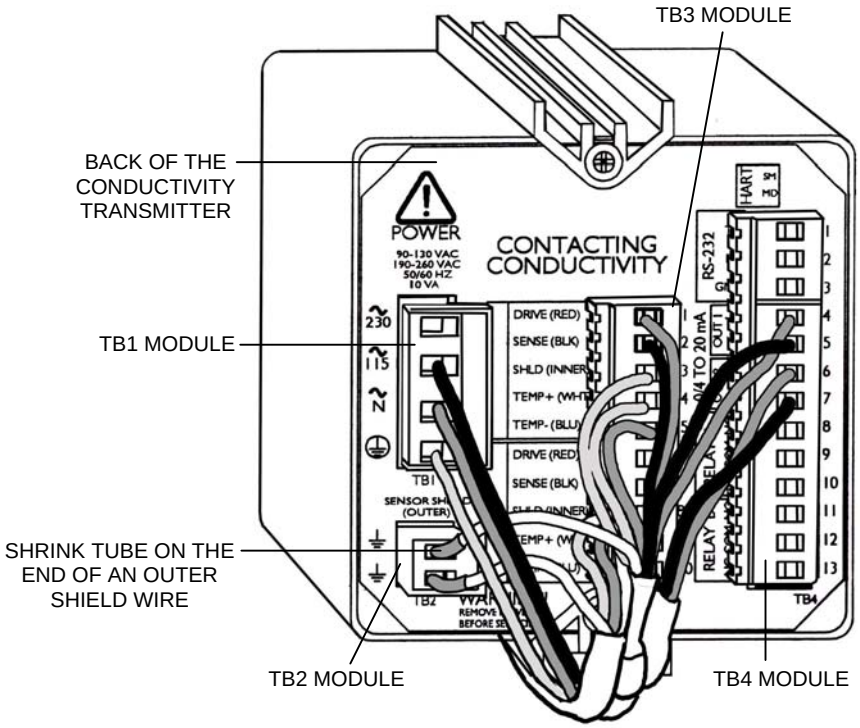

Figure 10. Conductivity Sensor Wiring Connections to the Conductivity Transmitter.

6. Configure the conductivity transmitter with the new conductivity sensor as described in **Conductivity Transmitter Configuration**.
7. Run the TWPS and check for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

MF and RO System Indicator Replacement:

Parts (TM 10-4610-309-24P):
- MF Feed Pressure Indicator PI-101
- MF Filtrate Pressure Indicator PI-201
- RO Feed Pressure Indicator PI-202
- HPP Discharge Pressure Indicator PI-301
- RO Feed Pressure Indicator PI-304
- RO Reject Pressure Indicator PI-401
- RO Product Pressure Indicator PI-501
- RO Feed Tank Temperature Indicator TI-202

Material:
Five Gallon Bucket
Antiseizing Tape (WP 0079, Table 1, item 30, 31)

Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace any of the MF or RO System pipe-threaded pressure, temperature or flow indicators listed below as follows:
- MF Feed Pressure Indicator PI-101
- MF Filtrate Pressure Indicator PI-201
- RO Feed Pressure Indicator PI-202
- HPP Discharge Pressure Indicator PI-301
- RO Feed Pressure Indicator PI-304
- RO Reject Pressure Indicator PI-401
- RO Product Pressure Indicator PI-501
- RO Feed Tank Temperature Indicator TI-202

NOTE

Make sure that the piping where any of these indicators are to be removed has been depressurized and drained.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the indicator as follows (see Figure 11 for the location and position of MF and RO system indicators):

NOTE

Note the direction of the front of the indicator is facing before removal to ensure that the new indicator faces in the same direction.

a. Where possible, place the five gallon bucket under the area where the indicator is to be removed to catch any leakage.
b. Remove the gauge.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

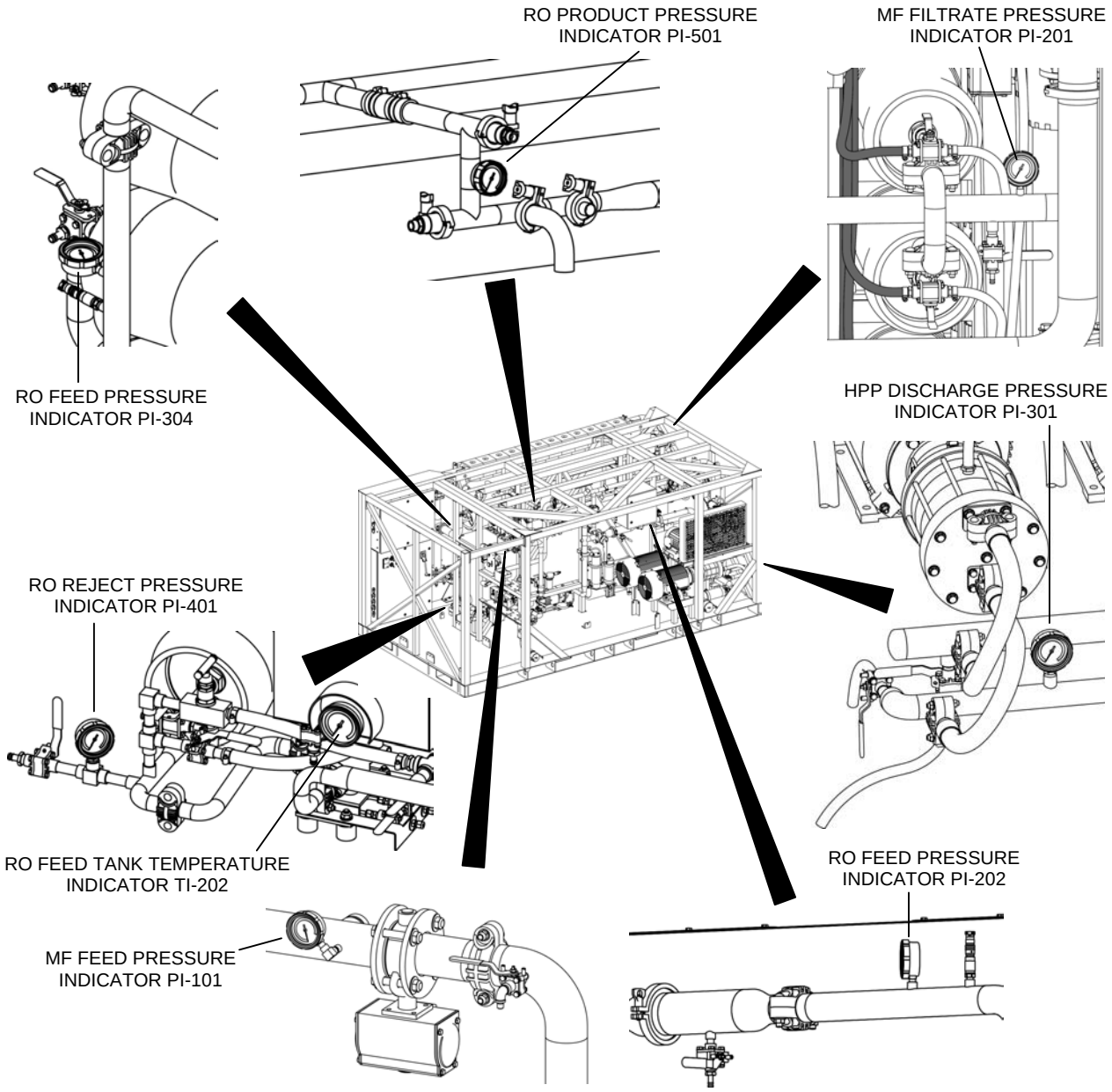

Figure 11. Location and Position of MF and RO System Indicators.

3. Clean the area where the indicator mounts and inspect for conditions that could cause leakage.
4. Wrap antiseizing tape on the gauge threads and thread the gauge into position.
5. Run the TWPS and check for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0062 00**
UNIT MAINTENANCE PROCEDURES
CONTROL INSTRUMENTS

MF and RO System Transmitter Replacement:

Parts (TM 10-4610-309-24P):
- MF Feed Pressure Transmitter PT-101
- MF Filtrate Pressure Transmitter PT-102
- RO Feed Tank Level Transmitter LT-201
- RO Feed Pressure Transmitter PT-201
- RO Feed Pressure Transmitter PT-302
- RO Feed (Filtrate) Temperature Transmitter TT-201

Material:
Five Gallon Bucket
Antiseizing Tape (WP 0079, Table 1, item 30, 31)

Equipment Condition:
TWPS in Standby Shutdown With Drain-Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace any of the MF or RO System Pipe threaded Pressure, Level, and Temperature Transmitters listed below as follows:
- MF Feed Pressure Transmitter PT-101
- MF Filtrate Pressure Transmitter PT-102
- RO Feed Tank Level Transmitter LT-201
- RO Feed Pressure Transmitter PT-201
- RO Feed Pressure Transmitter PT-302
- RO Feed (Filtrate) Temperature Transmitter TT-201

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on a transmitter. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on a transmitter. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the transmitter from the MF or RO system as follows (see Figure 12 for the location of the MF and RO system transmitters):
    a. Disconnect the electrical cable attached to the transmitter.

NOTE

Where possible, place a bucket under the transmitter that is to be removed to catch any excess fluid in the line.

    b. Remove the transmitter from the threaded pipe connection.

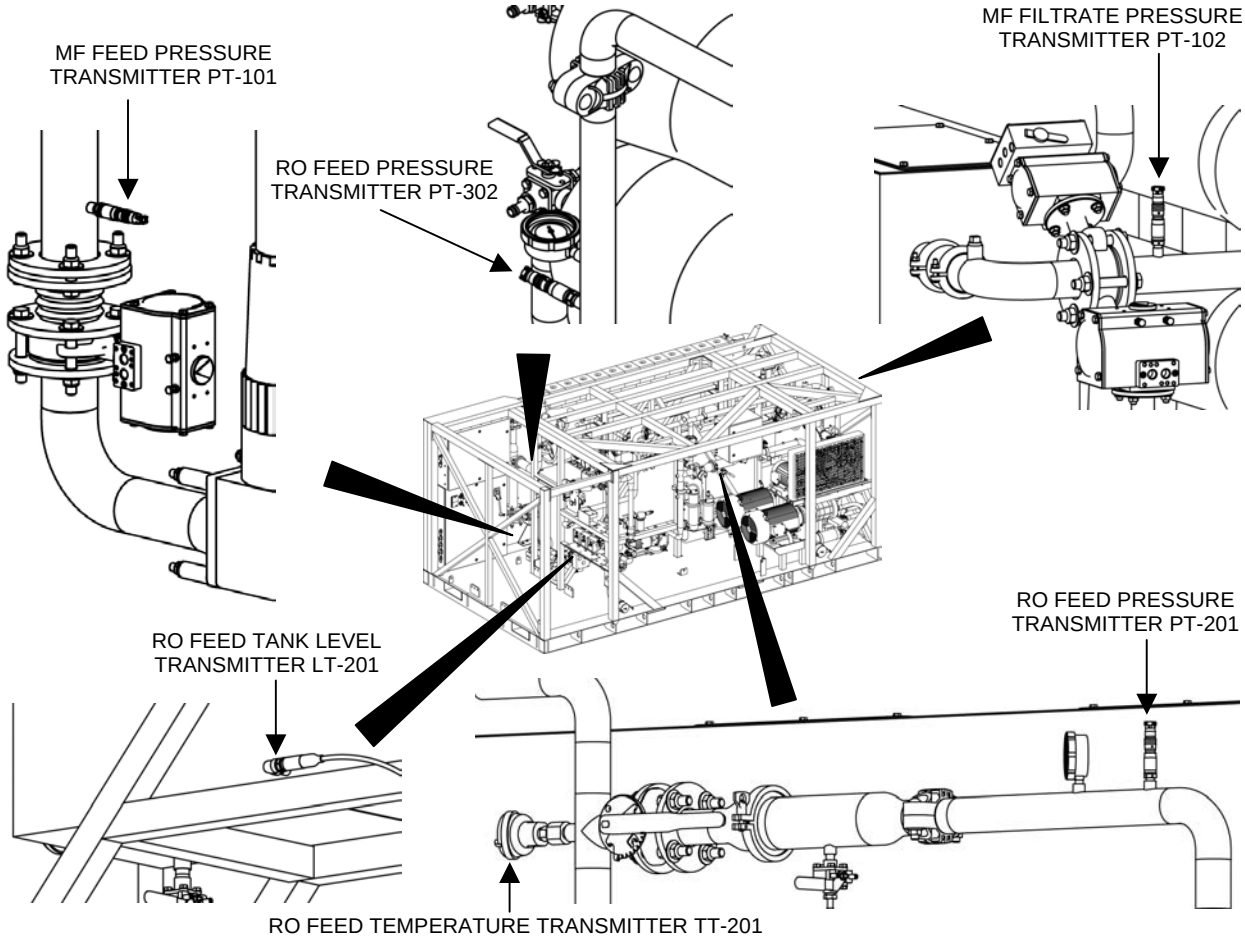

Figure 12. Location of MF and RO System Transmitters.

3. Clean the area around the removed transmitter and inspect the area for corrosion, cracks or other conditions that could cause the transmitter or pipe connection to leak or malfunction.
4. Install the new transmitter as follows:
    a. Wrap antiseizing tape on the transmitter threads and thread the transmitter into position.

NOTE

Be careful not to over-tighten the transmitter or back off the transmitter after tightening as this could weaken the pipe tape and cause leakage.

    b. Reconnect the electrical cable to the transmitter.
5. Operate the TWPS and check for leaks and proper operation.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0063 00**
UNIT MAINTENANCE PROCEDURES
POWER DISTRIBUTION SYSTEM

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One Maintainer
Equipment Condition
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

GENERAL:

This work package contains information and instructions for replacing components of the Power Distribution System. The procedures covered in this work package include:

- Circuit Breaker With Auxiliary Switch Replacement
- Circuit Breaker Replacement
- GFI Module Replacement
- Contactor/Overload Relay/Surge Suppressor Replacement
- Contactor/Surge Suppressor Replacement
- Surge Arrester Replacement
- Surge Arrester Assembly Replacement
- Busbar Jumper Replacement
- Surge Suppressor Replacement
- Transformer Replacement
- 125 Amp Main Power Circuit Breaker Replacement
- Distribution Block Replacement
- Power Connector Replacement
- Light Outlet Replacement
- Utility Outlet Replacement
- Light Switch Replacement
- Main Circuit Breaker Handle Replacement

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0063 00**
UNIT MAINTENANCE PROCEDURES
POWER DISTRIBUTION SYSTEM

REPLACE

Circuit Breaker with Auxiliary Switch Replacement:

Parts (TM 10-610-309-24P):
- Circuit Breaker, 10 amp 3 pole
- Circuit Breaker, 16 amp 3 pole
- Circuit Breaker, 63 amp 3 pole
- Circuit Breaker, 20 amp 3 pole
- Auxiliary Switch

Equipment Condition:
- TWPS in Standby Shutdown Without Draining Down
- Army TWPS: Generator off and TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Replace a circuit breaker with an auxiliary switch on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of Circuit Breaker before replacing.

1. Remove a circuit breaker with an auxiliary switch as follows (see Figure 1):
   a. Open the power distribution panel and locate the circuit breaker to be replaced.
   b. Remove wire duct covers above and below circuit breaker.
   c. Tag the wires attached to the circuit breaker and the attached auxiliary switch.
   d. Loosen the screw terminal connections and remove the connecting wires.
   e. Using a flat-tip screwdriver, insert it into the DIN rail holding clip at the bottom of the circuit breaker. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail. Then lift up on the breaker and remove it from the DIN rail.
   f. Set the circuit breaker to the “Off” position.
   g. Remove the two spring clamps that secure the auxiliary switch to the circuit breaker and retain for reassembly.
   h. Carefully separate the auxiliary switch from the circuit breaker and retain for reassembly.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0063 00**
UNIT MAINTENANCE PROCEDURES
POWER DISTRIBUTION SYSTEM

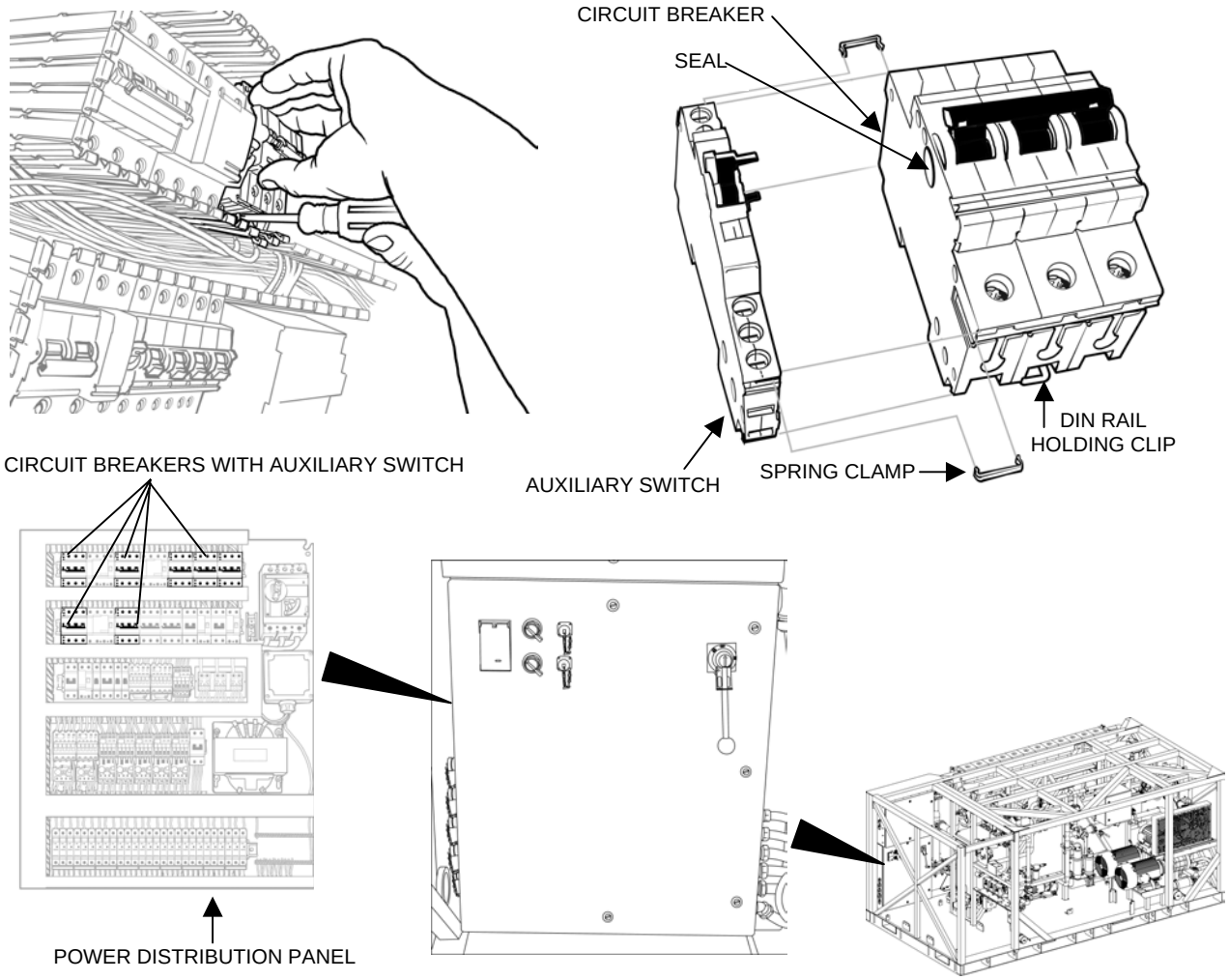

Figure 1. Circuit Breaker with Auxiliary Switch Replacement.

2. Install a new circuit breaker and auxiliary switch as follows:
    a. Set the new circuit breaker and auxiliary switch in the OFF position.
    b. Break out the opening on the side of the new circuit breaker and remove the seal.
    c. Position the auxiliary switch on the side of the circuit breaker.
    d. Secure the auxiliary switch to the side of the circuit breaker using the two spring clamps.
    e. Position the circuit breaker on the DIN Rail and carefully press the circuit breaker in place.
    f. Attach the wires to the screw connections in accordance to the wire tags.
    g. Tighten the screw connections to secure the wires.
    h. Remove the wire tags if necessary.
    i. Reinstall the wire duct covers.
    j. Close the power distribution panel.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0063 00**
UNIT MAINTENANCE PROCEDURES
POWER DISTRIBUTION SYSTEM

Circuit Breaker Replacement:

Parts (TM 10-610-309-24P):
- Circuit Breaker, 25 amp 3 pole
- Circuit Breaker, 16 amp 2 pole
- Circuit Breaker, 2 amp 1 pole
- Circuit Breaker, 4 amp 2 pole
- Circuit Breaker, 8 amp 1 pole
- Circuit Breaker, 4 amp 1 pole
- Circuit Breaker, 20 amp, 3 pole

Equipment Condition:
- TWPS in Standby Shutdown Without Draining Down
- Army TWPS: Generator off and TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Replace a circuit breaker on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct type of Circuit Breaker before replacing.

1. Remove a circuit breaker as follows (see Figure 2):
   a. Open the power distribution panel and locate the circuit breaker to be replaced.
   b. Remove wire duct covers above and below the circuit breaker.
   c. Tag the wires attached to the circuit breaker.
   d. Loosen the two screw terminal connections and remove the connecting wires.
   e. Using a flat-tip screwdriver, insert it into the DIN rail holding clip at the bottom of the circuit breaker. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail. Then lift up on the breaker and remove it from the DIN rail.

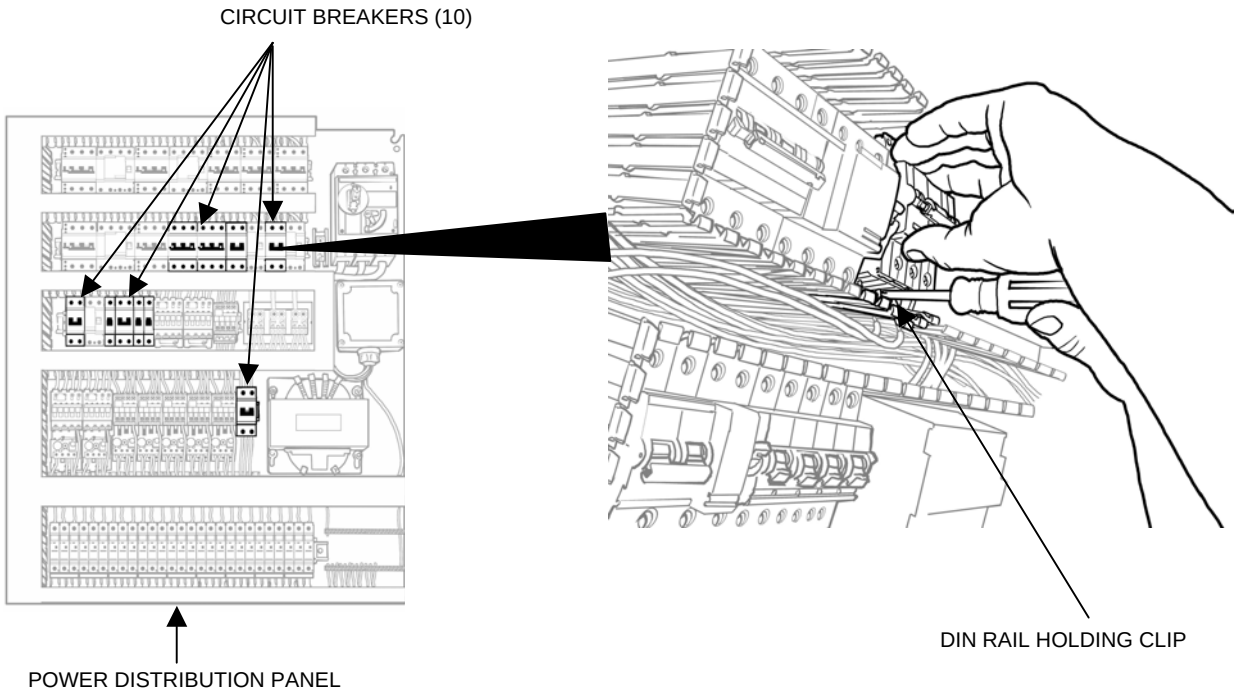

Figure 2. Circuit Breaker Replacement.

2. Install a new circuit breaker as follows:
    a. Position the new circuit breaker on the DIN rail and carefully press the circuit breaker in place.
    b. Attach the wires to the screw connections in accordance to the wire tags.
    c. Tighten the screw connections to secure the wires.
    d. Remove the wire tags if necessary.
    e. Reinstall the wire duct covers.
    f. Close the power distribution panel.

GFI Module Replacement:

Parts (TM 10-610-309-24P):
GFI Module, 4 pole, 300ma
GFI Module, 2 pole, 30ma
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0063 00**
UNIT MAINTENANCE PROCEDURES
POWER DISTRIBUTION SYSTEM

Replace a GFI module on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of GFI module before replacing.

1. Remove a GFI module as follows (see Figure 3):
    a. Open the power distribution panel and locate the GFI module to be replaced.
    b. Remove wire duct covers above and below the GFI module.
    c. Tag the wires attached to the GFI module.
    d. Loosen the two screw terminal connections and remove the connecting wires.
    e. Using a flat-tip screwdriver, insert it into the DIN rail holding clip at the bottom of the circuit breaker. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail. Then lift up on the breaker and remove it from the DIN rail.

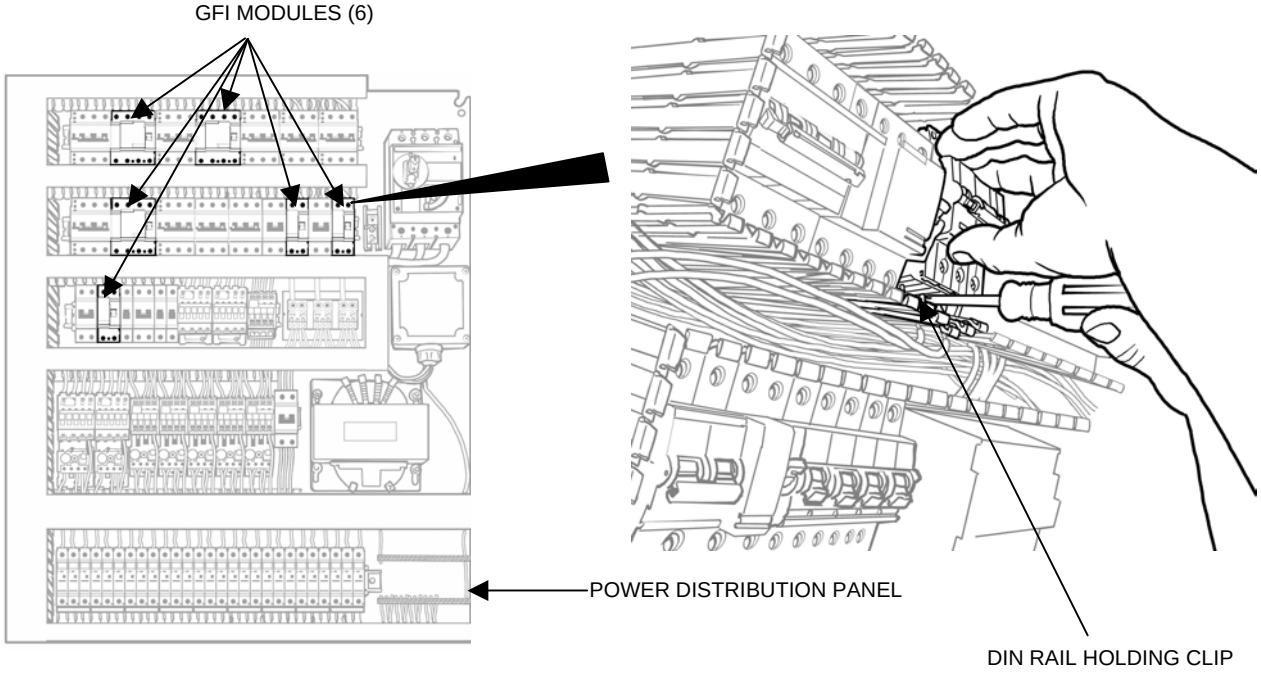

Figure 3. GFI Module Replacement.

2. Install a new GFI module as follows:
    a. Position the new GFI module on the DIN rail and carefully press the GFI module in place.
    b. Attach the wires to the screw connections in accordance to the wire tags.
    c. Tighten the screw connections to secure the wires.
    d. Remove the wire tags if necessary.
    e. Reinstall the wire duct covers.
    f. Close the power distribution panel.

Contactor/Overload Relay / Surge Suppressor Replacement:

Parts (TM 10-610-309-24P):
Contactor, 3 pole, 5 HP
Contactor, 3 pole, 7 1/2 HP
Contactor, 3 pole, 20 HP
Overload Relay, Adjustable, 28 - 42 amp
Overload Relay, Adjustable, 4.5 - 6.5 amp
Overload Relay, Adjustable, 10 - 14 amp
Overload Relay, Adjustable, 6 - 8.5 amp
Surge Suppressor, 120vac
Equipment Conduction:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a contactor/overload relay/suppressor assembly on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct type of contactor/overload relay/suppressor before replacing.

1. Remove a contactor/overload relay/suppressor assembly as follows (see Figure 4):
    a. Open the power distribution panel and locate the contactor assembly to be replaced.
    b. Tag the wires attached to the contactor assembly.
    c. Loosen the screw terminal connections and remove the connecting wires.
    d. Loosen the three terminal screws connecting the overload relay to the contactor. Separate the overload relay from the contactor.

e. Using a flat-tip screwdriver, insert it into the DIN rail holding clip at the bottom right side of the contactor. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail. Then lift up on the contactor and remove it from the DIN rail.
f. Remove the contactor assembly from the DIN rail.
g. Remove the surge suppressor clip from the contactor.

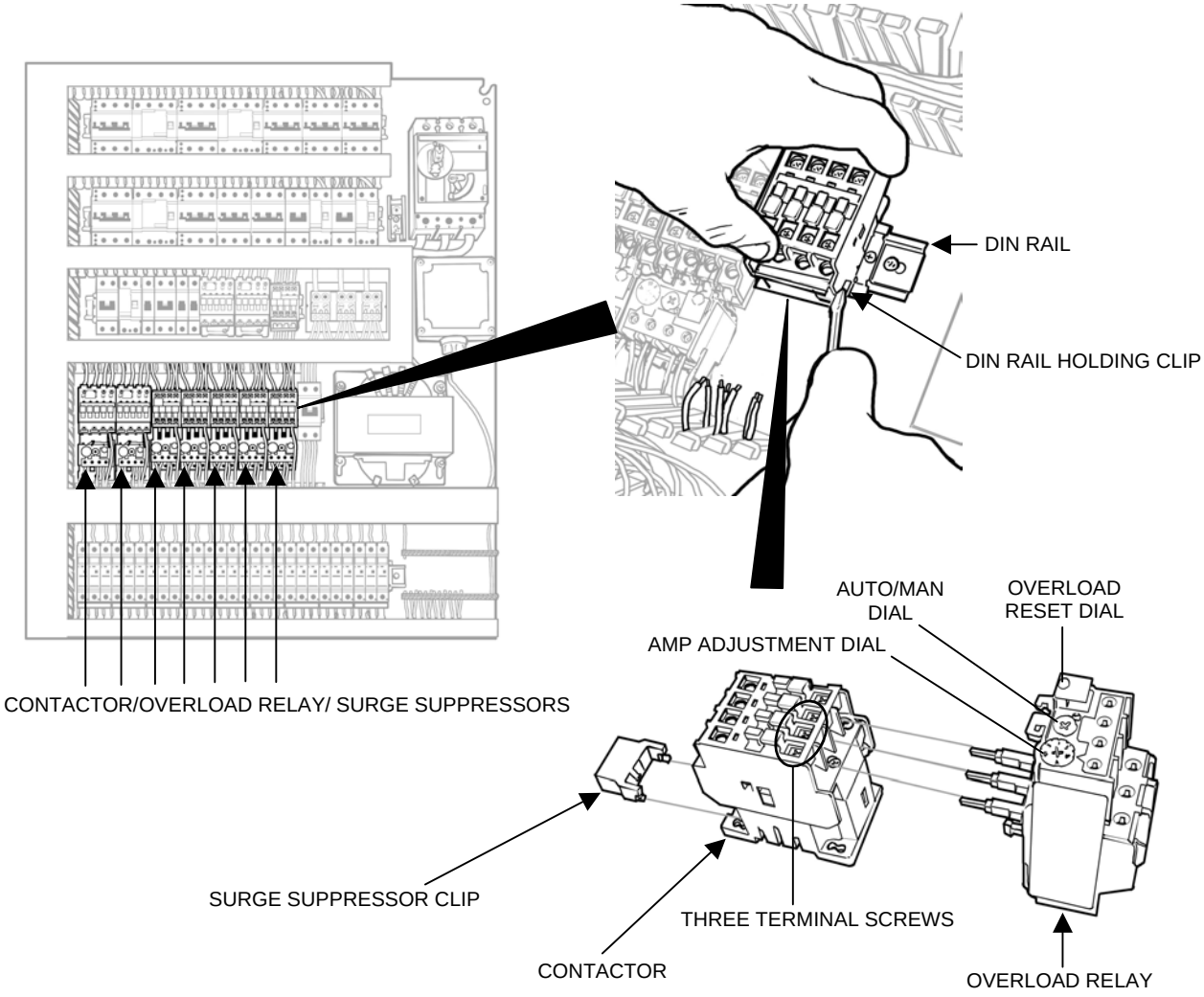

Figure 4. Contactor/Overload Relay/Surge Suppressor Assembly Replacement.

2. Install a new contactor/overload relay/surge suppressor assembly as follows:
   a. Install the surge suppressor clip on the new contactor.
   b. Position the new overload relay on the bottom of the new contactor.
   c. Carefully insert the overload relay terminals into the contactor until locked in place.
   d. Tighten the 3 terminal screws connecting the overload relay to the contactor.

e. Position the contactor assembly on the DIN rail and carefully press into place.
f. Attach the wires to the screw connections in accordance to the wire tags.
g. Tighten the screw connections to secure the wires.
h. Remove the wire tags if necessary.
i. Set the overload relay amp adjustment dial in accordance with the associated contactor number labeled on the contactor as called out in Table 1.

Table 1. Overload Relay Amp Settings.

Contactor Number	Overload Relay Amp Setting
501	5
502	10
503	7 ½
504	33
505	33
506	5
510	8

j. Position the pointer on the Auto/Man dial to MAN.
k. Position the dial on the OVERLOAD RESET to RO.
l. Close the power distribution panel.

Contactor/ Surge Suppressor Replacement:

Parts (TM 10-610-309-24P):
Contactor, 3 pole, 5 HP
Contactor, 3 pole, 20 HP
Surge Suppressor, 120vac
Equipment Conduction:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a contactor/surge suppressor on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of contactor before replacing.

1. Remove a contactor/surge suppressor as follows (see Figure 5):
    a. Open the power distribution panel and locate the contactor/surge suppressor to be replaced.
    b. Tag the wires attached to the contactor/surge suppressor.
    c. Loosen the screw terminal connections and remove the connecting wires.
    d. Using a flat-tip screwdriver, insert it into the DIN rail holding clip at the bottom right side of the contactor. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail. Then lift up on the contactor and remove it from the DIN rail.
    e. Remove the surge suppressor clip from the contactor.

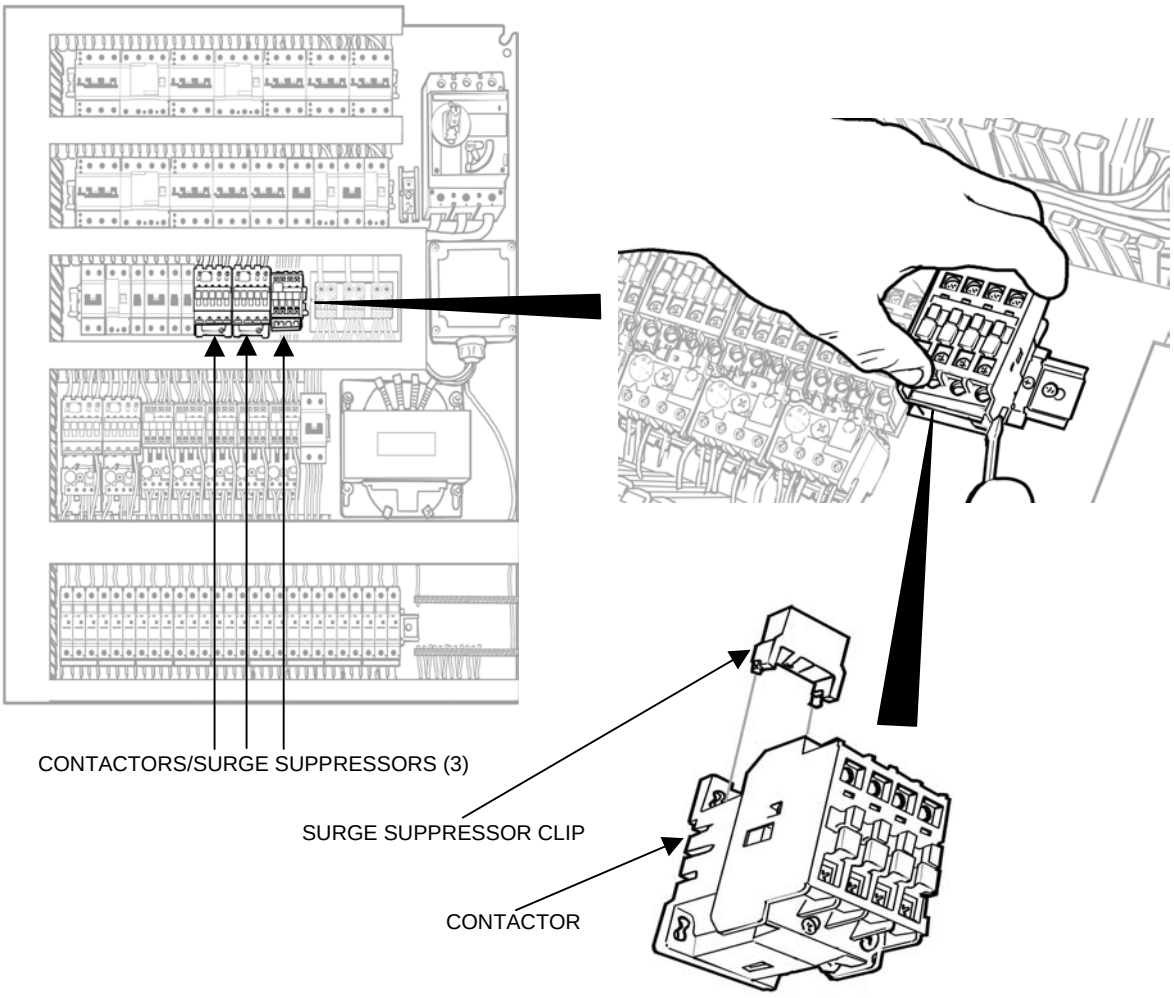

Figure 5. Contactor/Surge Suppressor Replacement.

2. Install a new contactor/surge suppressor as follows:
    a. Install the new surge suppressor clip on the new contactor.
    b. Position the contactor/surge suppressor on the DIN rail and carefully press into place.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Close the power distribution panel.

Surge Arrester Replacement:

Parts:
Surge arrester (TM 10-610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a surge arrester on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the surge arrester as follows (see Figure 6):
    a. Open the power distribution panel and locate the surge arrester.
    b. Carefully pull the surge arrestor from the arrestor assembly socket.

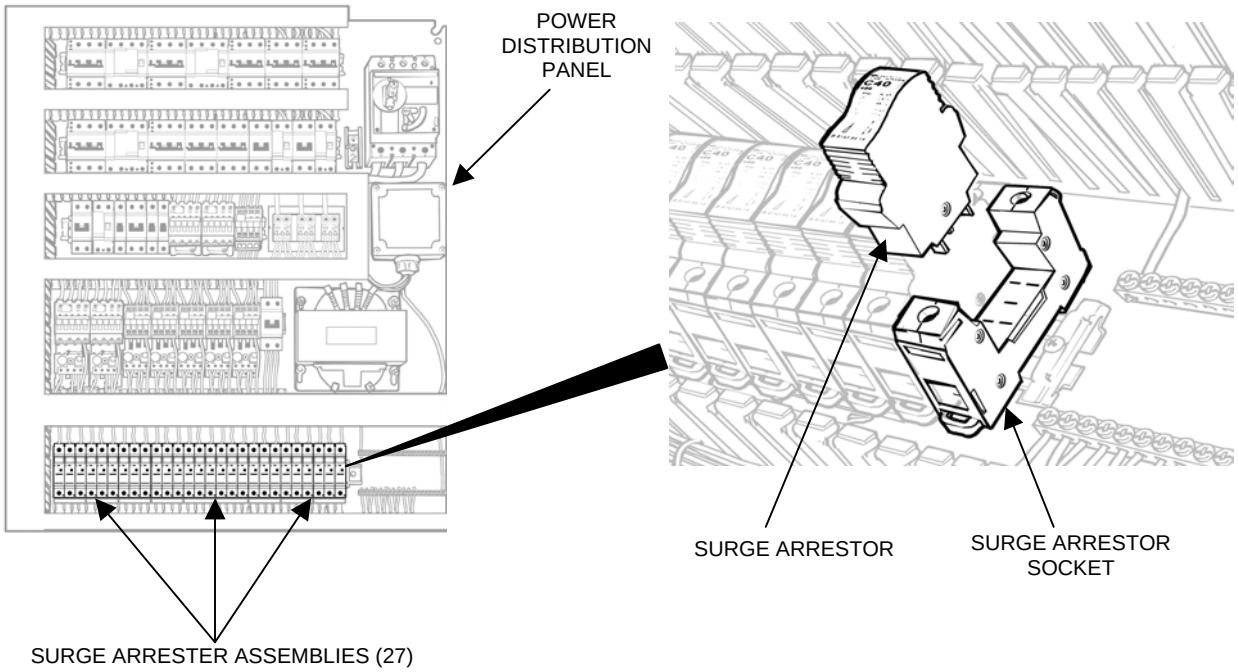

Figure 6. Surge Arrestor Replacement.

2. Install the new surge arrester as follows (see Figure 6):
    a. Position the new surge arrester in socket and align pins with socket pin holes.
    b. Carefully push surge arrester in place.
    c. Close power distribution panel.

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Surge Arrester Assembly Replacement:

Parts:
Surge arrester (TM 10-610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a complete surge arrester assembly on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the surge arrester assembly as follows (see Figure 7):
   a. Open the power distribution panel and locate the surge arrester.
   b. Tag the wires connected to the surge arrester.
   c. Loosen the screw connections and remove the connecting wires.
   d. Pull the busbar jumper from the bottom of the surge arrestor and retain for replacement.
   e. Using a flat-tip screwdriver, insert it into the DIN rail holding clip at the bottom of the arrestor assembly. Gently pry down on the holding clip with the screwdriver to release the clip from the DIN rail. Then lift up on the assembly and remove it from the DIN rail.

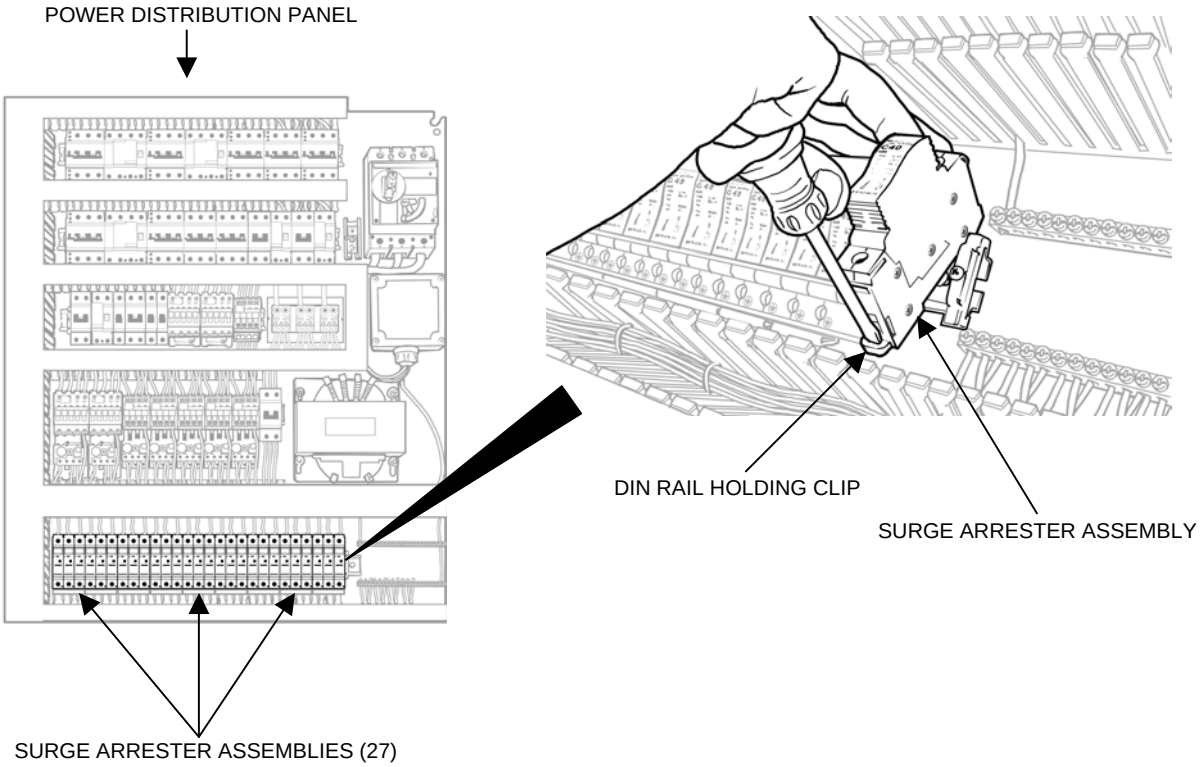

Figure 7. Surge Arrester Assembly Replacement.

2. Install the new surge arrester as follows:
    a. Position the new surge arrester on the DIN rail.
    b. Carefully press the surge arrestor in place on the DIN rail.
    c. Insert the wires in the screw/plug connections in accordance to the wire tags.
    d. Replace the busbar jumper at the bottom of the surge arrestor.
    e. Tighten the screw connections to secure the wires and busbar jumper.
    f. Remove the wire tags if necessary.
    g. Close the power distribution panel.

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Busbar Jumper Replacement:

Parts (TM 10-610-309-24P):
Busbar Jumper, 2 position
Busbar Jumper, 3 position
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace a busbar jumper on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type Busbar Jumper before replacing.

1. Remove a busbar jumper as follows (see Figure 8):
   a. Open the power distribution panel and locate the busbar jumper to be replaced.
   b. Loosen the screw connections at the bottom of the surge arrestor securing the busbar jumper.
   c. Pull the busbar jumper from the surge arrestor.

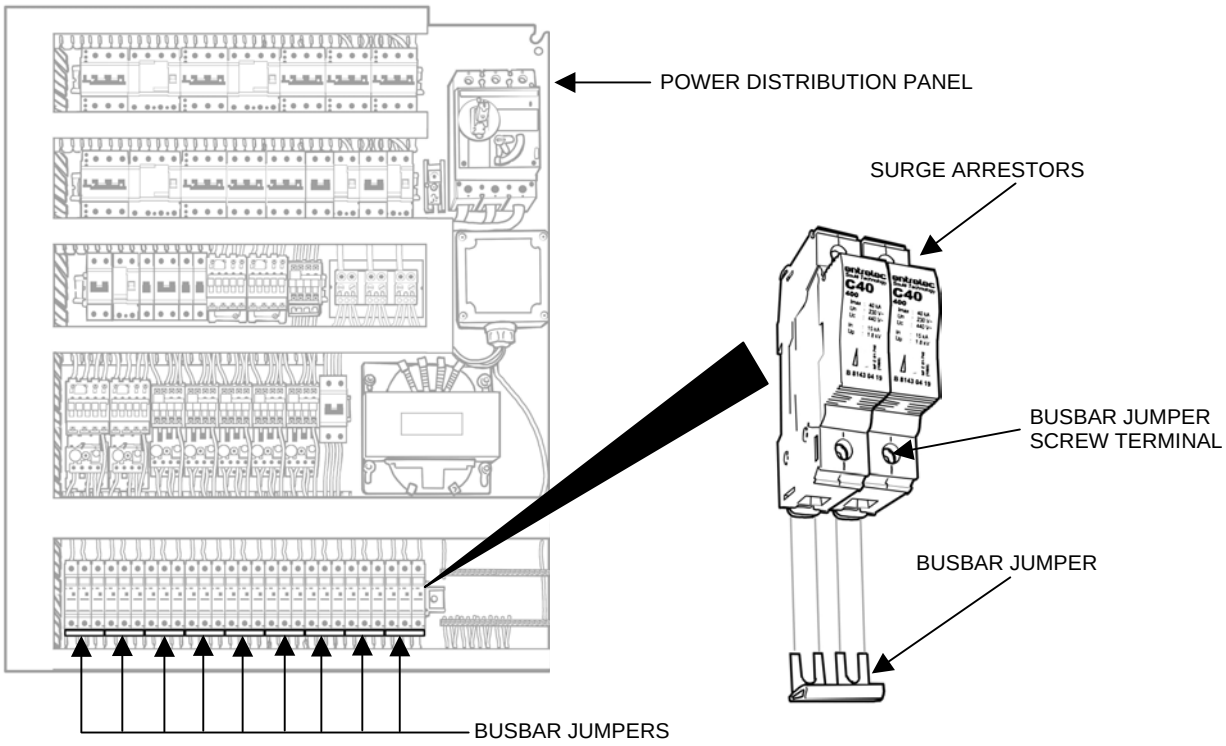

Figure 8. Busbar Jumper Replacement.

2. Install a busbar jumper as follows:
    a. Open the busbar jumper screw terminals fully before positioning the jumper.
    b. Position the new busbar jumper at the bottom of the surge arrestor.
    c. Push the busbar jumper into the surge arrestor until flush.
    d. Tighten the screw terminals at the bottom of the surge arrestor to secure the busbar jumper.

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Surge Suppressor Replacement:

Parts:
Surge Suppressor (TM 10-610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the surge suppressor on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the surge suppressor as follows (see Figure 9):
   a. Open the power distribution panel and locate the surge suppressor.
   b. Tag the wires running from the surge suppressor to the L1, 2, 3, Neutral, and Ground terminals.
   c. Disconnect the wires from the terminal lugs.
   d. Loosen the four screws that secure the surge suppressor cover to the surge suppressor.
   e. Carefully remove the cover and allow for the attaching wires.
   f. Remove the four screws inside the surge suppressor.
   g. Remove the surge suppressor.

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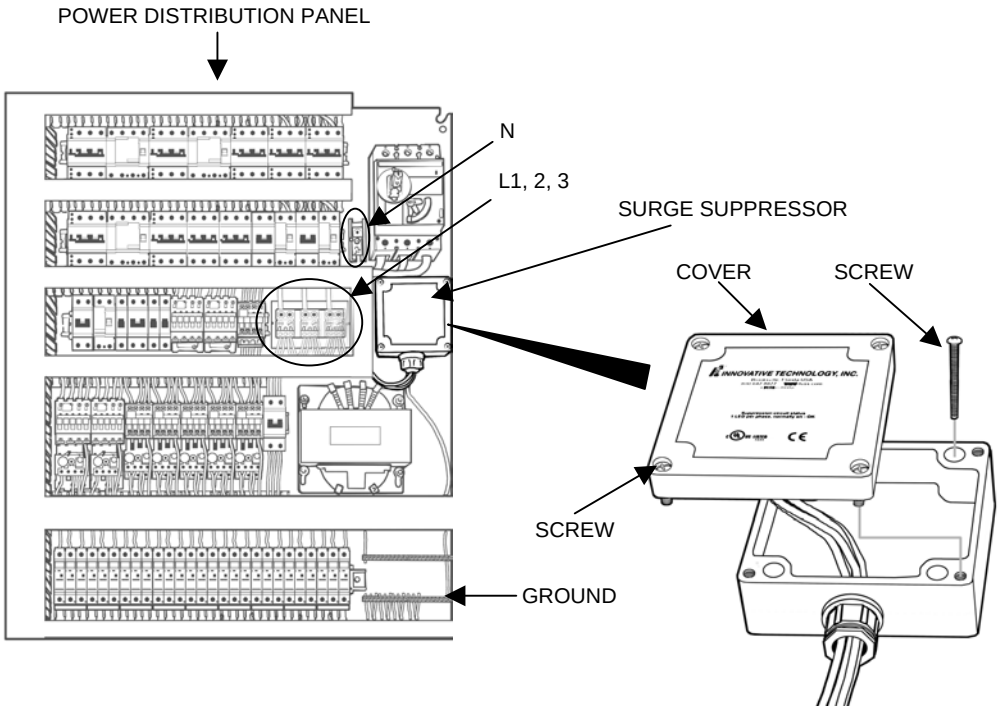

Figure 9. Surge Suppressor Replacement.

2. Install the new surge suppressor as follows:
    a. Position the new surge suppressor on the power distribution panel.
    b. Secure the surge suppressor to the power distribution panel using four screws inside the surge suppressor.
    c. Position the cover on the surge suppressor and tighten the four screws.
    d. Connect the wires from surge suppressor to the L1, 2, 3, Neutral, and Ground terminals.
    e. Remove the wire tags if necessary.
    f. Close the power distribution panel.

Transformer Replacement:

Parts:
Transformer (TM 10-610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the transformer on the power distribution panel as follows:

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WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the transformer as follows (see Figure 10):
    a. Open the power distribution panel and locate the transformer.
    b. Tag the wires attached to the transformer.
    c. Loosen the screw connections and remove the connecting wires.
    d. Remove the four nuts, flat washers and tooth washers that secure the transformer to the power distribution panel and retain for reassembly.
    e. Remove the transformer from the power distribution panel.

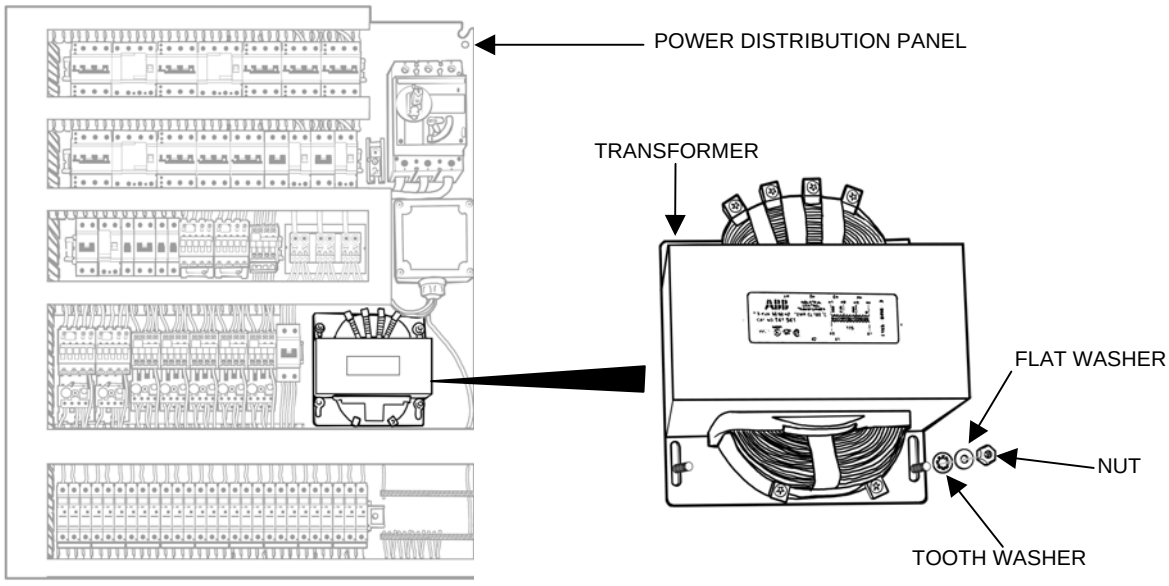

Figure 10. Transformer Replacement.

2. Install new transformer as follows:
    a. Position the transformer on the power distribution panel.
    b. Secure the transformer to the power distribution panel using the four nuts, flat washers and tooth washers.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Remove the wire tags if necessary.
    e. Close the power distribution panel.

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125 Amp Main Power Circuit Breaker Replacement:

Parts (TM 10-610-309-24P):
- Circuit Breaker, 125 Amp
- Breaker Disconnect Mechanism
- Disconnect shaft

Equipment Condition:
- TWPS in Standby Shutdown Without Draining Down
- Army TWPS: Generator off and TWPS main breaker off
- Marine Corps TWPS: TWPS disconnected from power source

Replace the 125 Amp Main Power circuit breaker on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the 125 Amp Main Power circuit breaker as follows (see Figure 11):
   a. Open the power distribution panel and locate the circuit breaker.
   b. Tag the wires attached to the circuit breaker.
   c. Remove the door breaker mechanism from the circuit breaker by loosening the four screws. Note that two screws are located behind the label at the top of the breaker mechanism.
   d. Remove the disconnect shaft from the breaker mechanism if replacement of new breaker mechanism is required.
   e. Loosen the hex key screw terminals on the circuit breaker and remove the connecting wires.
   f. Remove the four screws that secure the circuit breaker to the power distribution panel and retain for reassembly.
   g. Remove the circuit breaker from the panel.

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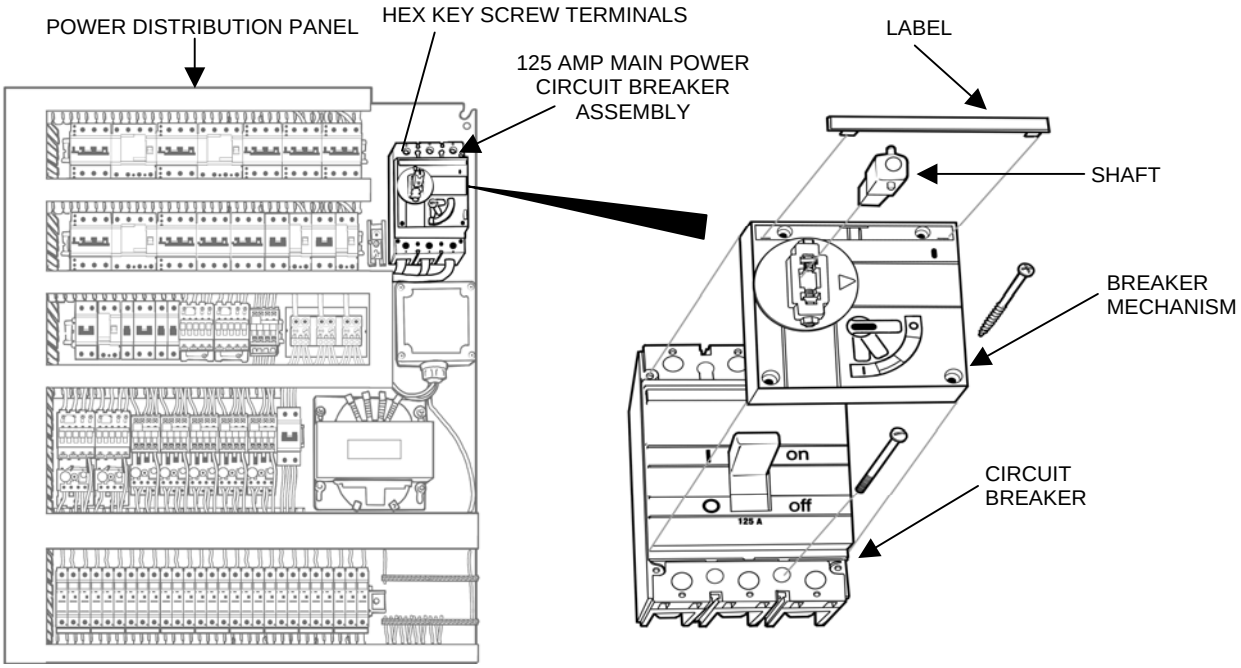

Figure 11. 125 Amp Main Power Circuit Breaker Assembly Replacement.

2. Install the new 125 Amp main power circuit breaker as follows:
    a. Position the new circuit breaker on the panel.
    b. Secure the circuit breaker to the panel using the four screws.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the hex key screw terminals to secure the wires.
    e. Remove the wire tags if necessary.
    f. Make sure the slot on the door breaker mechanism lines up with the switch on the breaker.
    g. Reinstall the shaft to the breaker mechanism if a new mechanism is being install.
    h. Reinstall the breaker mechanism to the circuit breaker. Tighten the four screws.
    i. Close the power distribution panel.

Distribution Block Replacement:

Parts (TM 10-610-309-24P):
    Distribution Block, three pole
    Distribution Block, single pole
Equipment Condition:
    TWPS in Standby Shutdown Without Draining Down
    Army TWPS: Generator off and TWPS main breaker off
    Marine Corps TWPS: TWPS disconnected from power source

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Replace a distribution block on the power distribution panel as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct type of distribution block before replacing.

1. Remove a distribution block as follows (see Figure 12):
    a. Open the power distribution panel and locate the distribution block to be replaced.
    b. Remove the distribution block cover and retain for reassembly.
    c. Tag the wires attached to the distribution block.
    d. Loosen the hex key terminal connections and the screw connections and remove the connecting wires.
    e. Remove the six screws and tooth washers that secure the distribution block to the power distribution panel and retain for reassembly.
    f. Remove the distribution block from the panel.

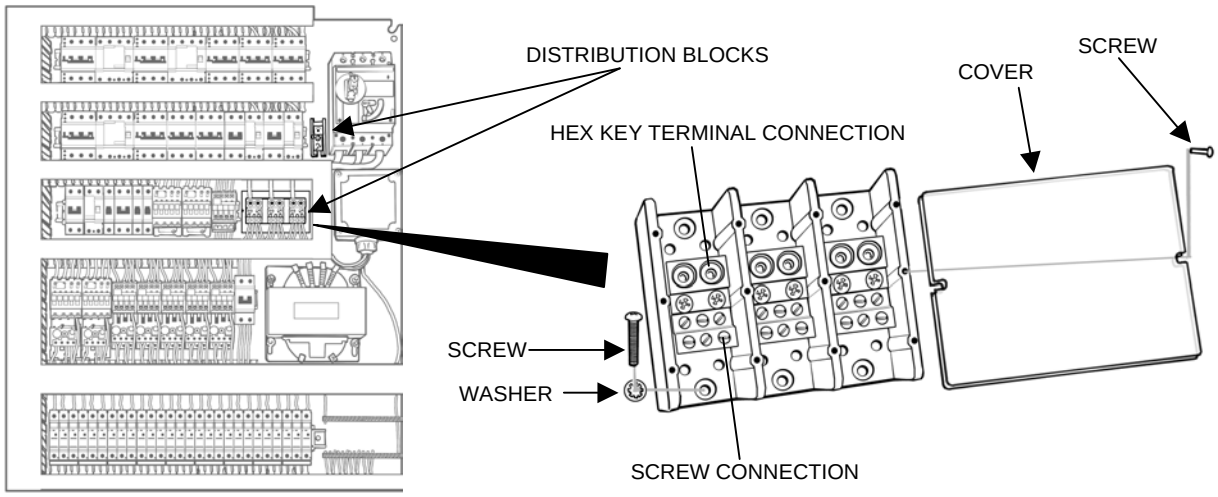

Figure 12. Distribution Block Assembly Replacement.

2. Install a new distribution block as follows:
    a. Position the new distribution block on the panel.
    b. Secure the distribution block to the panel using the six screws and tooth washers.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the hex key terminal connections and screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Install the distribution block cover.
    g. Close the power distribution panel.

Power Connector Replacement:

Parts (TM 10-610-309-24P):
Connector, 3 socket, 16 shell
Connector, 7 socket, 20 shell
Connector, 7 socket, 22 shell
Connector, 7 socket, 24 shell
Gasket, plain
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the power connectors on the power distribution box as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of connector and gasket before replacing.

1. Remove a power connector from the power distribution box as follows (see Figure 13)
    a. Locate the power connector requiring replacement.
    b. Remove the four screws, washers and nuts that secure the connector to the power distribution box and retain for re-installation.
    c. Carefully pull the connector from the distribution box without applying tension to the connecting wires.
    d. Tag the wires attached to the connector.
    e. Cut the attached wires as close to connector as possible and remove the connector.
    f. Remove the dust cover and retain for reinstallation.
    g. Carefully remove the gasket from the distribution box..

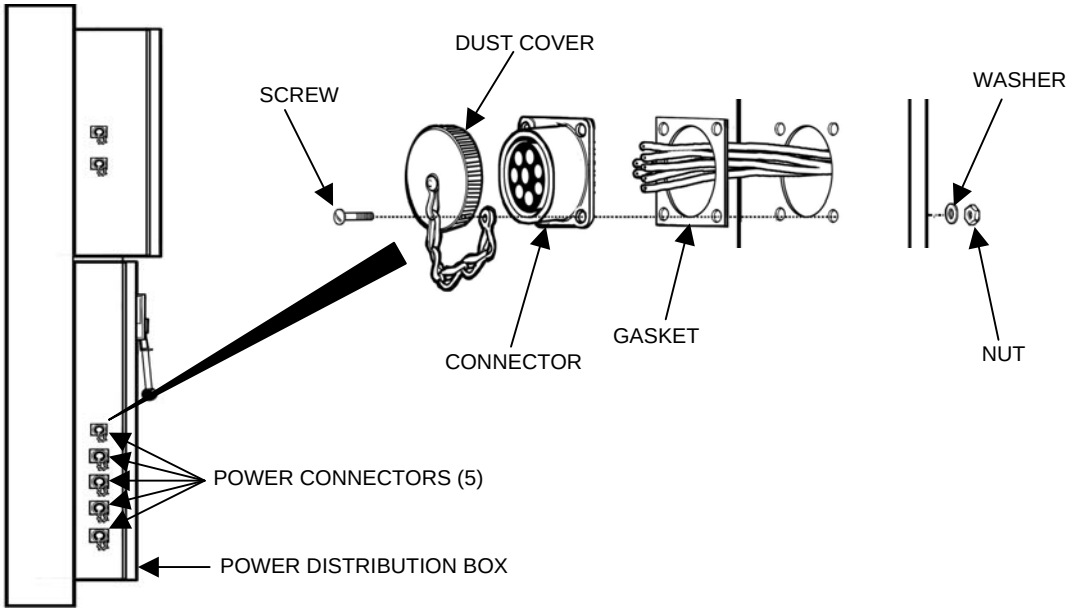

Figure 13. Power Connector Replacement

2. Install new power connector.
    a. Position the new gasket through the wires on the distribution box.
    b. Strip ¾ in. of insulation off the end of each wire.
    c. Solder the wires to new connector connecting pins according to wire tags.
    d. Align the connector and gasket with the screw holes on the power distribution box.
    e. Position the end of dust cover chain on one of the screw holes with the connector and gasket.
    f. Secure the connector, gasket and dust cover chain to the power distribution box using the four screws, washers and lock nuts.

Light Outlet Assembly Replacement:

Parts (TM 10-610-309-24P):
Light outlet assembly, 5 socket, 16 shell
Light outlet assembly, 3 socket, 16 shell
Gasket, plain
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

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Replace the light outlet assemblies on the power distribution box door as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE
Make sure to obtain the correct type of light outlet assembly before replacing.

1. Remove a light outlet assembly from the power distribution box door as follows (see Figure 14)
   a. Locate the light outlet assembly requiring replacement.
   b. Open the power distribution door and locate the back of the light outlet.
   c. Remove the four screws, washers and nuts that secure the light outlet to the power distribution box door and retain for re-installation.
   d. Tag the connection point of the wires from the light outlet to the outlet switches and the utility outlet.
   e. Disconnect the wires at the outlet switches and utility outlet.
   f. Carefully pull the light outlet assembly through the power distribution box door and remove the light outlet assembly.
   g. Remove the dust cap from the light outlet and retain for reassembly.
   h. Carefully remove the gasket from the power distribution box door.

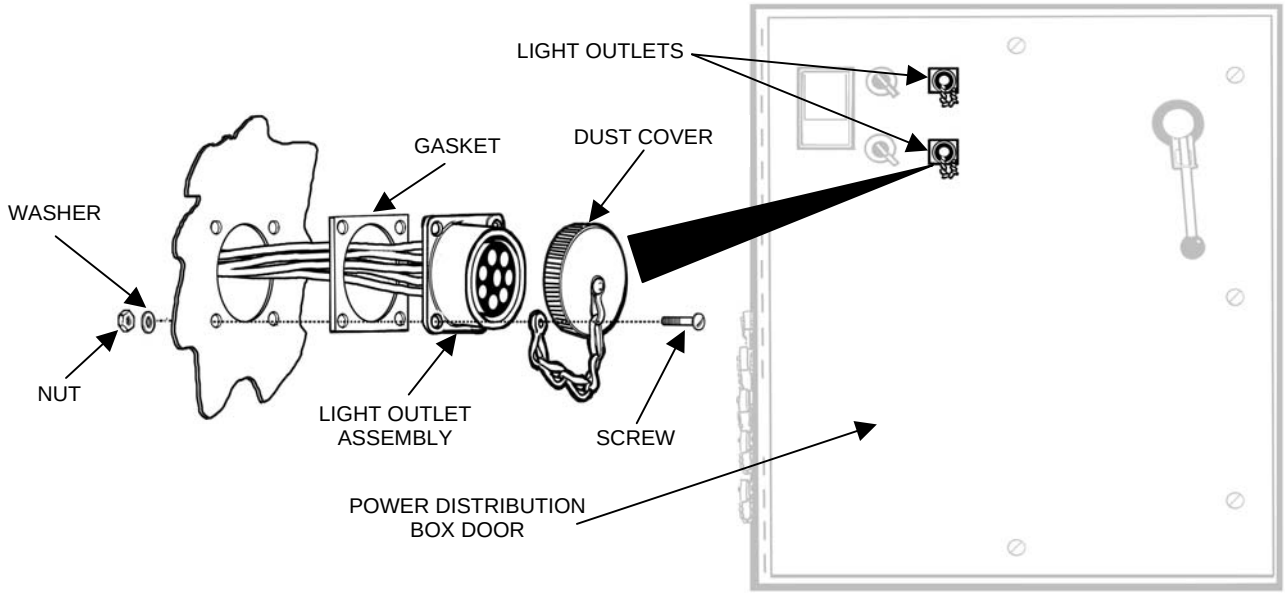

Figure 14. Light Outlet Assembly Removal.

2. Install the new light outlet assembly as follows:
    a. Position the new gasket through the wire end of the new light outlet assembly up to the light outlet connector end of the light outlet assembly.
    b. Insert the cable end of the light outlet assembly through the light outlet hole of the power distribution box door.
    c. Align the gasket and connector with the screw holes on the power distribution box door.
    d. Position the end of the dust cover chain on one of screw holes with the connector and gasket.
    e. Secure the connector, gasket and dust cover to the power distribution box using the four screws, washers and lock nuts.
    f. Connect the wire end of the light outlet assembly to the outlet switches and the utility outlet in accordance to the tagged connection points.
    g. Screw the dust cover on the light outlet.
    h. Close the power distribution box door.

Utility Outlet Assembly Replacement:

Parts (TM 10-610-309-24P):
Utility Outlet
Outlet Cover
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the utility outlet assembly on the power distribution box door as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the utility outlet from the power distribution box door as follows (see Figure 15):
    a. Locate the utility outlet assembly requiring replacement.
    b. Open the power distribution box door and locate the back of the utility outlet.
    c. Remove the four screws, washers and nuts that secure the outlet cover and retain for reinstallation.
    d. Remove the outlet cover.
    e. Remove the two screws, washers, and nut that secure the utility outlet and retain for reinstallation.
    f. Carefully pull the utility outlet from the distribution door without applying tension to the connecting wires.
    g. Tag the wires connected to the utility outlet.
    h. Loosen the screw connections and remove the connecting wires.
    i. Remove the utility outlet and box from the power distribution box door.

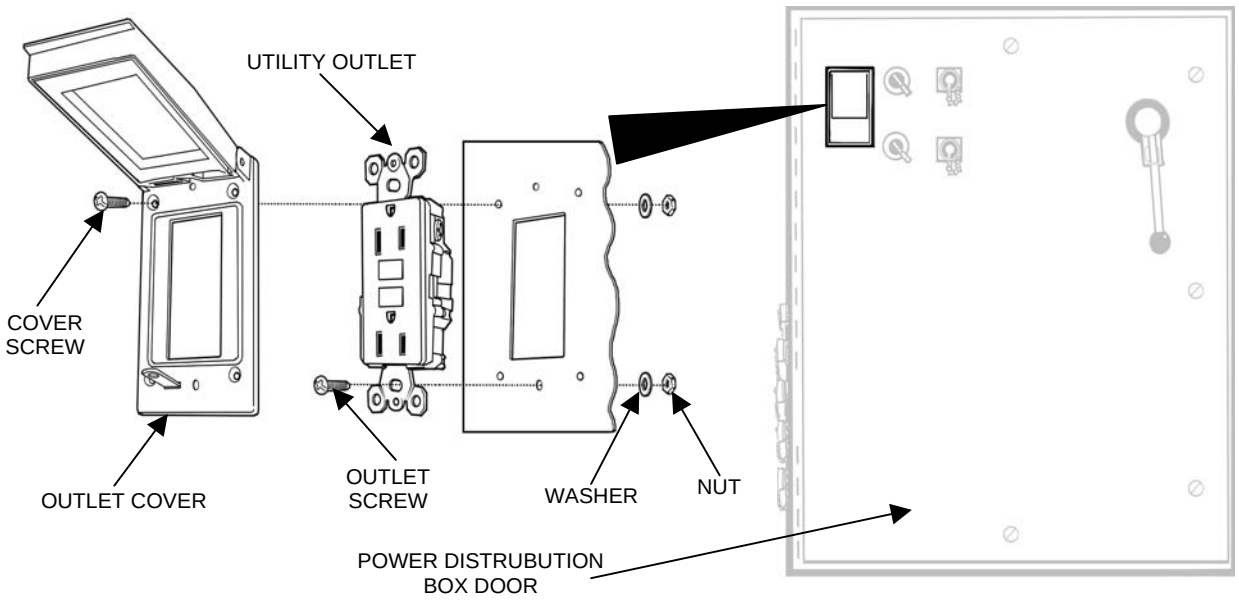

Figure 15. Utility Outlet Assembly Replacement.

2. Install the new utility outlet assembly as follows:
    a. Attach the wires to the screw connections on the new utility outlet in accordance to the wire tags.
    b. Tighten the screws to secure the wires.
    c. Remove the wire tags.
    d. Position the utility outlet on the power distribution box door and secure using the two screws, washers, and nuts.
    e. Position the outlet cover on the power distribution box door and secure using the four screws, washers, and nuts.
    f. Close the power distribution box door.

Light Switch Replacement:

Parts (TM 10-610-309-24P):
Selector Switch
Selector Switch
EMI Gasket
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

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Replace the light switches on the power distribution box door as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

NOTE

Make sure to obtain the correct type of switch before replacing.

1. Remove a light switch as follows (see Figure 16):
   a. Open the power distribution box door and locate the light switch to be replaced.
   b. Tag the wires attached to the light switch.
   c. Loosen the screw connections and remove the connecting wires.
   d. Remove the knob with the ring nut that secures the light switch to the door.
   e. Remove the light switch, rubber washer, locking washer, sealing washer and EMI gasket from the door.

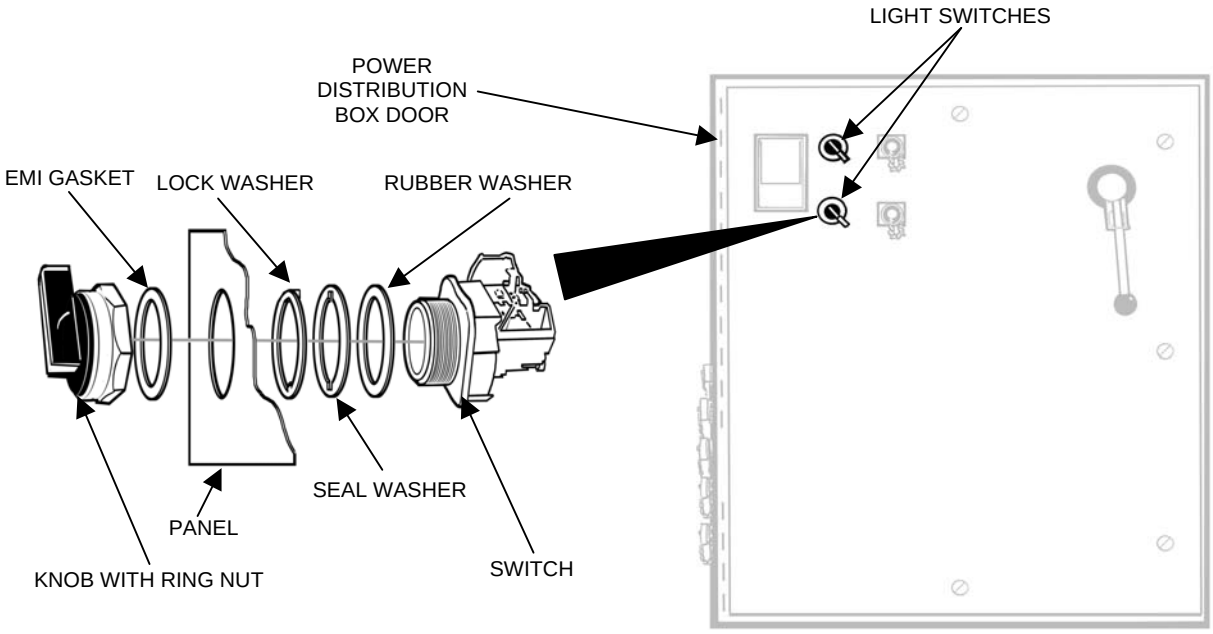

Figure 16. Light Switch Replacement.

2. Install a new light switch as follows:
    a. Position the new light switch, rubber washer, locking washer, sealing washer and EMI gasket in the power distribution box door.
    b. Secure the light switch to the door using the ring nut with the knob.
    c. Attach the wires to the screw connections in accordance to the wire tags.
    d. Tighten the screw connections to secure the wires.
    e. Remove the wire tags if necessary.
    f. Close the power distribution box door.

Main Circuit Breaker Handle Replacement:

Parts:
Main Circuit Breaker Handle (TM 10-610-309-24P)
Equipment Condition:
TWPS in Standby Shutdown Without Draining Down
Army TWPS: Generator off and TWPS main breaker off
Marine Corps TWPS: TWPS disconnected from power source

Replace the main circuit breaker handle on the power distribution box door as follows:

WARNING

Electrical hazard. Army personnel: make sure that the generator is off and the TWPS main breaker is off before working on the control panel. Marine Corps personnel: make sure that the TWPS is disconnected from its power source before working on the control panel. Failure to observe this warning could result in serious injury or death from electrical shock.

1. Remove the main circuit breaker handle as follows (see Figure 17):
    a. Open the power distribution box door.
    b. Locate the rear of the main circuit breaker handle and remove the two nuts and washers securing the rear bracket to the door.
    c. Remove the rear bracket and gasket.
    d. Remove the screws from the front of the main circuit breaker handle.
    e. Remove the handle, front bracket and gasket from the distribution box door.

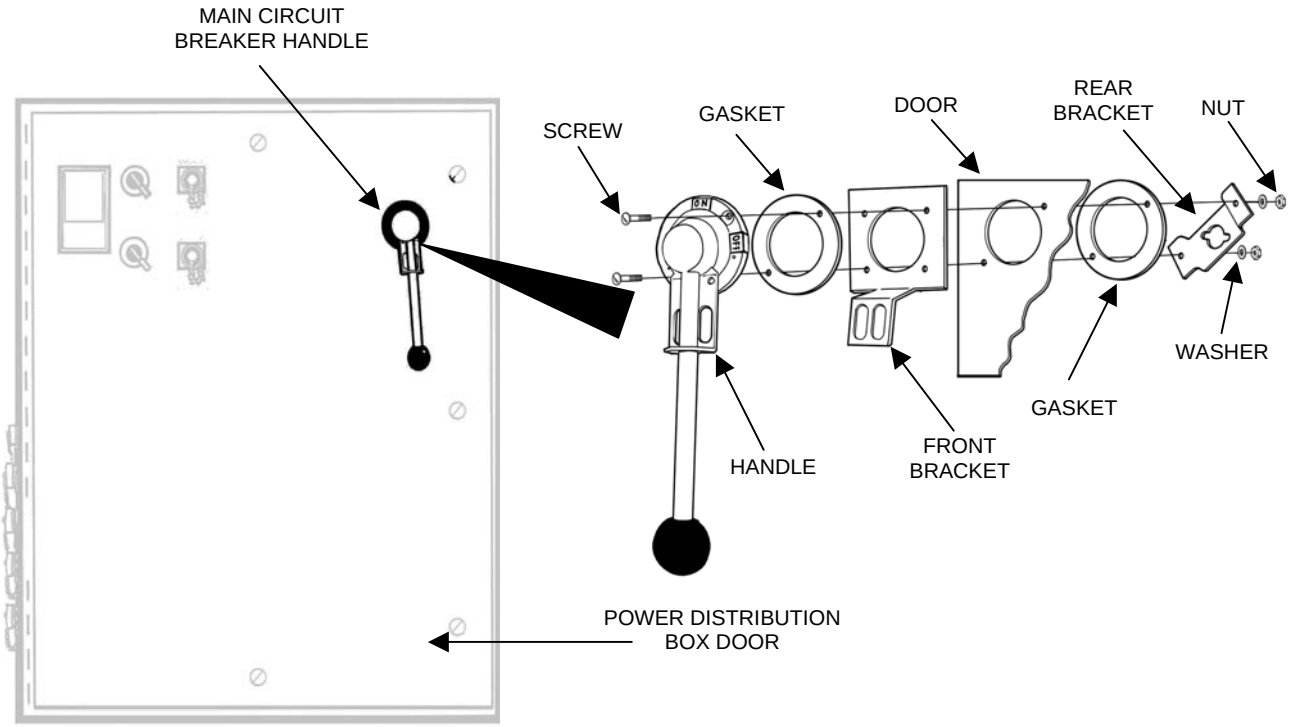

Figure 17. Main Circuit Breaker Handle Replacement.

2. Install new main circuit breaker handle as follows:
    a. Position the handle, front bracket and gasket on the front of the power distribution door and align with the holes in the door.
    b. Insert the two screws into the holes.
    c. Position the rear bracket on the screw inserts at the rear of the power distribution box door.
    d. Install the two nuts and washers to the screw inserts. Do not tighten.
    e. Close the power distribution box door slowly and check that the hole of the rear bracket is aligned with the main power circuit breaker switch on the power distribution panel. If it is not, make the necessary adjustment.
    f. Tighten the two nuts on the rear bracket.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

THIS SECTION COVERS:
Test, Replace, Service

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS set up for operation

GENERAL:

This work package contains information and instructions for testing, replacing, and servicing components in the Cold Weather System of the TWPS. The procedures covered in this work package include:

- Diesel Heater Burner Head Assembly Cleaning / Replacement
- Diesel Heater Fan Replacement
- Diesel Heater Fuel Filter Replacement
- Diesel Heater Motor Relay and Motor Testing/Replacement
- Diesel Heater Output Air Filter Replacement
- Diesel Heater Overheat Switch Testing/Replacement
- Diesel Heater Photocell Testing/Replacement
- Diesel Heater Safety Control Assembly Testing/Replacement
- Diesel Heater Spark Plug and Transformer Testing/Replacement
- General Purpose Transformer Electrical Outlet Assembly or Power Cord Replacement
- Diesel Heater Air Pump Pressure Adjustment

REPLACE

Diesel Heater Burner Head Assembly Cleaning/Replacement:

Part:
Diesel heater burner head assembly (TM 10-610-309-24P)
Material:
Solvent (WP 0079, Table 1, item 13)
Non-flammable liquid cleaning agent
A small container for soaking the nozzle in solvent
A small container for soaking other parts in cleaning agent
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

Clean or replace the diesel heater burner head assembly as follows:

WARNING

Mechanical and electrical hazard. Before opening up the top cover of the heater to access the burner head assembly, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury or death from electrical shock.

1. Remove the burner head from the heater combustion chamber as follows:
   a. Make sure the heater power switch is OFF.
   b. Make sure the heater power cord is unplugged from the power source and from the heater.
   c. Open the top cover of the heater.
   d. Open the access panel at the top of the heater.
   e. Loosen the setscrew that secures the fan to the motor shaft and slide the fan off the motor shaft. (Removing the fan makes it easier to access the burner head and reduces the chance of damaging the fan.) (See Figure 1).
   f. Disconnect the spark plug wire and remove the spark plug from the burner head.
   g. Gently pull the photocell out of its mounting bracket.
   h. Carefully pull the air hose off of the burner head.
   i. Carefully pry the fuel line off of the burner head.
   j. Remove the five screws that secure the burner head to the combustion chamber and lift the burner head out.
   k. If replacing the burner head assembly, remove the photocell bracket from the head, then discard the head assembly.

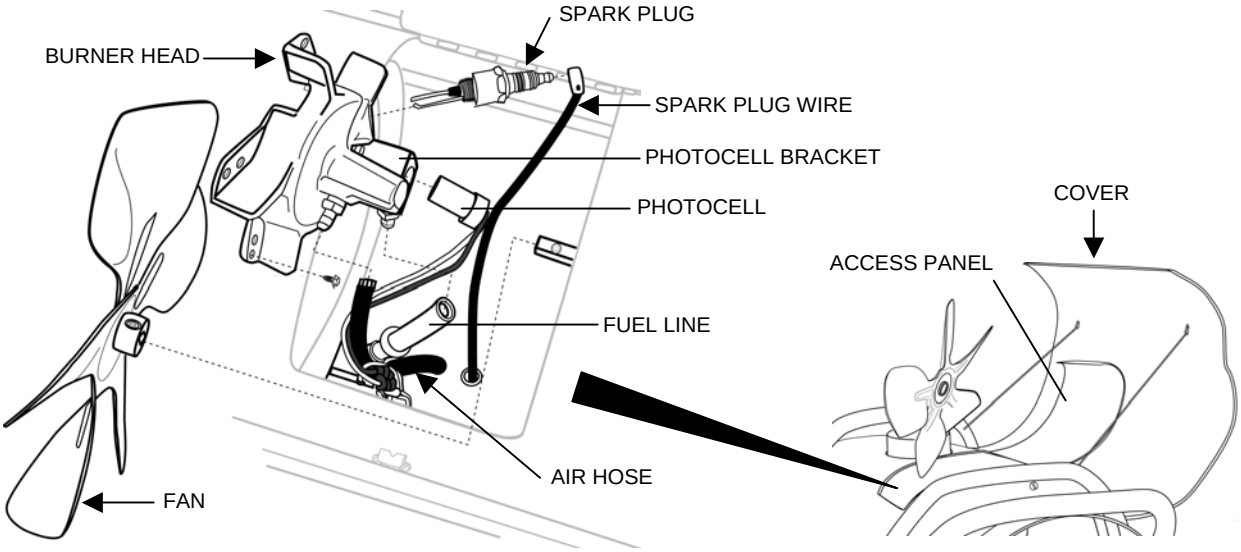

Figure 1. Diesel Heater Burner Head Removal.

2. Carefully remove the nozzle and its associated components (see Figure 2) from the burner head using a socket wrench. If the nozzle is damaged, replace the nozzle.

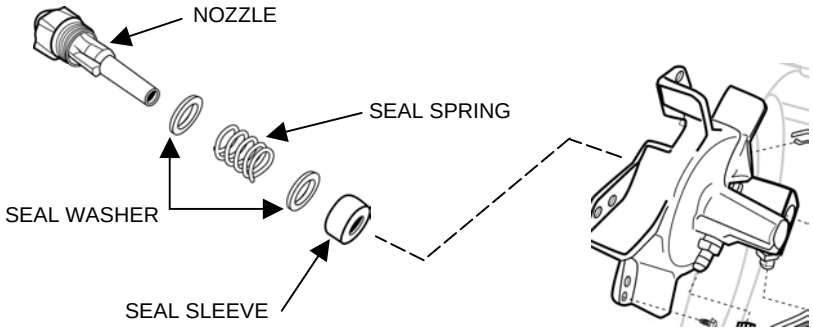

Figure 2. Diesel Heater Burner Head Nozzle.

NOTE

Never use a drill, wire or other tool to open nozzle passage. Any change in the nozzle opening will alter the flow characteristics of the nozzle and will affect the heater's performance.

3. Soak the nozzle in solvent for one hour. Dry the nozzle. Blow air into the discharge end of the nozzle only to clear the nozzle passage. If solvent and air do not remove contamination from the nozzle, replace the nozzle.
4. Soak the remaining parts of the burner head assembly for one hour in non-flammable liquid cleaning agent (do not use kerosene or fuel oil.) Air dry.
5. Reinstall the burner head assembly into the heater as follows:
    a. Screw the nozzle into the burner head with its associated parts in the order shown in Figure 2.
    b. Secure the photocell bracket to the burner head using the two screws if the bracket was removed earlier.
    c. Position the burner head with the fuel line fitting pointing down and the opening for the spark plug just above center and to the right, then secure the burner head to the combustion chamber using the 5 screws.
    d. Connect the fuel line to the fuel line fitting at the bottom of the burner head.
    e. Connect the air line to the air line fitting at the left side of the burner head.
    f. Gently reinsert the photocell all the way in to its holding bracket.
    g. Screw the spark plug into the burner head and tighten using the socket wrench. (Do not over-tighten.)
    h. Reconnect the spark plug wire to the spark plug.
    i. Position the fan so that the setscrew is aligned with the index in the motor shaft and slide the fan onto the shaft. (See Figure 3 if necessary for fan positioning.)
    j. Tighten the setscrew to secure the fan to the shaft.
    k. Close the access panel.
    l. Close and snap the top cover.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

Diesel Heater Fan Replacement:

Part:
Diesel heater fan (TM 10-610-309-24P)
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Replace the diesel heater fan blades as follows:

WARNING

Mechanical and electrical hazard. Before opening up the top cover of the heater to access the fan blades, be sure the heater switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury if the fan operates or injury or death from electrical shock.

1. Make sure the heater power switch is OFF.
2. Make sure the heater power cord is unplugged from the power source and from the heater.
3. Open the top cover of the heater.
4. Open the access panel at the top of the heater.
5. Loosen the setscrew and slide the damaged fan off the motor shaft (see Figure 3).
6. Position the new fan so that the setscrew is aligned with the index in the motor shaft and slide the fan onto the shaft.
7. Tighten the setscrew to secure the fan to the shaft.
8. Close the access panel.
9. Close and snap the top cover.

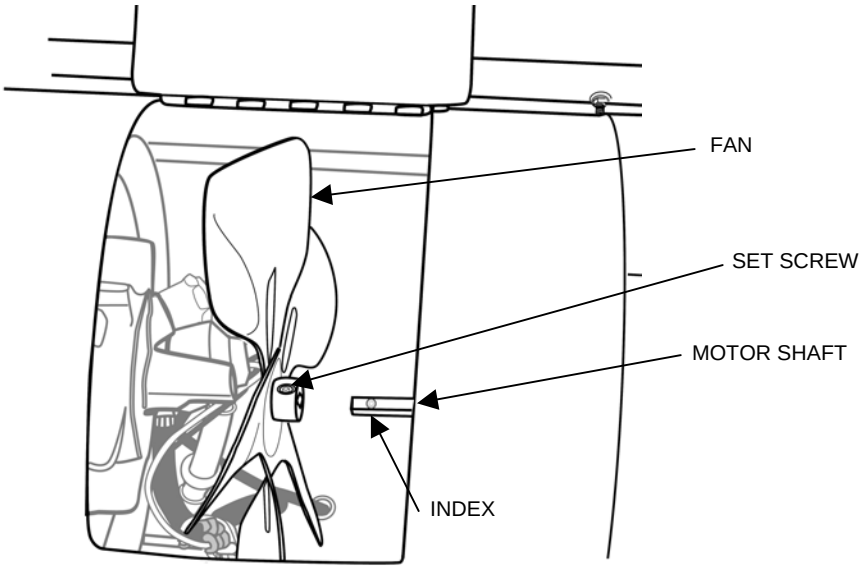

Figure 3. Diesel Heater Fan Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

Diesel Heater Fuel Filter Replacement:

Part:
Diesel heater fuel filter (TM 10-610-309-24P)
Material:
Small amount of motor oil (WP 0079, Table 1, item 19)
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Clean or replace the diesel heater fuel filter as follows:

WARNING

Mechanical and electrical hazard. Before opening up the top cover of the heater to access the burner head assembly, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury or death from electrical shock.

1. Make sure the heater power switch is OFF.
2. Make sure the heater power cord is unplugged from the power source and from the heater.
3. Open the top cover of the heater by unsnapping the three “screws” at the front of the cover and lifting the cover.
4. Open the access panel at the top of the heater.
5. Loosen the setscrew that secures the fan to the motor shaft and slide the fan off the motor shaft. (Removing the fan makes it easier to access the fuel lines and fuel filter and reduces the chance of damaging the fan.) (See Figure 3.)

NOTE

It may be difficult to disconnect the fuel line from the fuel filter. So two methods for removing the fuel filter are described here. If you follow Method One to remove the filter, follow Method One for installing the new fuel filter. If you follow Method Two to remove the fuel filter, follow Method Two for installing the new fuel filter.

6. Fuel filter removal Method One (see Figure 4):
    a. Gently pull both male ends of the fuel filter out of the fuel line.
    b. Discard the fuel filter.
7. Fuel filter removal Method Two:
    a. Disconnect the fuel line from the burner head assembly.

NOTE

When pulling the fuel line out of the fuel tank, be careful not to pull the rubber bushing out of the fuel tank. If the bushing comes out, it may be necessary to disassemble a significant portion of the heater frame in order to access the fuel tank to reinstall the bushing.

    b. Gently pull the fuel filter so that the bottom fuel line comes completely out of the fuel tank.
    c. Lift the fuel line and fuel filter assembly out of the heater.
    d. Pull the fuel lines off both ends of the old fuel filter. Discard the filter.

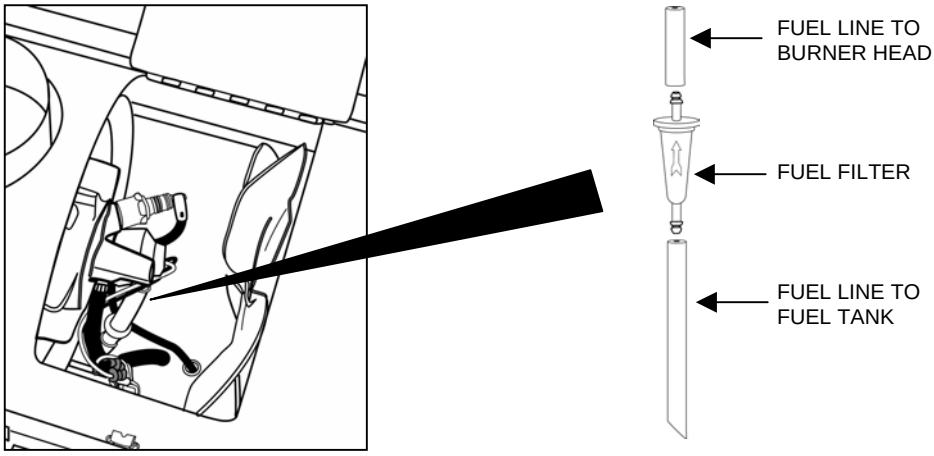

Figure 4. Diesel Heater Fuel Filter Removal and Installation.

8. Fuel filter installation Method One:
    a. Moisten the male ends of the new filter.
    b. Line up the filter with the fuel lines so that the arrow on the side of the filter points in the direction of fuel flow from the tank to the burner.
    c. Insert the male ends of the filter into the fuel lines.
9. Fuel filter installation Method Two:
    a. Moisten the male ends of the new filter.
    b. Line up the filter with the fuel lines so that the arrow on the side of the filter points to the shorter of the two fuel lines and insert the male end of the filter into the fuel line.
    c. Insert the other end of the filter into the longer of the two fuel lines.

NOTE

Be sure to oil the longer of the two fuel lines before inserting it into the rubber bushing. When pushing the fuel line through the bushing and into the fuel tank, be careful not to push the rubber bushing into the fuel tank. If the bushing is pushed into the tank, it may be necessary to disassemble a significant portion of the heater frame in order to access the fuel tank to remove and reinstall the bushing.

    d. Lightly apply motor oil to the longer of the two fuel lines that were attached to the fuel filter.
    e. Carefully push the oiled fuel line through the rubber bushing and into the tank until the top of the shorter, un-oiled fuel line is even with the fuel line fitting on the burner head.
    f. Insert the end of the shorter fuel line onto the fuel line fitting on the burner head.
10. Position the fan so that the setscrew is aligned with the index in the motor shaft and slide the fan onto the shaft. (See Figure 3 if necessary for fan positioning.)
11. Tighten the setscrew to secure the fan to the shaft.
12. Close the access panel.
13. Close and snap the top cover.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

Diesel Heater Motor Relay and Motor Testing/Replacement:

Parts (TM 10-610-309-24P):
Diesel heater motor starting relay
Diesel heater motor and pump assembly
Tool:
Test/ground lead with alligator clips or comparable wire for jumping between two terminals
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

When the diesel heater motor fails to start, check to make sure the power cord is in good condition and plugged in. Also check that the thermostat is in operating condition and set to call for heat. If the power cord and thermostat check out, there may be a problem with the motor relay or the motor.

Test the diesel heater motor relay and motor as follows:

WARNING

Electrical hazard. Before working on the motor relay and motor, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Then, when power is required, be extremely careful not to let any part of your person touch bare wires, leads, or terminals. Failure to observe this warning may result in serious injury from electrical shock.

1. Remove the motor starting relay as follows:
    a. Make sure the heater power switch is OFF.
    b. Make sure the heater power cord is unplugged from the power source and from the heater.
    c. Remove the three screws that secure the screen to the inlet duct adapter and remove the screen.
    d. (See Figure 5) Remove the two screws that hold the motor starting relay to its bracket inside the inlet end of the heater shell and gently pull the relay out as far as the wires will reach. (If the wires are bound with a plastic tie-wrap, it may be necessary to clip the tie-wrap.)
2. Test the motor starting relay and motor as follows
    a. Tag and remove the black motor wire from terminal three (3) of the starting relay.
    b. Clip one end of the jumper to terminal three (3) of the starting relay.
    c. Clip the other end of the jumper to terminal two (2) of the starting relay.
    d. Make sure the relay is oriented in the same position as when it is installed in the heater. The relay is position sensitive.
    e. Make sure the heater thermostat is set to call for heat.

WARNING

Electrical hazard. After restoring power to the heater to conduct the test, be extremely careful not to let any part of your person touch the spark plug, bare wires, leads, or terminals. Failure to observe this warning may result in serious injury or death from electrical shock.

f. Plug in the heater power cord.
g. If the motor starts, allow it to reach operating speed, then remove the jumper from the right terminal (2) of the relay. The motor should continue to run.

3. If the motor starts and continues to run, the relay is bad. Replace the relay as described below.
4. If the motor does not start, check your test procedures to make sure the test was performed properly.
5. If the test was performed properly and the motor failed to start, the motor is bad. Replace the motor and pump assembly as described below.

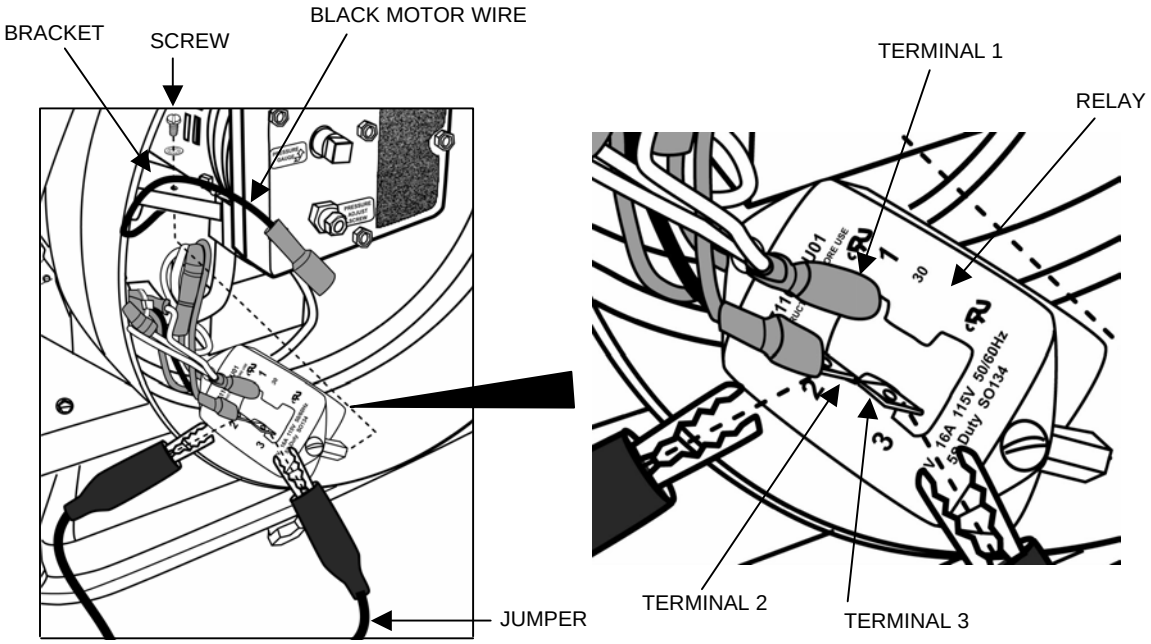

Figure 5. Diesel Heater Motor Relay and Motor Test Set-Up.

Replace / reinstall the motor starting relay as follows (see Figure 5):

1. Unplug the heater power cord from the power source and then from the heater.
2. Remove the jumper from the relay terminals three (3) and two (2).
3. Tag and disconnect the wires from relay terminals one (1) and two (2).
4. Discard the old relay.
5. Connect the two, tagged, white wires to relay terminal one (1).
6. Connect the tagged red and black wires to relay terminal two (2).
7. Connect the black motor wire to relay terminal three (3).

NOTE

The relay is position sensitive. Make sure the relay is mounted to the heater shell with the terminals on the bottom (facing down).

8. Orient the relay so it is in the same position it was in before it was removed and secure the relay to its mounting bracket with the two screws removed earlier.
9. Install new wires ties on the wires.
10. Secure the screen to the inlet duct adapter using the three screws removed earlier.

Replace the diesel heater motor and pump assembly as follows (see Figure 6):

WARNING

Mechanical and electrical hazard. Before starting the procedures to replace the motor and pump assembly, be sure the heater switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury if the fan operates or injury or death from electrical shock.

1. Remove the diesel heater motor and pump assembly as follows:
    a. Make sure the heater power switch is OFF.
    b. Make sure the heater power cord is unplugged from the power source and from the heater.
    c. Remove the fan blades. Refer to **REPLACE** and **Diesel Heater Fan Replacement**.
    d. Remove the ignition transformer but **do <u>not</u>** disconnect or cut any of the wires. Refer to **REPLACE** and **Diesel Heater Spark Plug and Transformer Testing/Replacement**.
    e. Disconnect the white, red, and black motor wires from relay terminals one (1), two (2), and three (3). (See Figure 5.)
    f. Disconnect the green wire from the motor mounting bracket.
    g. Unplug the air line from the bottom of the pump.
    h. Remove the two lock nuts that secure the motor to the motor bracket.
    i. Lift the motor and pump assembly off the motor mounting bracket and out of the inlet end of the heater.
    j. Discard the motor and pump assembly.

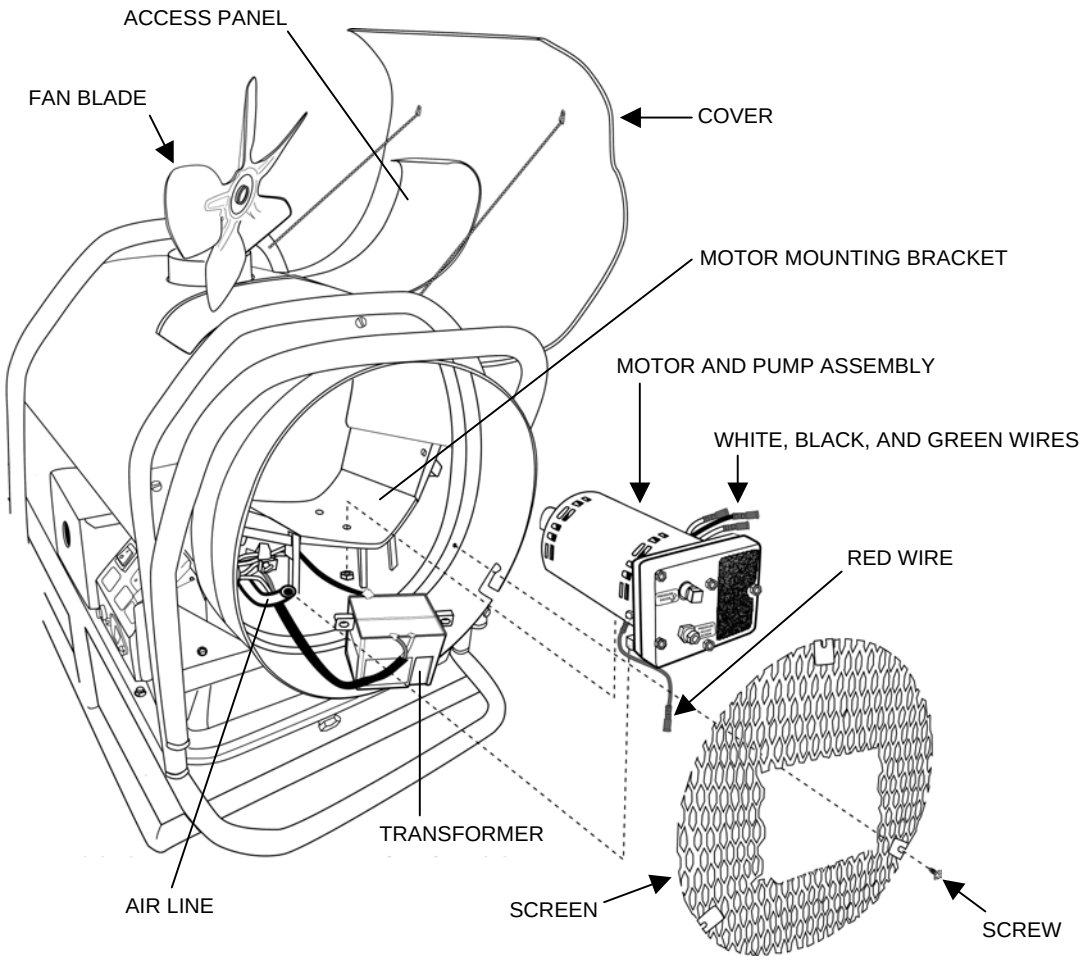

Figure 6. Diesel Heater Motor and Pump Assembly Replacement.

2. Install the new motor and pump assembly as follows:
    a. Set the motor and pump assembly on the motor mounting bracket so that the threaded studs at the bottom of the motor fit thru the holes in the bracket.
    b. Secure the motor to the bracket using the two lock nuts removed earlier.
    c. Connect the air line to the bottom of the new pump.
    d. Connect the green wire of the new motor to the motor mounting bracket, the white wire to relay terminal one (1), the red wire to relay terminal two (2), and the black wire to relay terminal three (3). (See Figure 5.)
    e. Reinstall the ignition transformer. Refer to **REPLACE** and **Diesel Heater Spark Plug and Transformer Testing/Replacement**.
    f. Reinstall the fan blades. Refer to **REPLACE** and **Diesel Heater Fan Replacement**.
3. Close the access panel.
4. Close and snap the top cover.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

Diesel Heater Output Air Filter Replacement:

Part:
Diesel heater output air filter (TM 10-610-309-24P)
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Replace the diesel heater output air filter as follows (see Figure 7):

1. Remove the five screws and washers that attach the end cover to the filter housing.
2. Remove the end cover.
3. Lift the output air filter out of the filter housing and discard the filter.
4. Insert a new output air filter.
5. Reinstall the end cover using the five screws and washers.
6. Start the heater. If the heater burns improperly, it may be necessary to check and adjust the pump output pressure. Refer to **SERVICE** and **Diesel Heater Air Pump Pressure Adjustment**.

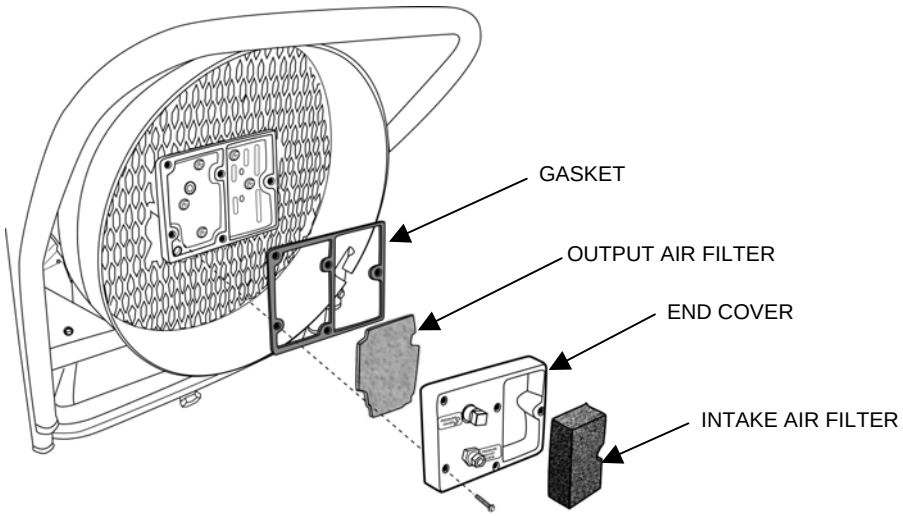

Figure 7. Diesel Heater Output Air Filter Removal.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

Diesel Heater Overheat Switch Testing/Replacement:

Part:
Diesel heater overheat switch (TM 10-610-309-24P)
Tool:
Test/ground lead comparable wire for jumping between two terminals
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Test and, if necessary, replace the diesel heater overheat switch as follows:

WARNING

Electrical hazard. Before accessing the diesel heater overheat switch, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury or death from electrical shock.

1. Test the diesel heater overheat switch as follows (see Figure 8):
   a. Make sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater.
   b. Remove the two screws that secure the overheat switch to its bracket on the duct outlet adapter.
   c. Unplug the two leads from the overheat switch terminals.
   d. Using a test lead, jump the white wires that were disconnected from the overheat switch terminals.

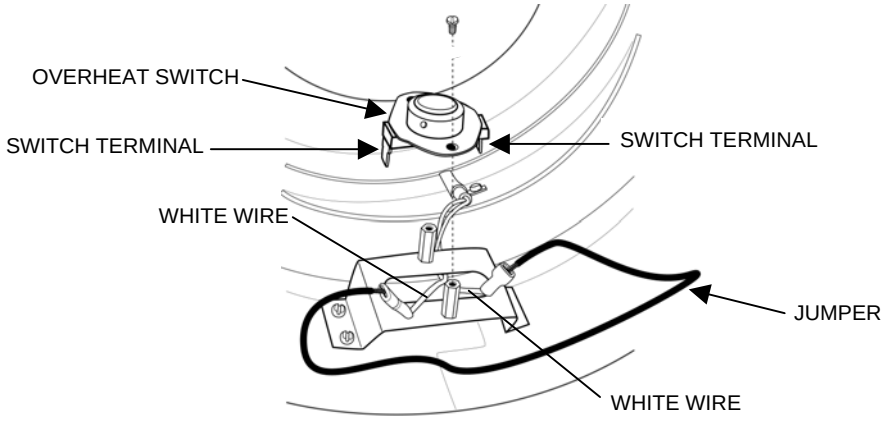

Figure 8. Diesel Heater Overheat Switch Test Set-Up.

WARNING

Electrical hazard. After restoring power to the heater to conduct the test, be extremely careful not to let any part of your person touch the spark plug, bare wires, leads, or terminals. Failure to observe this warning may result in serious injury or death from electrical shock.

e. Plug the heater power cord in first at the heater and then at the power source.
f. Switch the heater ON.
g. If the heater runs properly, install a new overheat switch.

2. Install a new overheat switch, or reinstall the existing overheat switch as follows:
   a. Turn the heater power switch OFF and unplug the power cord first from the power source and then from the heater.
   b. Plug the two white wires onto the overheat switch terminals. (It does not matter which lead is connected to which terminal.)
   c. Secure the overheat switch to its bracket on the duct outlet adapter using the two screws.

Diesel Heater Photocell Testing/Replacement:

Part:
Diesel heater photocell (TM 10-610-309-24P)
Tool:
Multi-meter, ohmmeter, or equivalent test instrument
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Test and, if necessary, replace the diesel heater photocell as follows:

WARNING

Electrical hazard. Before opening up the top cover of the diesel heater to access the photocell, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in injury or death from electrical shock.

1. Test the diesel heater photocell as follows (see Figure 9):
   a. Make sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater.
   b. Open the top cover of the heater by unsnapping the three “screws” at the front of the cover and lifting the cover.
   c. Open the access panel at the top of the heater.
   d. Gently pull the photocell out of the bracket that is attached to burner head.
   e. Tag and disconnect the blue and white photocell leads.
   f. Connect the ohmmeter test leads to the photocell leads.
   g. Hold the open end of photocell towards a light source (a 60 watt light bulb or direct sunlight). The resistance indicated on the ohmmeter should be low.

h. Block off light completely by covering the open end of the photocell. Within 10 seconds the resistance indicated should be high.
i. Replace the photocell with a new photocell if there is no change in resistance during this procedure.

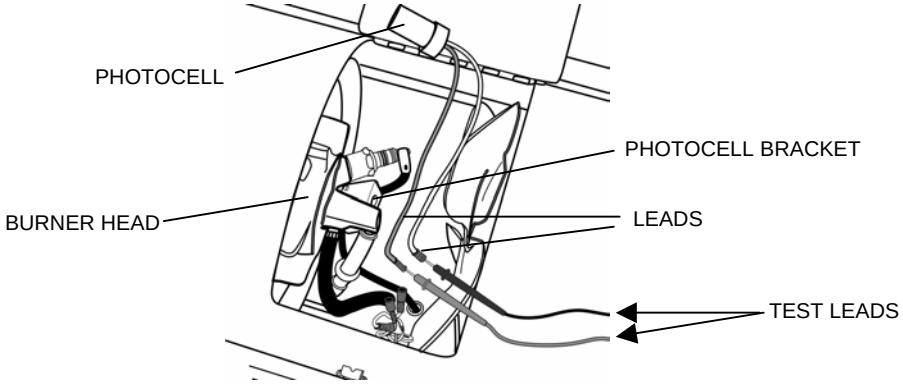

Figure 9. Diesel Heater Photocell Test Set-Up.

2. Install a new photocell, or reinstall the existing photocell as follows:
   a. Connect the blue and white leads of the new or existing photocell to the tagged wires.
   b. Gently reinsert the photocell all the way in to its holding bracket.
   c. Close the access panel.
   d. Close and snap the top cover.

Diesel Heater Safety Control Assembly Testing/Replacement:

Part:
Diesel heater safety control assembly (TM 10-610-309-24P)
Tool:
Multi-meter, voltmeter and ohmmeter, or equivalent test instrument
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Test and, if necessary, replace the diesel heater safety control assembly when the diesel heater will not start.

Test the diesel heater safety control assembly as follows (see Figure 10):

WARNING

Electrical hazard. Before working on the safety control, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Then, when power is required, be extremely careful not to let any part of your person touch the spark plug, bare wires, leads, or terminals. Failure to observe this warning may result in serious injury from electrical shock.

1. Make sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater.
2. Remove the 4 screws that secure the electric control box to its bracket.
3. Pull the electric control box away from the electrical panel but do not disconnect any electrical connections.

WARNING

Electrical hazard. After restoring power to the heater to conduct the test, be extremely careful not to let any part of your person touch the spark plug, bare wires, leads, or terminals. Failure to observe this warning may result in serious injury or death from electrical shock.

a. Plug the heater power cord in first at the heater and then at the power source.
b. Switch the heater ON.
c. Touch one test lead of a voltmeter to any one of the white leads on the distribution bar.
d. Touch the second voltmeter test lead first to the orange wire on the left side of the distribution bar. You should get a reading of 110 volts from a good safety control.
e. Then touch the second voltmeter test lead to the blue wire on the left side of the distribution bar. You should get a reading of 110 volts from a good safety control.
f. If one or both wires do not read 110 volts (approximately) replace the safety control assembly.
g. Turn the heater OFF.
h. Unplug the heater power cord first from the power source and then from the heater.
i. If the safety control assembly does not need to be replaced, reattach the electric control box to its bracket using the 4 mounting screws.

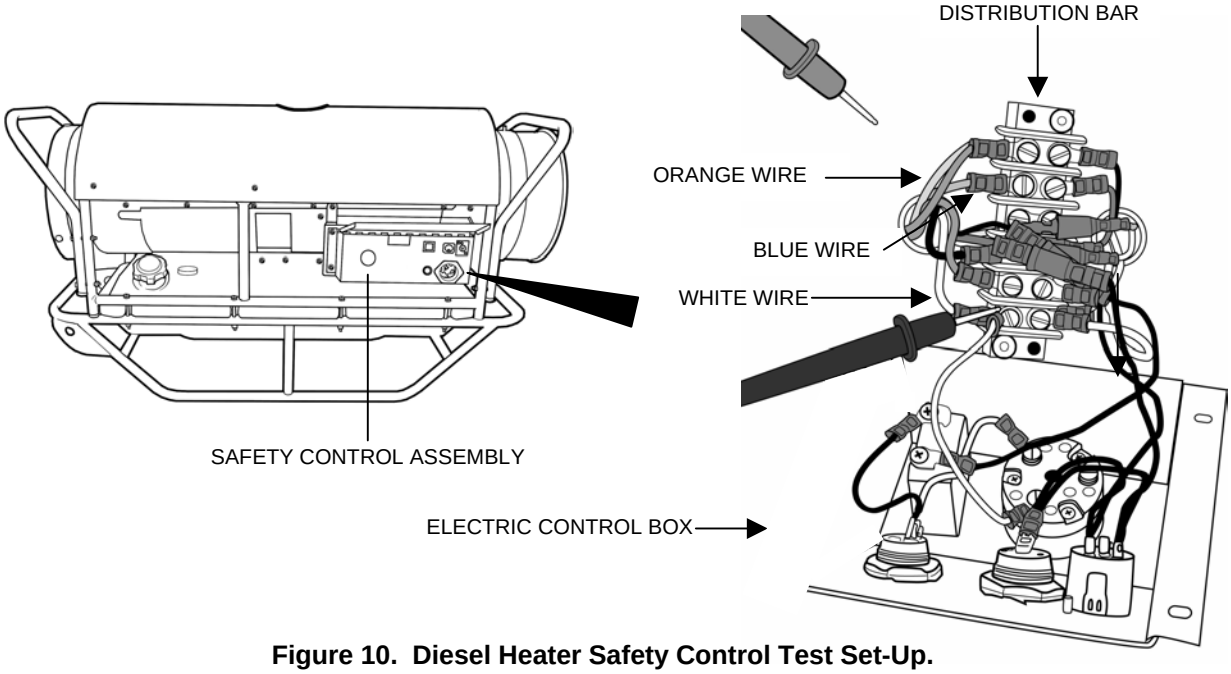

Figure 10. Diesel Heater Safety Control Test Set-Up.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

Replace the diesel heater safety control assembly as follows:

WARNING

Electrical hazard. Before removing the diesel heater safety control assembly, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in serious injury from electrical shock.

1. Make sure the heater power switch is OFF.
2. Make sure the heater power cord is unplugged from the power source and from the heater.
3. Remove the diesel heater safety control assembly as follows (see Figure 11):
    a. Remove the four screws and washers holding the control box assembly to its bracket.
    b. Remove the four screws holding the safety control assembly to its bracket.
    c. Remove the four screws and one bolt holding the bracket to the heater frame. (One corner of the bracket remains riveted to the heater.)
    d. Pull the bracket away from the heater enough to access the wires behind the bracket.
    e. Tag and disconnect the four wires from the terminals on the safety control assembly.
    f. Trace the four wires that come out the back of the safety control assembly to the distribution bar and disconnect the wires from the distribution bar. Leave all other wires connected to the distribution bar.
    g. Carefully pull the wires through both holes in the bracket.
    h. Discard the safety control assembly.

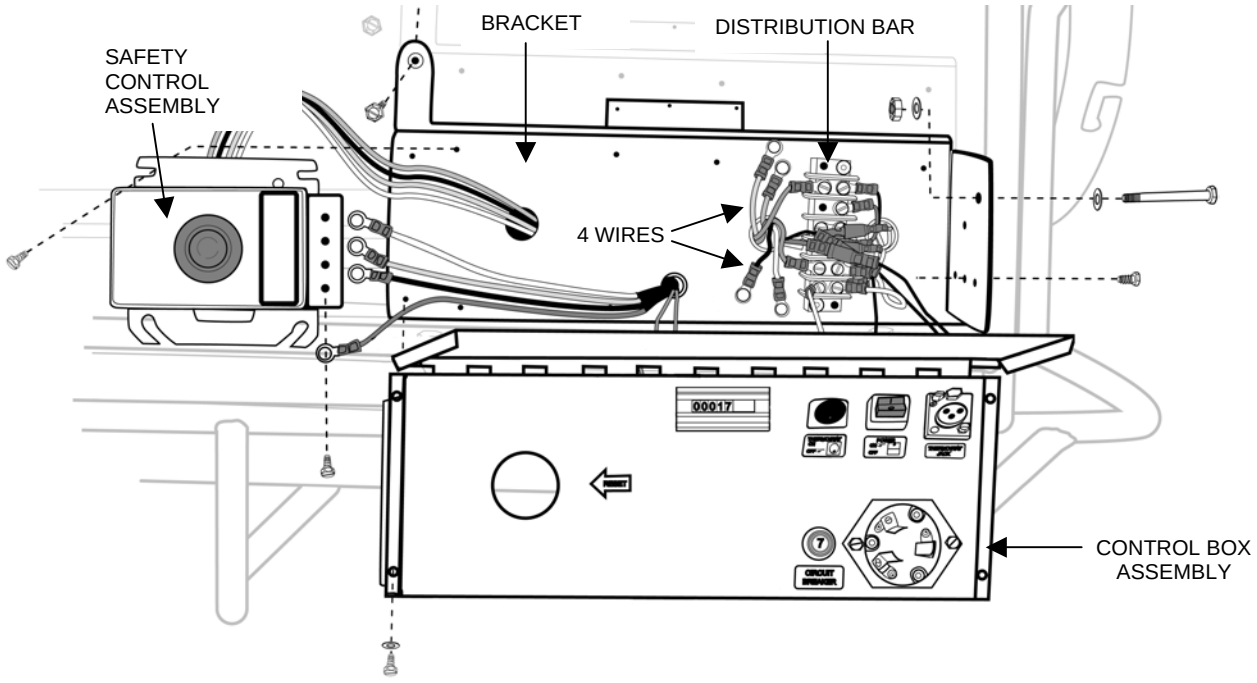

Figure 11. Diesel Heater Safety Control Assembly Replacement.

4. Install the new diesel heater safety control assembly as follows:
    a. Thread the four wires from the back of the new safety control assembly through the two holes of the bracket.
    b. Connect the four safety control wires to the distribution bar as shown in the wiring diagram in Figure 12.
    c. Secure the bracket to the heater frame using the four screws and one bolt.
    d. Connect the four tagged wires to the terminals on the new safety control assembly as shown in the wiring diagram in Figure 12.

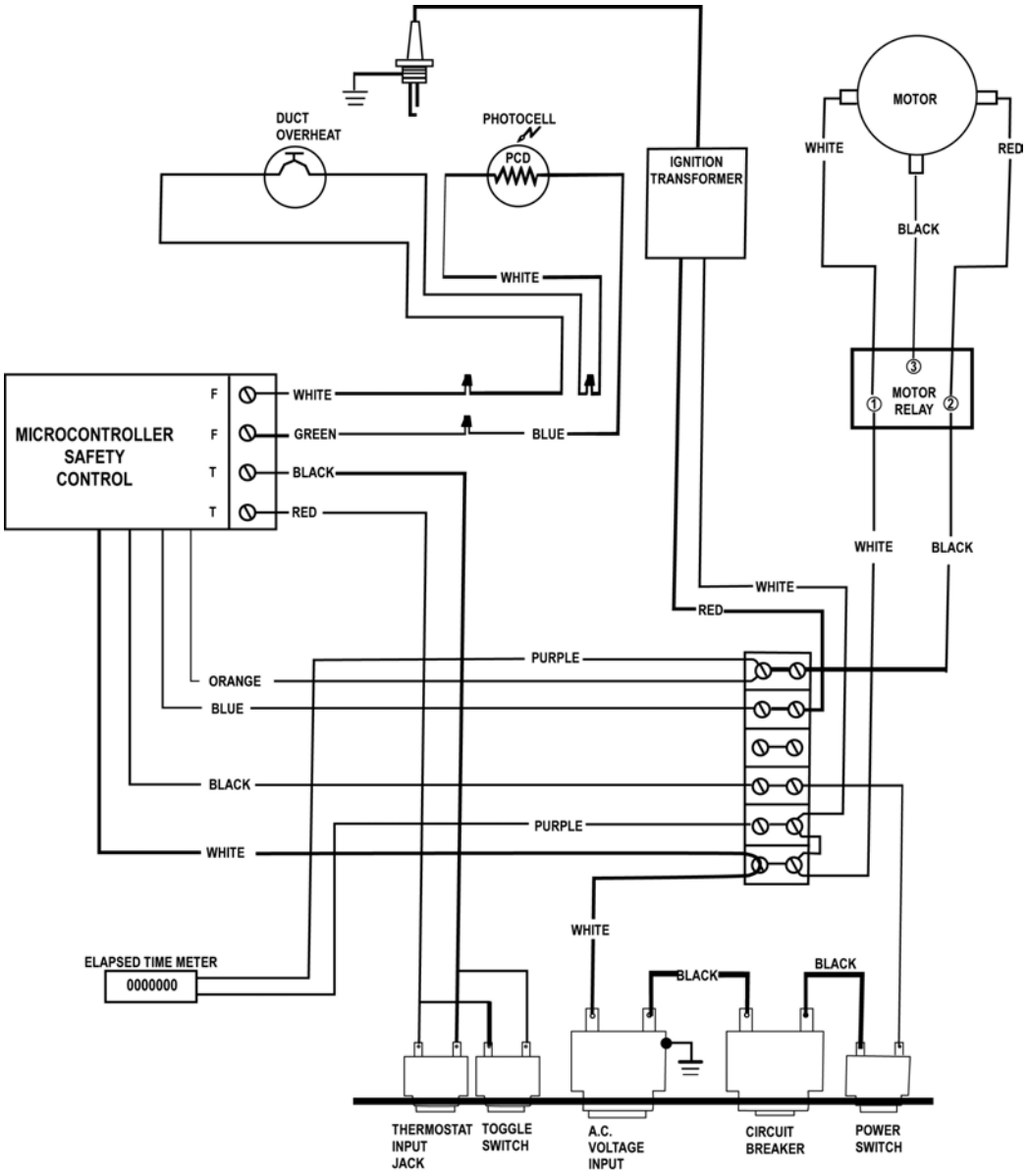

Figure 12. Diesel Heater Safety Control Wiring Diagram.

e. Secure the safety control assembly to the bracket using the four screws removed earlier.
f. Secure the control box assembly to the bracket using the four screws and washers removed earlier.

NOTE

After the safety control is replaced, the operation of the safety control should be checked before starting the heater by testing for conductance at the ignition transformer.

5. Check the operation of the safety control as follows (see Figure 13):

WARNING

Electrical hazard. A transformer in good condition produces very high voltage at the output terminals. Before accessing the transformer, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Failure to observe this warning may result in serious injury from electrical shock.

a. Make sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater.
b. Remove the screen from the inlet end of heater.
c. Tag and disconnect the red and white transformer wires from the red and white ignition wires.

WARNING

Electrical hazard. After restoring power to the heater to check the operation of the safety control, be extremely careful not to let any part of your person touch the spark plug, bare wires, leads, or terminals. Failure to observe this warning may result in serious injury or death from electrical shock.

d. Plug the heater power cord in first at the heater and then at the power source.
e. Switch the heater ON.
f. **DO NOT TOUCH any bare wires, leads, or terminals with any part of your person.** Touch ohmmeter test probes to the red and white transformer wires.
g. If the new safety control is working properly, the ohmmeter should indicate an open line (no conductance).
h. If the ohmmeter does not indicate an open line, retest the safety control.
i. Turn the heater OFF.
j. Unplug the heater power cord first from the power source and then from the heater.
k. Reconnect the red and white ignition and transformer wires.
l. Reinstall the screen to the inlet end of heater.

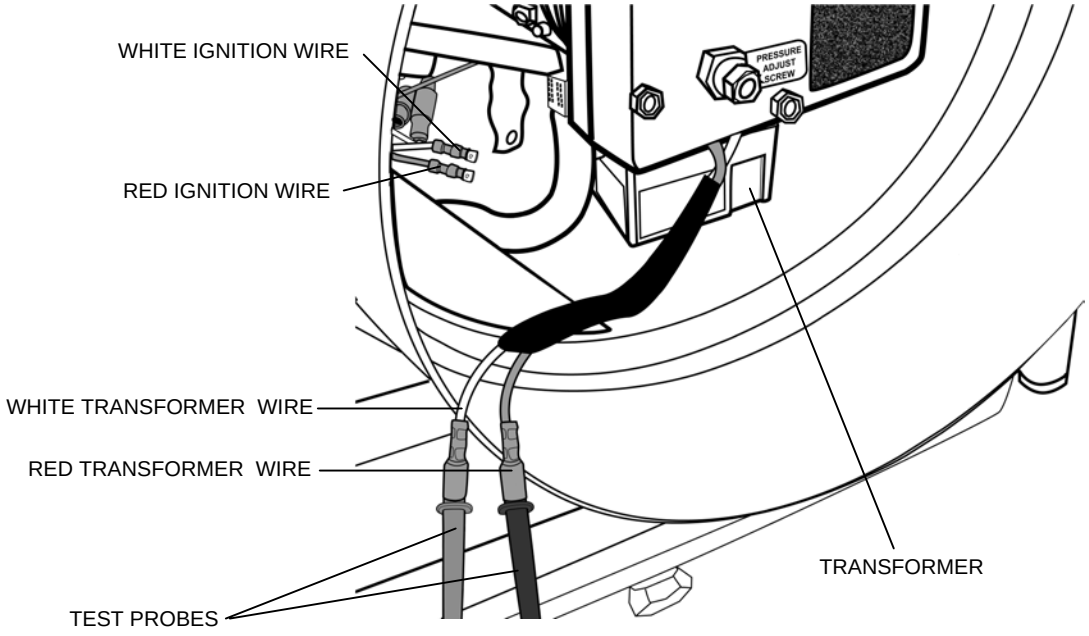

Figure 13. Diesel Heater Safety Control Operation Test Set-Up.

Diesel Heater Spark Plug and Transformer Testing/Replacement:

Parts (TM 10-610-309-24P):
- Diesel heater spark plug
- Diesel heater ignition transformer

Tool:
- Test/ground lead with alligator clips or comparable wire for grounding the spark plug

Material:
- Wire nut
- Electrical tape

Equipment condition:
- Diesel heater OFF and power cord disconnected from source and from heater

Test and, if necessary, replace the diesel heater spark plug and ignition transformer when the heater will not ignite, but the motor runs for a short time.

WARNING

Electrical hazard. A transformer in good condition produces very high voltage at the output terminal. The spark plug wire carries high voltage during heater operation. Before opening up the top cover of the diesel heater to access the spark plug, be sure the heater power switch is OFF and the power cord is unplugged from the power source and the heater. Then, when power is required, be extremely careful not to let any part of your person touch bare wires, leads, or terminals. Failure to observe this warning may result in injury or death from electrical shock.

1. Remove the diesel heater spark plug as follows:
   a. Make sure the heater power switch is OFF.
   b. Make sure the heater power cord is unplugged from the power source and from the heater.
   c. Open the top cover of the heater by unsnapping the three “screws” at the front of the cover and lifting the cover.
   d. Open the access panel at the top of the heater.
   e. Disconnect the spark plug wire.
   f. Remove the spark plug using a socket wrench.
2. Test the diesel heater spark plug and transformer as follows (see Figure 14):
   a. Check the gap between the spark plug electrodes. The gap should be between 0.045 and 0.055.
   b. Adjust the gap between the electrodes if necessary by bending the outside electrode.
   c. Reattach the spark plug wire to the spark plug.
   d. Establish a good ground between the spark plug and the heater. Be careful not to let any part of your person become a portion of the grounded circuit.

WARNING

Electrical hazard. After restoring power to the heater to conduct the test, be extremely careful not to let any part of your person touch the spark plug, bare wires, leads, or terminals. Failure to observe this warning may result in serious injury or death from electrical shock.

   e. Connect the heater power cord in first at the heater and then at the power source.
   f. Set the thermostat switch on the electric control box to the “ON” position.
   g. Switch the heater ON. Sparks should appear between the plug’s electrodes. If the ground is good and a spark does NOT jump between the electrodes, replace the spark plug as described in the next step.

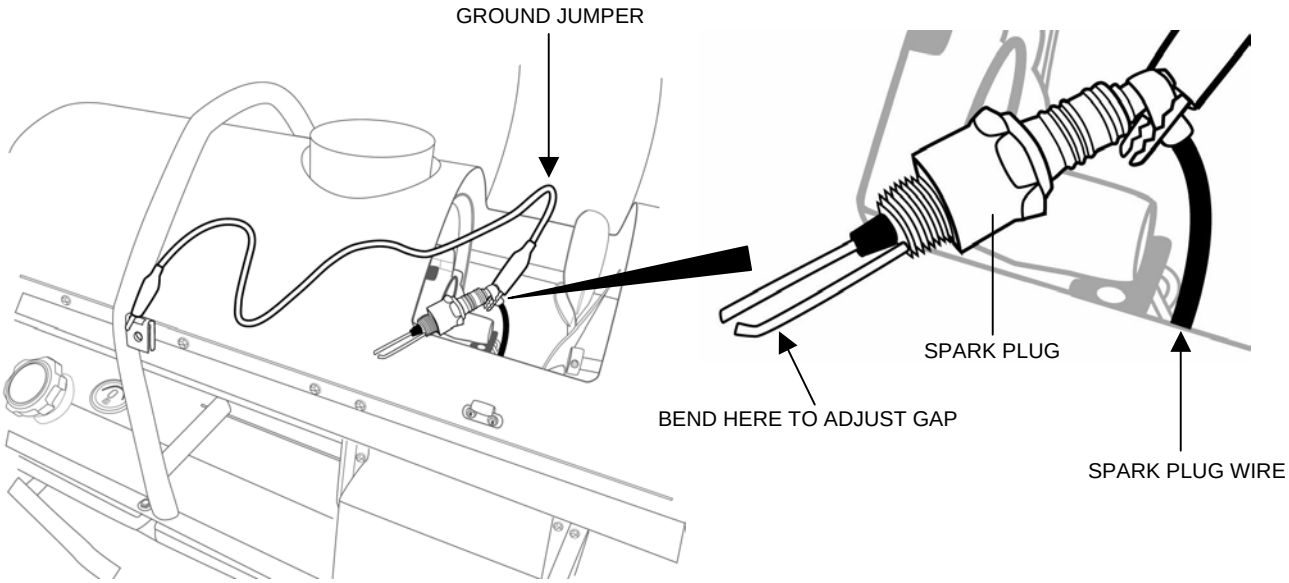

Figure 14. Diesel Heater Spark Plug / Transformer Test Set-Up.

3. Replace the diesel heater spark plug as follows:
    a. Switch the heater OFF.
    b. Unplug the heater power cord first from the power source and then from the heater.
    c. Remove the ground from the spark plug.
    d. Unplug the spark plug from the spark plug wire and discard the spark plug.
    e. Test a new diesel heater spark plug and the existing transformer by repeating the test steps above.
    f. If a spark still does not appear between the plug's electrodes, the transformer may be defective. First, install the spark plug then replace the transformer (both procedures are described below.)
4. Install the spark plug as follows:
    a. Switch the heater OFF.
    b. Unplug the heater power cord first from the power source and then from the heater.
    c. Remove the ground from the spark plug.
    d. Screw the spark plug into the burner head.
    e. Tighten snug tight using the socket wrench. (Do not over-tighten.)
    f. Reconnect the spark plug wire to the spark plug.
    g. Close the access panel.
    h. Close and snap the top cover.
5. Remove the old diesel heater transformer as follows:
    a. Make sure the heater is switched OFF.
    b. Make sure the heater power cord is unplugged first from the power source and then from the heater.

c. Remove the three screws that secure the screen to the inlet duct adapter and remove the screen.
d. Remove the two screws that secure the transformer to its mounting bracket inside the inlet end of the heater shell and gently pull the transformer out as far as the wires will reach. (If the wires are bound with a plastic tie-wrap, it may be necessary to clip the tie-wrap.) (See Figure 15)
e. Tag and disconnect the red and white transformer wires.
f. From the transformer end of the spark plug wire, pull the spark plug wire through the bushing in the bottom of the lower housing until there is enough wire at the inlet end of the heater to work with.
g. Cut the spark plug wire close to where it enters the old transformer.
h. Remove the transformer.

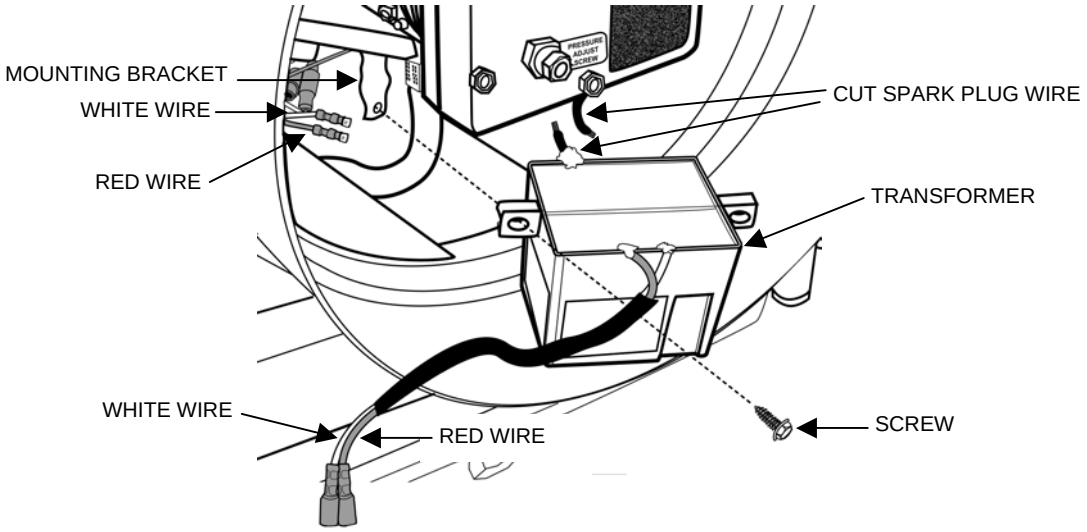

Figure 15. Transformer Replacement.

6. Install the new diesel heater transformer as follows.
   a. Cut the spark plug wire on the new transformer several inches from the transformer.
   b. Strip about one-half inch of insulation off the end of the spark plug wire on the new transformer and from the end of the spark plug wire remaining in the heater.
   c. Connect the two wires together using a suitable wire nut and tape with electrical tape.
   d. Carefully pull enough spark plug wire up through the inside of the heater housing to connect the wire to the spark plug and connect the spark plug wire to the spark plug.
   e. Connect the new transformer red and white wires to the tagged red and white wires.
   f. Make sure the new transformer mounting tabs are free of paint to ensure a good ground connection when the transformer is installed.
   g. Secure the new transformer to its bracket using the two screws.
   h. Secure the screen to the inlet duct adapter with the three screws.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

General Purpose Transformer Electrical Outlet Assembly or Power Cord Replacement:

Part (TM 10-610-309-24P):
General Purpose Transformer Electrical Outlet Assembly
General Purpose Transformer Power Cord
Equipment Condition:
TWPS in Standby Shutdown without Draining
Air Compressor switched to OFF
PDP Main Circuit Breaker switched to OFF

Replace the general purpose transformer electrical outlet assembly or power cord as follows:

WARNING

Electrical hazard. Make sure the PDP Main Circuit Breaker is switch to OFF before unplugging the general purpose transformer power cord from the PDP. Failure to observe this warning may result in serious injury or death from electrical shock.

1. Make sure the TWPS is in Standby Shutdown without Draining.
2. Make sure the air compressor is switched to OFF.
3. Make sure the PDP Main Circuit Breaker is switched to OFF.
4. Remove the general purpose transformer from the TWPS as follows (see Figure 16):
    a. If the diesel heater is plugged into the transformer outlet, make sure the diesel heater is switched to OFF, then unplug the heater.
    b. Disconnect the general purpose transformer power cord cannon plug from the connector on the right side of the Power Distribution Panel (PDP).
    c. Lift the general purpose transformer off the TWPS frame and set it down in a clean work location.

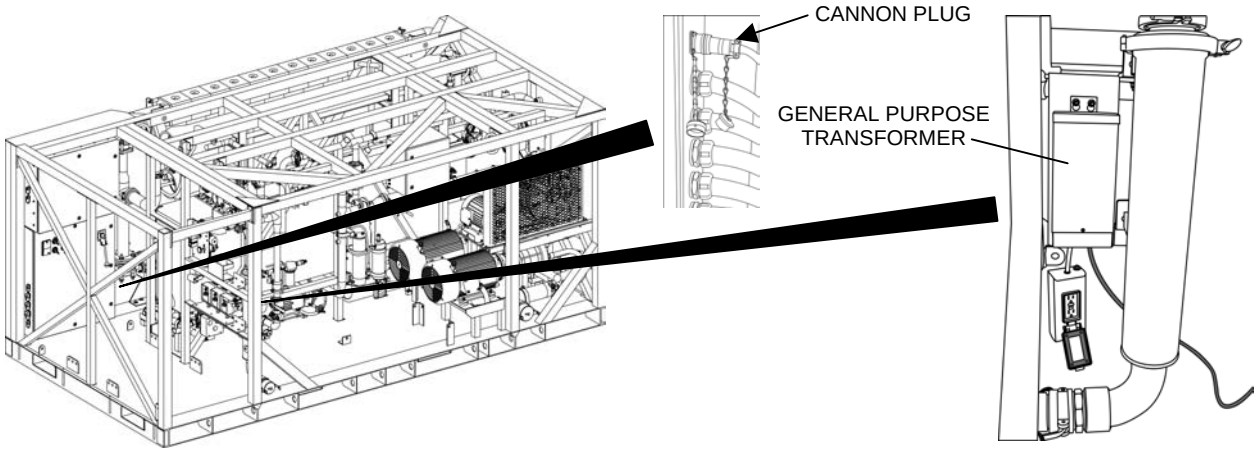

Figure 16. General Purpose Transformer Removal.

5. Disconnect the electrical outlet assembly cable or power cable from the transformer as follows (see Figure 17):
    a. Remove the 20 screws and 20 flat washers from the transformer enclosure cover and remove the cover.
    b. Remove the one screw from the transformer cover and lift the cover off the transformer.
    c. Pull the wires out of the enclosure for the cable to be disconnected.
    d. Tag and disconnect the cable wires.
    e. Unscrew the ring nut from the cable strain relief fitting at the bottom of the transformer enclosure for the cable to be removed.
    f. Pull the cable out through the transformer and the transformer enclosure fittings.
    g. Retain the washer and wire bushing.

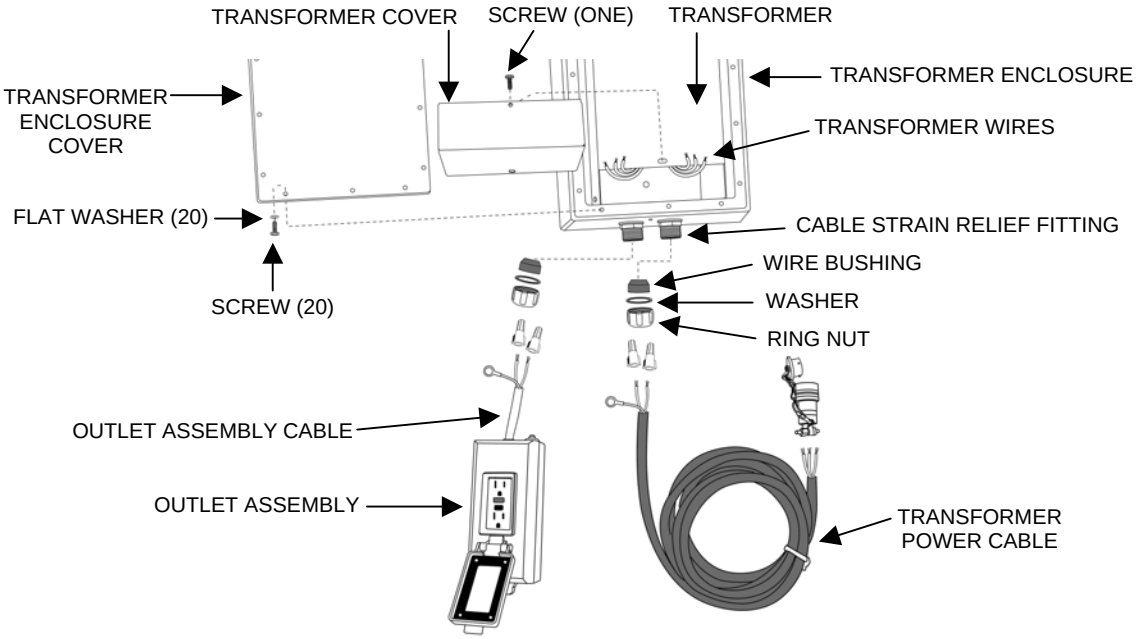

Figure 17. General Purpose Transformer Cable Removal.

6. Connect the new electrical outlet assembly cable or power cable from the transformer as follows (see Figure 17):
    a. Slide the ring nut over the cable. Ensure proper orientation.
    b. Slide the washer over the cable.
    c. Slide the wire bushing over the cable. Ensure proper orientation.
    d. Feed the cable through the fittings in the transformer enclosure and transformer.
    e. Connect the cable wires to the transformer wires and ground connection according to the tags.
    f. Slide the wire bushing and washer up to the cable strain relief fitting and secure with the ring nut.
    g. Push the connected wire ends into the box.
    h. Secure the transformer cover to the transformer using the one screw.
    i. Secure the enclosure cover to the transformer enclosure using the 20 screws and 20 flat washers.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0064 00**
UNIT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

SERVICE

Diesel Heater Air Pump Pressure Adjustment:

Tools:
0-10 psig pressure gauge
Equipment condition:
Diesel heater OFF and power cord disconnected from source and from heater

Adjust the diesel heater air pump pressure as follows (see Figure 18):

1. Remove the plug from the air filter housing.
2. Install the pressure gauge into the hole.
3. Start the heater (it is not necessary to have fuel in the tank for this pressure check and adjustment.)
4. Pump pressure should read five psi, plus or minus one-quarter psi. If the pressure is not within this range, adjust the pressure relief valve as follows:
    a. Loosen the lock nut.
    b. Screw the pressure adjust screw in to raise the pressure; out to lower the pressure.
    c. Tighten the lock nut.
5. Turn the heater OFF
6. Remove the gauge.
7. Reinstall the plug.

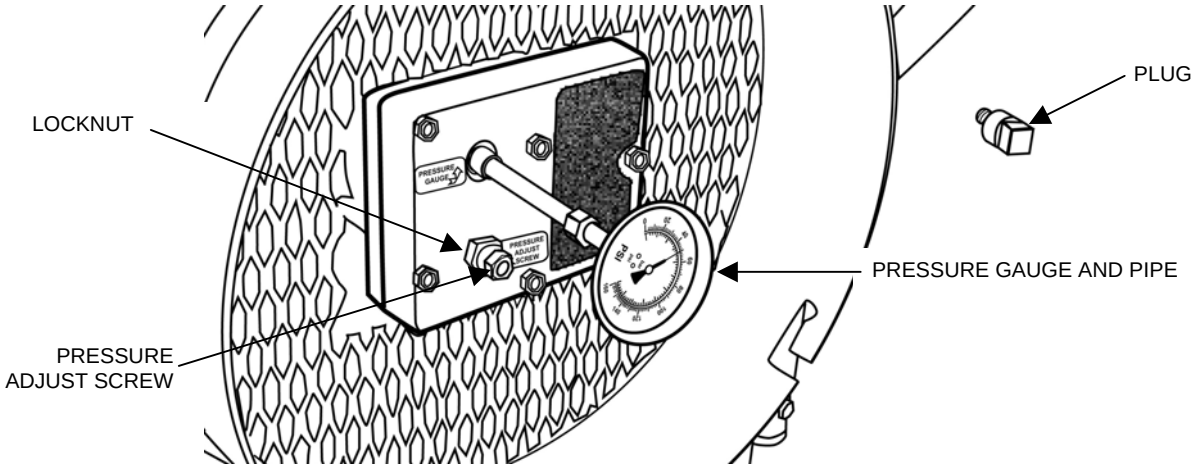

Figure 18. Diesel Heater Air Pump Pressure Adjustment.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0065 00**
UNIT MAINTENANCE PROCEDURES
FLAT RACK AND TACTICAL QUIET GENERATOR

THIS SECTION COVERS:
Replace, Service

INITIAL SETUP

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Reference
Refer to TM 10-4610-309-24P for repair parts information
Refer to TM 5-6115-545-12 for TQG Unit Maintenance procedures
Personnel Required
One
Equipment Condition
These repairs can be performed regardless of the condition of the TPWS

GENERAL:

This work package contains information and instructions for replacing A-TWPS flat rack latches and seals and for lowering the A-TWPS bail bar in order to access and service components in the TQG diesel engine compartment. The procedures covered in this work package include:

- Latch Replacement
- Seal Replacement
- Lowering and Raising the Bail Bar

Refer to TM 5-6115-545-12 for TQG Unit Maintenance procedures.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0065 00**
UNIT MAINTENANCE PROCEDURES
FLAT RACK AND TACTICAL QUIET GENERATOR

REPLACE

Latch Replacement:

Parts (TM 10-610-309-24P):
Flat rack latch
Gasket
Equipment Condition:
This procedure can be performed regardless of the condition of the TPWS

Replace flat rack latches as follows (see Figure 1):

1. Remove the bolt and retaining plate from the back of the latch.
2. Pull the latch assembly and gasket out through the front of the flat rack panel.
3. Insert a new latch and gasket in through the front of the panel ensuring that the latch points toward the outer edge of the panel.
4. Secure the latch with the retaining plate and bolt removed earlier.

NOTE
Do not tighten the bolt so tight that the retaining plate bows, otherwise the latch will not function.

5. Tighten the bolt snug tight.
6. Check the operation of the latch. Loosen the bolt if the latch does not function.

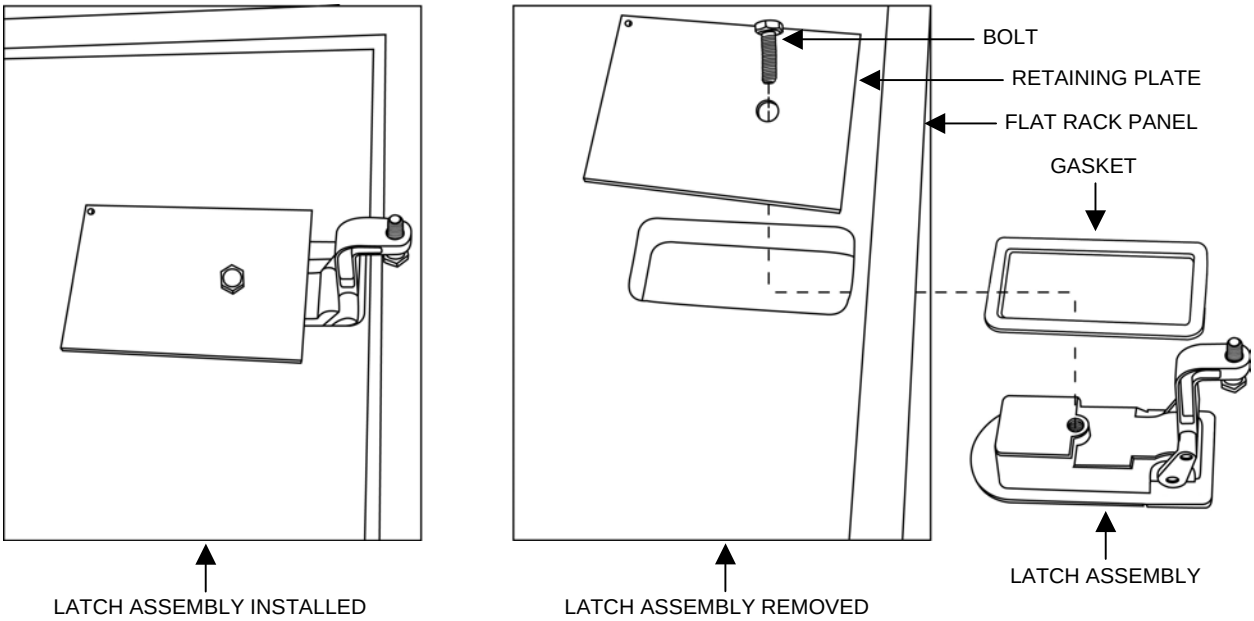

Figure 1. Flat Rack Latch Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0065 00**
UNIT MAINTENANCE PROCEDURES
FLAT RACK AND TACTICAL QUIET GENERATOR

Seal Replacement:

Parts (TM 10-610-309-24P):
Seal, channel, flat rack
Seal, self-adhering, flat rack
Seal, flat, flat rack
Equipment Condition:
This procedure can be performed regardless of the condition of the TPWS

1. Replace flat rack channel seals as follows (see Figure 2):
   a. Pull the old seal off the flat rack.
   b. Cut new seal to length from bulk.
   c. Press the new seal in place.

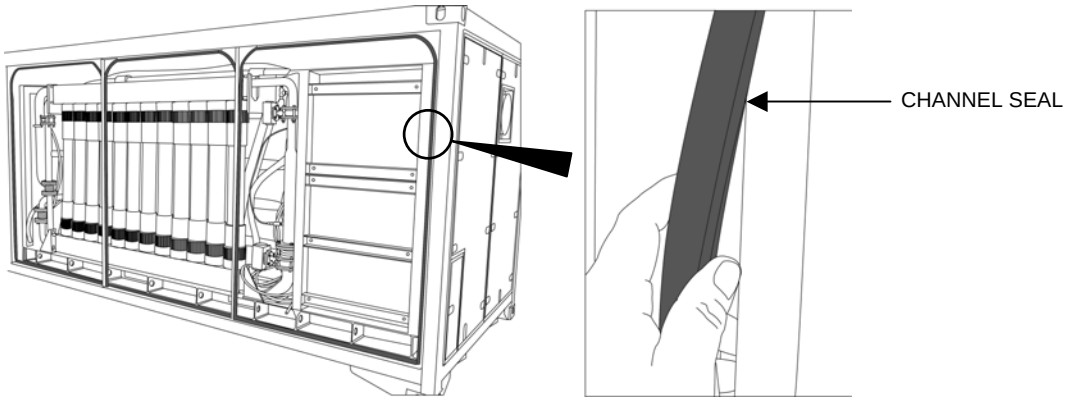

Figure 2. Flat Rack Channel Seal Replacement.

2. Replace flat rack self-adhering seals as follows (see Figure 3):
   a. Note the orientation of the existing seal.
   b. Pull the old seal off the flat rack.
   c. Cut new seal to length from bulk.
   d. Orient the seal where it is to be installed on the flat rack.
   e. Remove the protective paper strip from the seal.
   f. Press the adhesive side of the seal to the TWPS surface.

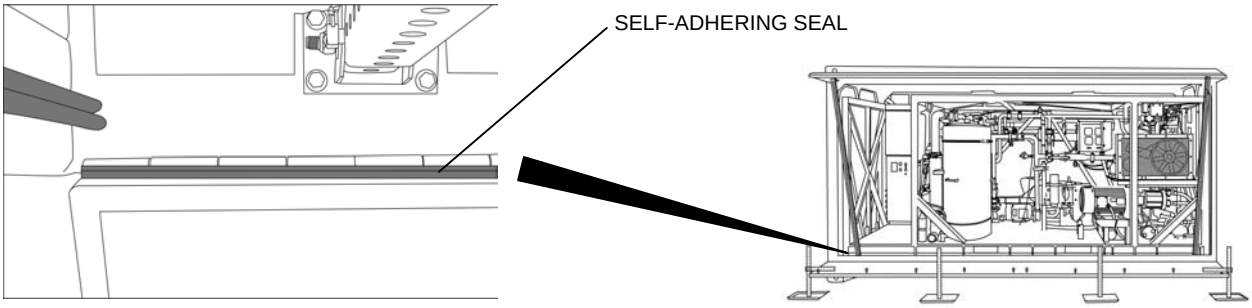

Figure 3. Flat Rack Self-Adhering Seal Replacement.

3. Replace the flat rack flat seal as follows (see Figure 4):

WARNING

Potential for head and eye injury. Make sure that two people are holding up the hinged top panel before removing the retaining pins from the top panel supports. Failure to observe this warning could result in the top panel falling down suddenly, resulting in head injury or the possibility of a top panel latch causing eye injury.

a. While two people hold up the hinged top panel, the third person removes the retaining pins from the top panel supports.
b. Carefully lower the top panel and latch it shut. Insert and secure the two retaining pins to an accessible part of the supports.
c. Remove the 21 flat head screws that secure three flat bars and the flat seal to the flat rack.
d. Remove the three flat bars.
e. Remove the old flat seal.
f. Cut a new flat seal to length from bulk.
g. Punch holes along the top edge of the new seal to match the screw holes in the flat rack.
h. Position the new seal and one of the flat bars in place on the flat rack.
i. Secure the flat bar and seal to the flat rack using 7 of the flat head screws.
j. Secure the other two flat bars and remaining length of the flat seal to the flat rack in the same manner.

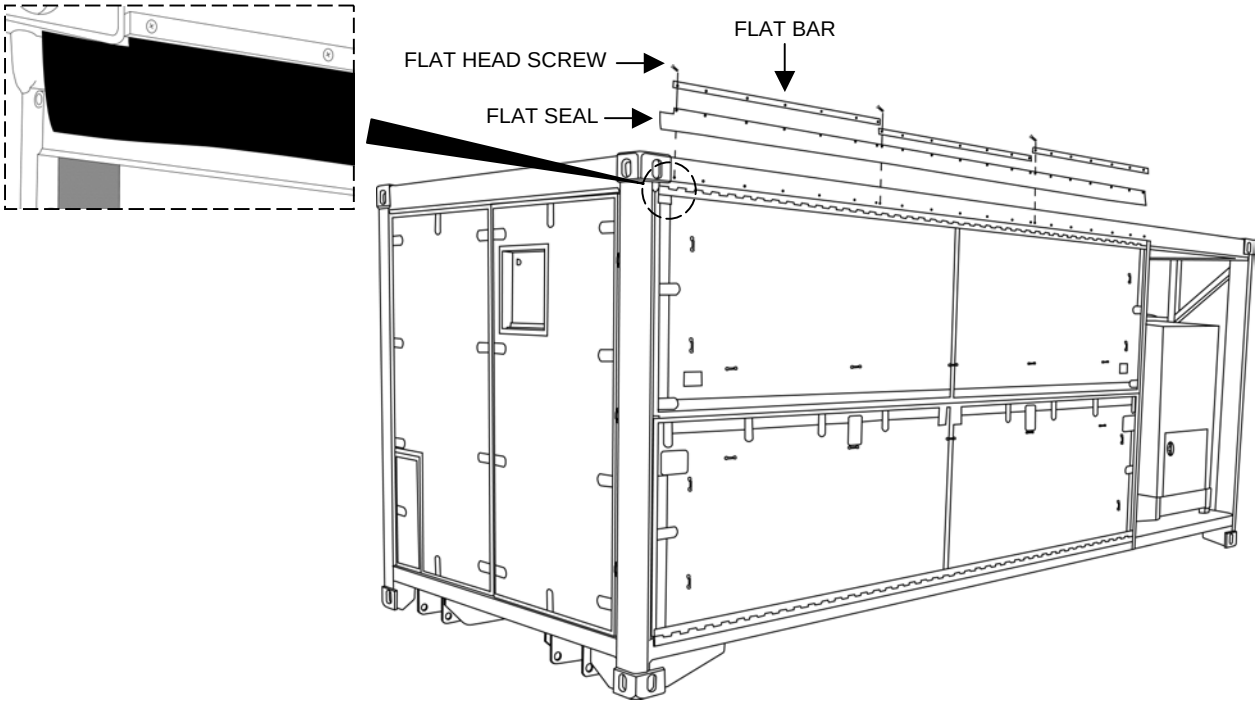

Figure 4. Flat Rack Flat Seal Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0065 00**
UNIT MAINTENANCE PROCEDURES
FLAT RACK AND TACTICAL QUIET GENERATOR

SERVICE

Lowering and Raising the Bail Bar:

Tool:
Wrench, Bail Bar, aluminum (BII)
Equipment Condition:
Tactical Quiet Generator shut down

1. Lower the flat rack bail bar as follows:

WARNING

Crushing hazard. Always attach the winch cable hook to the bail bar ring before removing any bolts from the bail bar. Failure to observe this warning could result in the bail bar falling down unrestrained, killing anyone underneath it.

a. Attach the winch cable hook onto the ring near the top of the bail bar (see Figure 5).

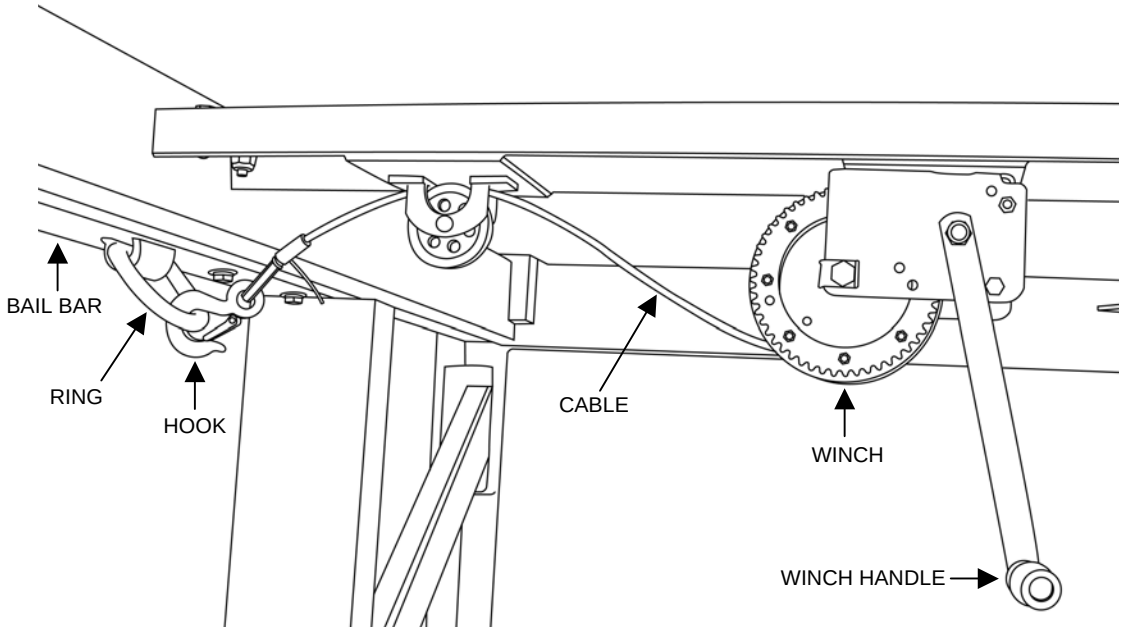

Figure 5. Winch Cable Hook Attached to Bail Bar Ring.

b. Remove the hardware that secures the bail bar to the flat rack as follows (see Figure 6):
   1) Remove the eleven bolts, lockwashers, and flat washers that secure the bail bar to the top horizontal beam of the flat rack.
   2) Remove the four bolts, eight flat washers, four lock washers, and four nuts that secure the bail bar to the diagonal beam of the flat rack.
   3) Insert the flat end of the pinch bar between the large back nut and the flat rack frame at the bottom of the flat rack.
   4) Unscrew the bolt out of the nut using the bail bar socket wrench. Retain the bolt, lock washer and nut.
   5) Remove the back bolt, lock washer and nut at the other side of the bail bar in the same manner.

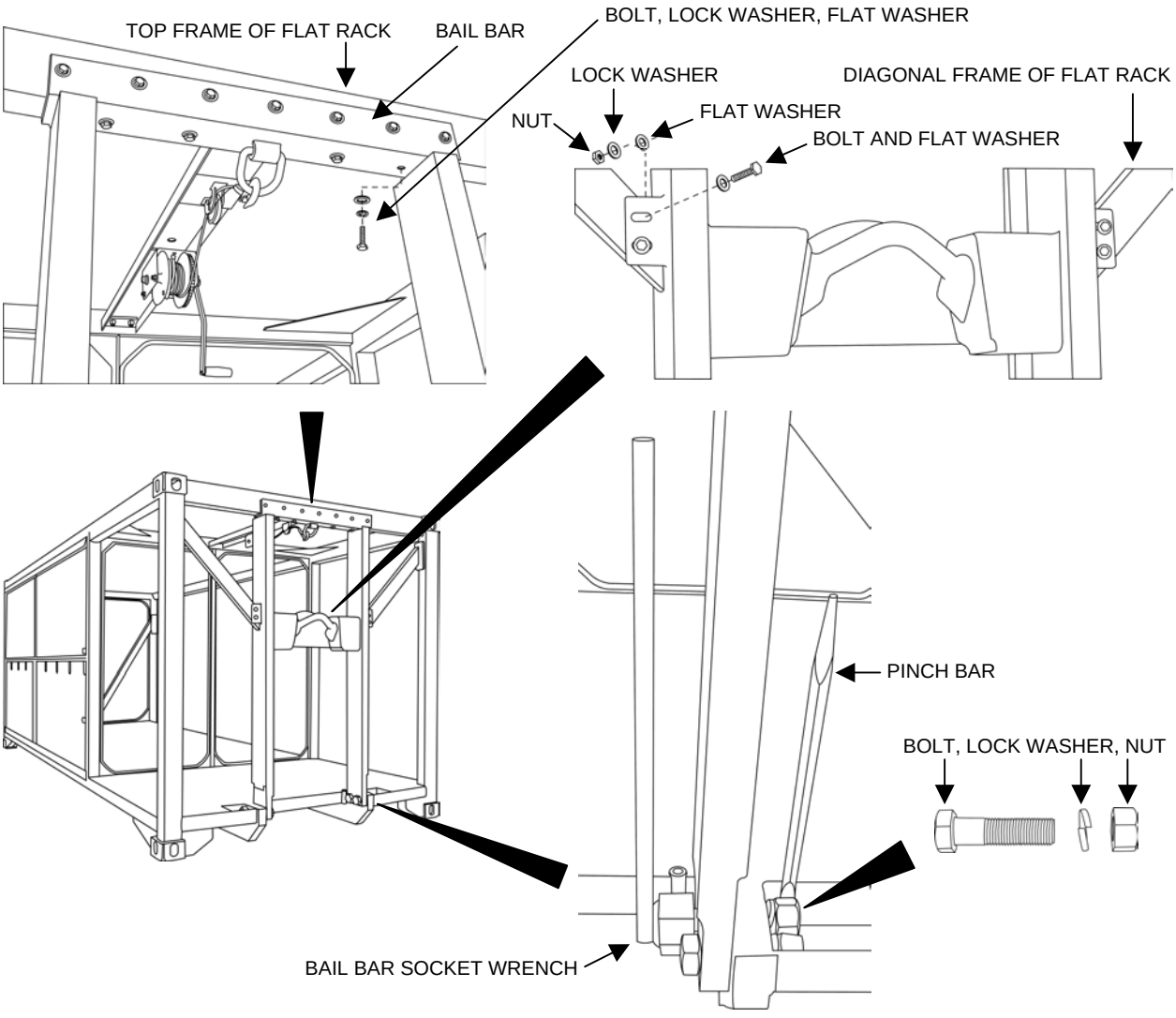

Figure 6. Removing the Bolts from the Bail Bar.

c. Turn the winch crank handle to lower the bail bar to the desired position (see Figure 7).
d. Disconnect the cable and move it out of the way so it is not a hazard.

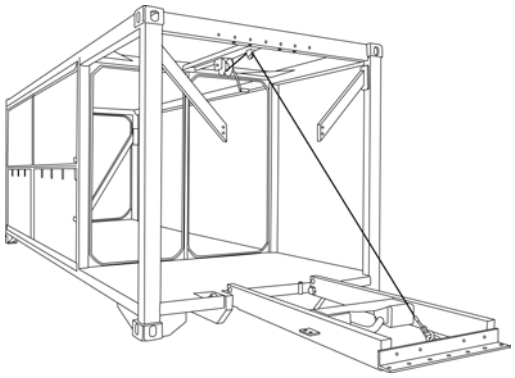

Figure 7. Flat Rack Bail Bar Lowered.

2. Raise and secure the bail bar as follows:
   a. Turn the winch crank handle to raise the bail bar.

NOTE

Installing the two large bolts, lockwashers, and nuts at the bottom of the bail bar first helps align the holes for the other bolts and makes the other bolts easier to install.

   b. Install the two large bolts, lock washers, and nuts that secure the bottom of the bail bar to the flat rack (see Figure 6).

WARNING

A minimum of 6 bolts in the front of top horizontal beam of the flat rack and a minimum of 3 bolts in the underside of the top horizontal beam are required in order to safely lift the flat rack by the bail bar. Failure to observe this warning may result in equipment damage and severe injury or death.

CAUTION

The middle and upper bail bar bolts must be installed in their proper locations. There are three different length bolts that are used. The longest of the three is used with washers and nuts to secure the bail bar to the diagonal beam of the flat rack. The other two shorter bolts thread into rivet nuts, which are threaded inserts in the top horizontal beam of the flat rack. Installing the wrong length bolt into a rivet nut may loosen the rivet nut causing it to turn inside the beam. If this happens, it will not be possible to remove the bolt as the rivet nut will turn with the bolt.

c. Separate the three different size bolts that are used to secure the middle of the bail bar to the diagonal beam of the flat rack and the top of the bail bar to the top horizontal flat rack beam (see Figure 8).
d. Loosely secure the top part of the bail bar to the front of the top horizontal flat rack beam using the seven short bolts with their lock washers and flat washers. Do NOT tighten yet.
e. Loosely secure the top part of the bail bar to the underside of the top horizontal flat rack beam using the four longer bolts with their lock washers and flat washers. Do NOT tighten yet.
f. Secure the middle of the bail bar to the diagonal flat rack beam of the using the four longest bolts with eight flat washers, four lock washers, and four nuts.
g. Tighten all 15 bolts. Torque to 250 in-lbs.

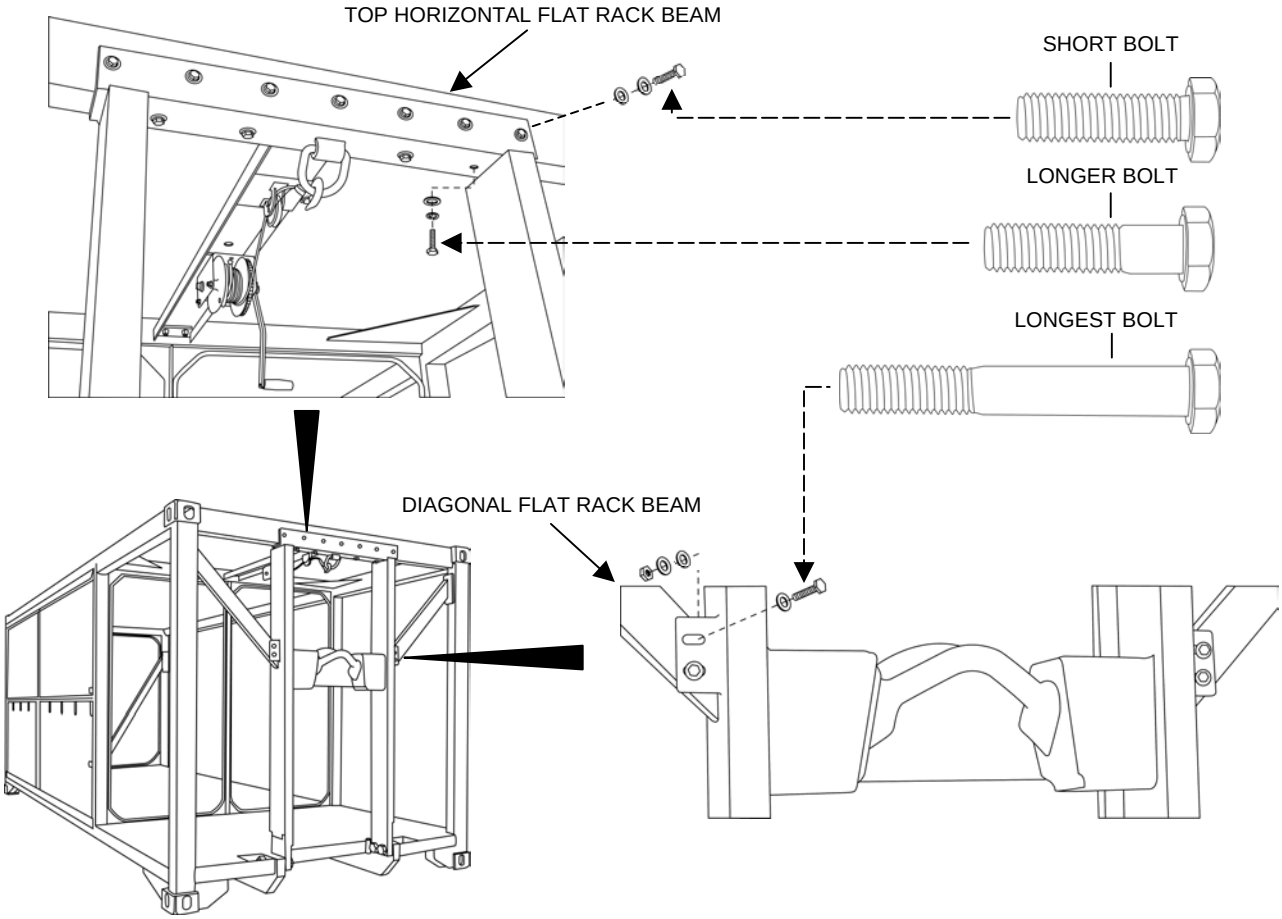

Figure 8. Correct Bail Bar Bolt Installation Locations.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

THIS SECTION COVERS:
Replace, Repair, Assembly

INITIAL SETUP:

Maintenance Level
Unit
Tools
Army: General Mechanic's Tool Kit (WP 0075)
Marine Corps: Common No. 1 Tool Set (WP 0075)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS in Standby Shutdown

GENERAL:

This work package contains information and instructions for replacing, repairing, and assembling components common to a number of TWPS systems. The procedures covered include:

- Clamped-On Hose Replacement
- Compression Fitting Connected Hose Replacement
- Push-On Hose Replacement
- Tube Fitting-Connected Tube Replacement
- Welded Ball Valve Replacement
    - MF Clean Feed Valve V-704
    - RO Clean Mixing Valve V-703
    - RO Feed Tank Drain to Waste Valve V-412
- Threaded Ball Valve Replacement
    - MF Strainer Vent/Sample Valve V-110
    - MF Vent Valve V-114
    - MF Filtrate Drain Valve V-203
    - MF Filtrate Sample Valve V-204
    - MF Shell Drain Valve V-403
    - RO Feed Tank Auxiliary Drain Valve V-210
    - RO Feed Pump Drain Valve V-211
    - HP Pump Inlet Drain Valve V-213
    - HP Pump Case Drain Valve V-214
- Butterfly Valve Replacement
    - MF Main Feed Valve V-111
    - MF Upper Feed Inlet Valve V-112
    - MF Lower Feed Inlet Valve V-113
    - MF Upper Filtrate Valve V-201
    - MF Filtrate Flow Control Valve V-202
    - HP Pump Inlet Valve V-212
    - MF Upper Backwash Out Valve V-401
    - MF Lower Shell Out Valve V-402
- Limit Stop Replacement

- Actuator (with Mechanical Position Indicator) Replacement
  - Mounted on all butterfly valves listed above.
- Actuator (with Pneumatic Positioner) Replacement
  - Mounted on MF Filtrate Flow Control Butterfly Valve V-202
- Grooved Coupling Replacement
- Flexi Joint Expansion Joint Replacement
- Pipe Coupling Replacement
- Sanitary Clamp Replacement
- Locking Arm Replacement
- Actuator Repair
- Collapsible Fabric Tank Repair
- Antiseize Pipe Tape Installation

REPLACE

Clamped-On Hose Replacement:

Parts (TM 10-4610-309-24P):
Replacement hose
Replacement clamp
Equipment Condition:
TWPS in Standby Shutdown with or without draining down as required

Replace a hose that is clamped onto a fitting as follows (see Figure 1):

1. When replacing a clamped-on drain hose, make sure the TWPS is in Standby Shutdown without Draining Down. Refer to WP 0017.
2. For all clamped-on hoses other than a drain hose, make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
3. Turn the screw on the hose clamp to loosen the clamp and pull the clamp back down the hose from the fitting.
4. Pull or cut the hose off the fitting.
5. Remove the hose from the fitting at the other end in the same manner.

NOTE

When measuring the length of a hose to be replaced, remember to include any portions of the old hose that you cut off in the total length for the replacement hose.

The black product tubing must be cut to a length so that, when installed, it does not drop below the end connection on the 3-way valve.

6. Measure the hose length.
7. Cut new hose to length from bulk.
8. Obtain replacement clamps if the existing clamps are rusted, corroded, or need replacement for any other reason.
9. Slide a clamp over one end of the replacement hose.
10. Push the hose all the way onto its fitting.

11. Slide the clamp up the hose over the fitting and tighten the clamp.
12. Connect the other end of the new hose to its fitting in the same manner.

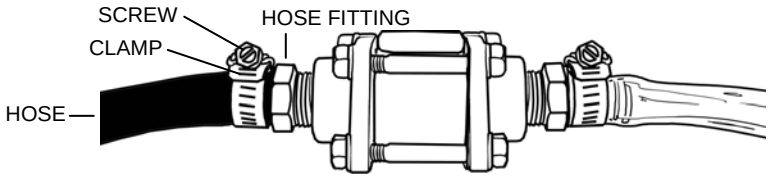

Figure 1. Replacing a Clamped-On Hose.

Compression Fitting Connected Hose Replacement:

Parts (TM 10-4610-309-24P):
Replacement hose, ferrules, and conical compression nuts
Material:
Antiseizing tape (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown without Draining Down
Air bled from air system

Replace a hose with a compression fitting as follows (see Figure 2):

WARNING

High pressure. Hoses that are connected with compression fittings typically operate under high pressure. Make sure that the pressure is released from the system in which the hose functions before disconnecting the hose. Failure to observe this warning can result in serious injury.

1. Make sure the TWPS is in Standby Shutdown without Draining Down. Refer to WP 0017.
2. Make sure the air has been bled from the air system. Refer to WP 0055, **ENTIRE AIR SYSTEM BLEED DOWN**.
3. Disassemble the hose and compression fitting as follows:
    a. Remove the nut, compression fitting, ferrule, and conical compression nut from the air fitting.
    b. Disconnect the other end of the hose in the same manner.
    c. Discard the hose with the compression fitting, the ferrules, and the conical compression nuts.
    d. Remove the old antiseize tape from the air fitting threads and clean the threads.
4. Assemble the new hose and compression fitting as follows:
    a. Apply new antiseize tape on the cleaned threads of the air fitting.
    b. Slide a nut over the tube on the compression fitting at one end of the replacement hose.
    c. Slide a ferrule and a conical compression nut over the tube with the tapered ends away from the compression fitting and toward the air fitting.
    d. Push the tube, nut, ferrule, and compression fitting onto the air fitting.
    e. Thread the nut onto the air fitting and tighten
    f. Assemble the other end of the new hose to its air fitting in the same manner.

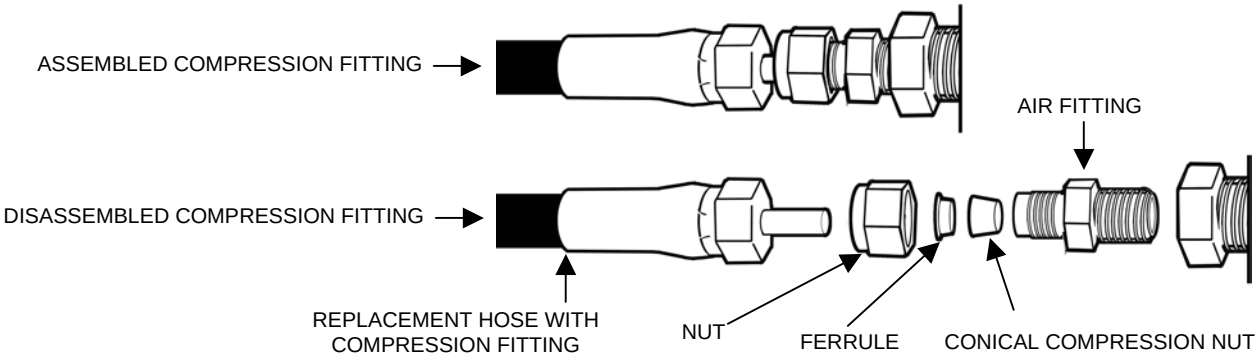

Figure 2. Replacing a Hose with a Compression Fitting.

Push-On Hose Replacement:

Parts (TM 10-4610-309-24P):
Replacement hose
Equipment Condition:
TWPS in Standby Shutdown without Draining Down
Air bled from air system

Replace a hose that is pushed onto a barbed coupling as follows (see Figure 3):

1. Make sure the TWPS is in Standby Shutdown without Draining Down. Refer to WP 0017.
2. Make sure the air has been bled from the air system. Refer to WP 0055, **ENTIRE AIR SYSTEM BLEED DOWN**.
3. Cut the hose off the fitting.
4. Remove the hose from the fitting at the other end in the same manner.

NOTE

When measuring the length of a hose to be replaced, remember to include any portions of the old hose that you cut off in the total length for the replacement hose.

5. Measure the hose length.
6. Cut new hose to length from bulk.

NOTE

Failure to lubricate the inside of the hose may result in an inability to push the hose all of the way onto the hose barb.

7. Lubricate the inside of both ends of the hose with glycerin.
8. Push one end of the hose all the way onto its barbed coupling.
9. Connect the other end of the new hose to its barbed coupling in the same manner.

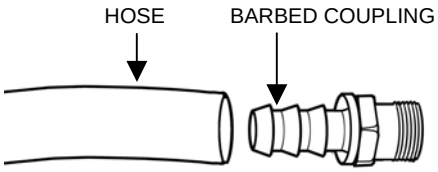

Figure 3. Replacing a Push-On Hose.

Tube Fitting-Connected Tube Replacement:

Parts (TM 10-4610-309-24P):
Replacement tubing
Equipment Condition:
TWPS in Standby Shutdown without Draining Down
Air bled from air system

Replace a ¼-in. or a $^{3}/_{8}$-in. tube that is pushed onto a tube fitting as follows (see Figure 4):

1. Make sure the TWPS is in Standby Shutdown without Draining Down. Refer to WP 0017.
2. Make sure the air has been bled from the air system. Refer to WP 0055, **ENTIRE AIR SYSTEM BLEED DOWN**.
3. Push the tube fitting collet in and pull the tube out of the fitting.
4. Remove the tube at the other end in the same manner.
5. Measure the tube and cut new tube to length.
6. Push the ends of the new tube all the way into each of the tube fittings and twist back and forth once.

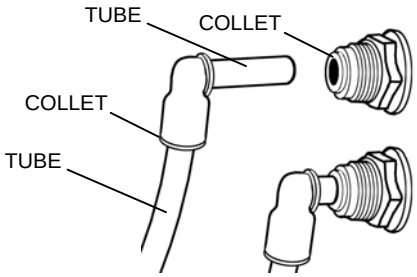

Figure 4. Disconnecting Tubing from a Tube Fitting.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Welded Ball Valve Replacement:

Parts (TM 10-4610-309-24P):
MF clean feed valve V-704
RO feed tank drain to waste valve V-412
RO clean mixing valve V-703
Materials:
Clean, dry, lint-free rags (WP 0079, Table 1, item 33)
Valve Seal Lubricant (WP 0079, Table 1, item 26)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace the any of the welded ball valves listed below as follows:
- MF System: V-704
- RO System: V-412, V-703

NOTE

1-1/4 in. and larger ball valves have piping welded to the valve.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the welded ball valve from the pipe line as follows (see Figure 5):
   a. Make sure that the valve is in the open position with the valve handle in-line with the pipeline. This prevents the ball from protruding out of the body and scoring the body connectors when the body is removed.
   b. Remove the four nuts and bolts that hold the valve to the body connectors.
   c. Slightly pull the body connectors apart to prevent scoring of the machined faces.
   d. Slide the valve body completely away from the body connectors. Care must be taken not to damage the connector sealing faces.

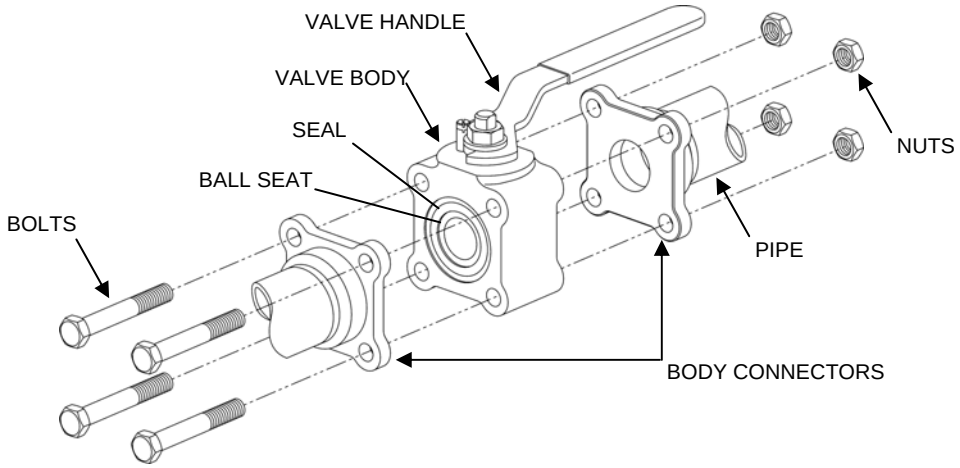

Figure 5. Welded Ball Valve Body Replacement.

3. Clean and inspect the body connector faces.

4. Install the new valve body as follows (see Figure 5):
    a. Make sure that the new valve body is in the open position with the valve handle in-line with the pipeline. This prevents the ball from protruding out of the body and scoring the body connectors when the body is being installed.

NOTE
Make sure that the lubricant used is compatible with the pipeline media.

    b. Apply a little valve seal lubricant to the seats and seals.
    c. Slightly pull the body connectors apart to get the body assembly in position and to avoid damaging the seats, seals and sealing faces.
    d. Center the body, install the bolts and nuts and tighten them diagonally and evenly.
    e. Check the valve for leaks, tightness and proper operation.

Threaded Ball Valve Replacement:

Parts (TM 10-4610-309-24P):
MF strainer drain valve V-109
MF strainer vent/sample valve V-110
MF vent valve V-114
MF filtrate drain valve V-203
MF filtrate sample valve V-204
MF shell drain valve V-403
RO feed tank auxiliary drain valve V-210
Strainer S-4 drain valve V-213
HP pump inlet drain valve V-214
HP pump case drain valve V-215
HP pump outlet drain valve V-301
RO feed pump drain valve V-211
Materials:
Clean, dry, lint-free rags (WP 0079, Table 1, item 33)
Antiseize tape (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace any of the threaded ball valves listed below as follows:
- MF System: V-109, V-110, V-114, V-203, V-204, V-403
- RO System: V-210
- Strainer S-4 Drain Valve V-213
- HP Pump Inlet Drain Valve V-214
- HP Pump Case Drain Valve V-215
- HP Pump Outlet Drain Valve V-301
- RO Feed Pump Drain Valve V-211

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the threaded ball valve from the pipe line as follows (see Figure 6):
    a. Make sure that the valve is in the open position with the valve handle in-line with the pipeline. This prevents the ball from protruding out of the body and scoring the body connectors if the body is removed first.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

NOTE

If no union or pipe connection is found close to the valve, then remove the valve as you would a welded ball valve. Refer to REPLACE and Ball Valve, Welded.

b. Find the closest union or connection on either side of the valve and disconnect that part of the piping.
c. Unscrew and remove the disconnected end of the piping from the valve-threaded connection.
d. Unscrew the valve from the other fixed section of the pipe line.
e. Place the old valve on a clean workbench.

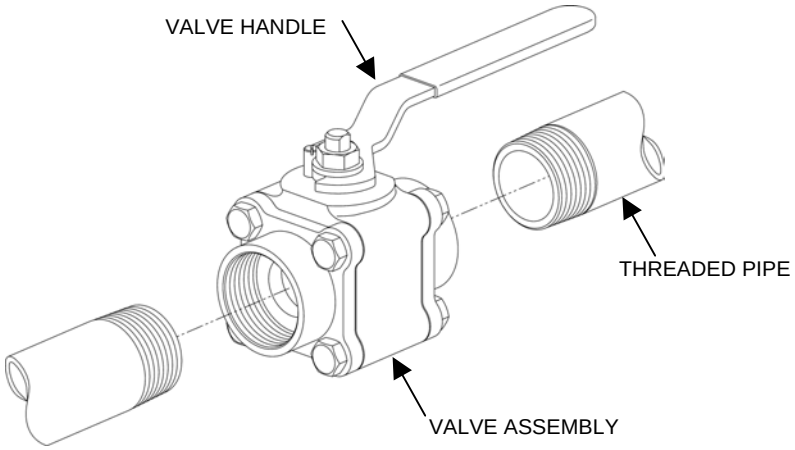

Figure 6. Threaded Ball Valve Replacement.

3. Clean the pipe threads and apply antiseize tape to the pipe threads.
4. Inspect the new valve. Remove any shipping residue and make sure that the valve is clean.
5. Install the new valve as follows:
    a. Make sure that the valve is in the open position (as shown in Figure 6).
    b. Thread the new valve onto the fixed piping so that it is in the same position as the old valve.
    c. Thread the piping that was disconnected from the old valve to the new valve and tighten.
    d. Install the union or connection that was removed to disconnect the piping and tighten.
6. Operate the system to check for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Butterfly Valve Replacement:

Parts (TM 10-4610-309-24P):
- MF Main Feed Valve V-111
- MF Upper Feed Inlet Valve V-112
- MF Lower Feed Inlet Valve V-113
- MF Upper Filtrate Valve V-201
- MF Filtrate Flow Control Valve V-202
- HP Pump Inlet Valve V-212
- MF Upper Backwash Out Valve V-401
- MF Lower Shell Out Valve V-402

Materials:
- Clean, lint-free rags (WP 0079, Table 1, item 33)
- Sealing compound (WP 0079, Table 1, item 35)
- Five gallon bucket
- Drip Pan

Equipment Condition:
- TWPS in Standby Shutdown with Drain-Down

Replace any of the butterfly valves listed below as follows (see Figure 7):
- MF System: V-111, V-112, V-113, V-201, V-202, V-401, V-402
- High Pressure Pump Inlet Manual Valve V-212

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the butterfly valve assembly as follows:
   a. Push the actuator swivel joint adapter collet in and pull the air hose out of the adapter.
   b. Where possible place the five-gallon bucket or drip pan under the valve to be removed.
   c. Remove the four lock nuts, four bolts, and eight flat washers that secure the butterfly valve assembly to the TWPS. Separate the pipe flanges and remove the valve.

NOTE
Valve V-113 has hex nuts, lock washers, and threaded studs to secure the actuator to the valve rather than the cap screws and lock washers used for the other valves.

3. Remove the four cap screws and four lock washers that hold the actuator to the butterfly valve and remove the valve from the actuator.
4. Unthread the swivel joint adapter from the actuator.

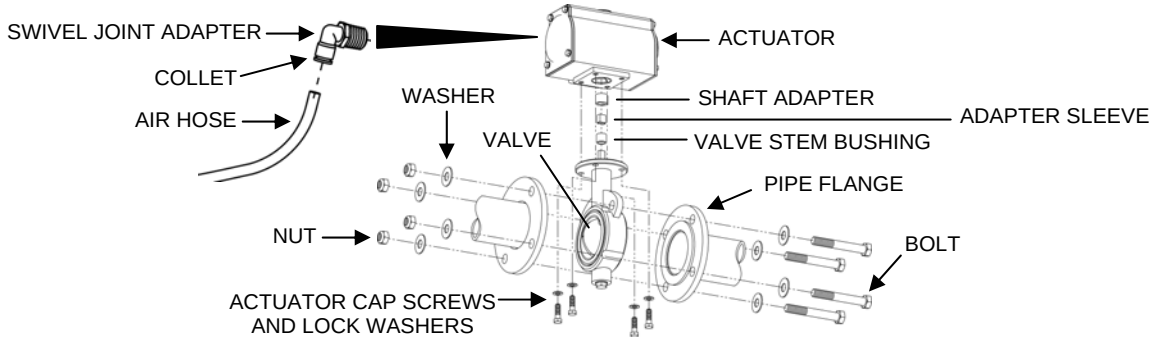

Figure 7. Butterfly Valve Replacement.

5. Install the new butterfly valve assembly onto the actuator as follows:
    a. Make sure the new valve is in the same normal position as the valve it is replacing.
        1) The valve is either normally open (NO) or normally closed (NC).
        2) A new valve can be moved to its proper starting position by securing the valve body and using a wrench on the valve stem to turn the valve.
        3) The table below lists each of the automatic valves and its normal position.

VALVE	VALVE SIZE	NORMAL POSITION
V-111 Main Feed Valve	3-in.	NO
V-112 Upper Feed Valve	2-in.	NO
V-113 Lower Feed Valve	3-in.	NC
V-201 Upper Filtrate Outlet Valve	2-in.	NO
V-202 Filtrate Flow Control Valve	2-in.	NO
V-401 Shell Backwash Upper Outlet Valve	3-in.	NC
V-402 Shell Backwash Lower Outlet Valve	2-in.	NC

    b. Clean the actuator with clean, lint-free rags and inspect for corrosion, nicks and damage.
    c. Apply sealing compound to the threads of the swivel joint adapter and thread the adapter into the actuator.
    d. For MF Lower Feed Inlet Valve V-113, see the **Limit Stop Replacement** procedures to ensure proper limit stop installation.
    e. If the shaft adapter and adapter sleeve fell out of or were removed from the actuator, insert the shaft adapter into the actuator drive bore. Set the key of the shaft adapter into the actuator bore keyway so that when the valve is assembled onto the actuator, the valve body will be aligned with the actuator as shown in Figure 7.
    f. Insert the shaft adapter sleeve into the shaft adapter.
    g. Make sure a valve stem bushing is inserted over the new valve stem and into the opening between the valve stem and valve body.
    h. Insert the valve stem into the shaft adapter / adapter sleeve.
    i. Make sure the valve body is aligned with the actuator as shown in Figure 7. If it is not, remove the valve and the shaft adapter / adapter sleeve. Reinsert the shaft adapter into the actuator bore with the adapter key fitted into the other keyway in the bore. Then insert the shaft adapter sleeve and the valve stem.
    j. Secure the actuator to the new valve with the 4 lock washers and cap screws.
6. Install the butterfly valve assembly onto the TWPS as follows:
    a. Clean the pipe flanges with clean lint-free rags and inspect for nicks and any other damage that may cause the flange to leak.

NOTE

Install the butterfly valve and actuator in the same position as the valve/actuator assembly that was removed.

    b. Separate the pipe flanges, insert the valve and secure the valve to the pipe flanges only snug tight using the four bolts, eight washers, and four nuts that were removed earlier.
    c. Make sure that the valve is centered between the flanges then tighten the nuts and bolts in a crisscross pattern.
    d. Push the air hose into the swivel joint adapter.
    e. Check the new butterfly valve for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Limit Stop Replacement:

Parts (TM 10-4610-309-24P):
Limit Stop Assembly
Material:
Antiseizing tape (BII) (WP 0079, Table 1, item 43, 44)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

MF Lower Feed Inlet Valve V-113 is the only butterfly valve on the TWPS that has a limit stop assembly. The limit stop replacement procedures listed here may be used to replace the limit stop assembly or for ensuring proper limit stop installation when replacing the valve or actuator for MF Lower Feed Inlet Valve V-113. Replace the limit stop as follows:

1. Back the stop screws most of the way out of the limit stop body.
2. Remove MF Lower Feed Inlet Valve V-113 from the TWPS and remove the actuator from the valve. Refer to the **Butterfly Valve Replacement** procedures.
3. If replacing an existing limit stop assembly, remove the old limit stop cam, body, and threaded studs from the bottom of the actuator.
4. Install a limit stop assembly as follows:
    a. Secure the actuator in a vise with the bottom of the actuator facing up.
    b. Make sure the valve shaft adapter and adapter sleeve are inserted into the actuator bore so that when the valve is assembled onto the actuator, the valve body will be aligned with the actuator as shown in Figure 8).

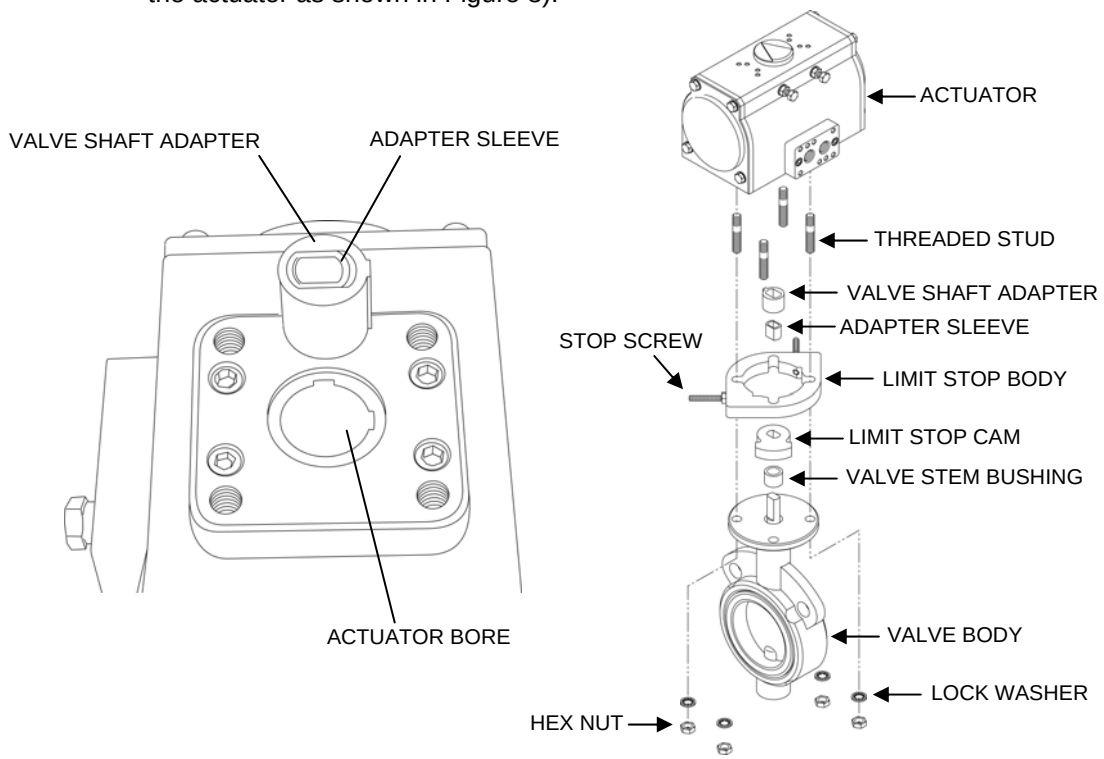

Figure 8. Valve Shaft Adapter and Adapter Sleeve Installation.

c. Apply antiseizing tape to the threads of the four new limit stop threaded studs.
d. Screw the short threaded end of the 4 threaded studs into the base of the actuator (see Figure 9).

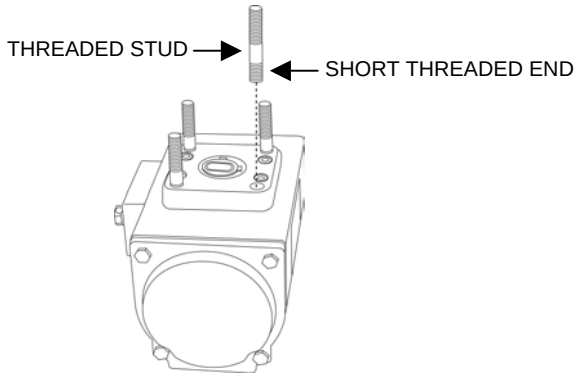

Figure 9. Limit Stop Threaded Stud Installation.

e. Place the limit stop body over the four studs and on the actuator base with the stop screws pointing away from the actuator air connection plate (see Figure 10).

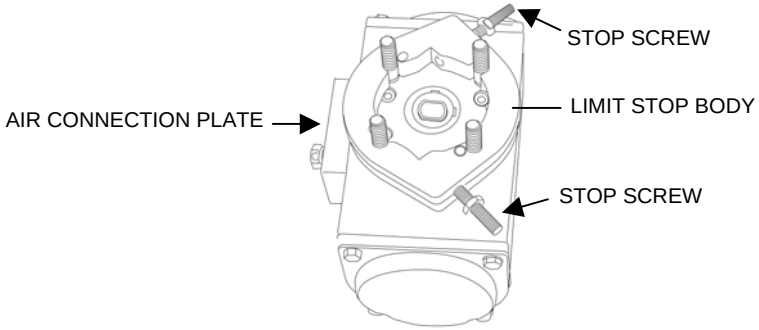

Figure 10. Limit Stop Body Installation.

f. Place the limit stop cam inside the limit stop body with the center hole in the cam aligned with the center hole of the valve shaft adapter / adapter sleeve. Orient the cam as shown in Figure 11.

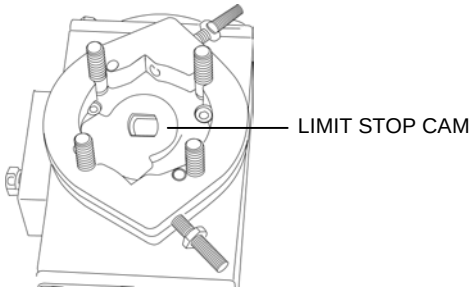

Figure 11. Limit Stop Cam Installation.

g. Set the valve over the threaded studs and onto the limit stop body with the valve oriented as shown in Figure 12.
h. Secure the valve to the limit stop body and actuator using the four star washers and four nuts that were supplied with the limit stop assembly.

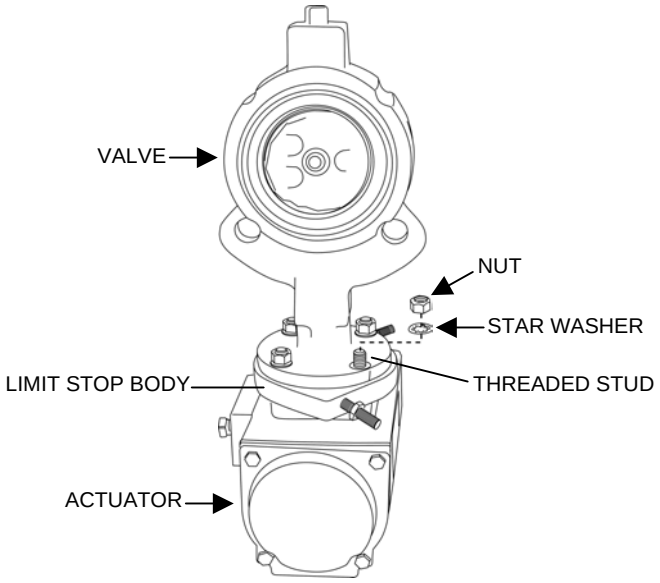

Figure 12. Valve V-113 Installation on the Limit Stop.

5. Install the butterfly valve assembly onto the TWPS. Refer to the **Butterfly Valve Replacement** procedures.
6. Set the limit stop stop-screws as follows (see Figure 13):
    a. Perform the diagnostic self-test procedures through V-113 Valve Cycle test step # 6. Refer to WP 013.
    b. Check that the triangle-shaped position indicator on the V-113 actuator is pointing straight up, indicating that the valve is fully open.
    c. Back the jam nut on the top stop-screw to the end of the stop-screw.
    d. Screw the top stop-screw into the limit stop body so that approximately 3/8-in of stop screw is sticking out of the limit stop body.
    e. Tighten the jam nut onto the limit stop body.
    f. Unscrew the bottom stop-screw out of the limit stop body, then screw it back in about a half inch.
    g. Tighten the jam nut onto the limit stop body.
    h. Complete the diagnostic self-test procedure. Refer to WP 013.
    i. Check that the triangle-shaped position indicator on the V-113 actuator is pointing about 45 degrees to the right of the fully open, straight up position.
    j. If the triangle-shaped position indicator is not at 45 degrees, repeat the diagnostic self-test procedure stopping at step # 6. Readjust the top stop-screw by turning in to increase the angle or turning out to decrease the angle
    k. Complete the diagnostic self-test procedure and check that the position indicator is at 45 degrees. Repeat the adjusting procedure if necessary until the position indicator is at 45 degrees at the completion of the self-test procedure.

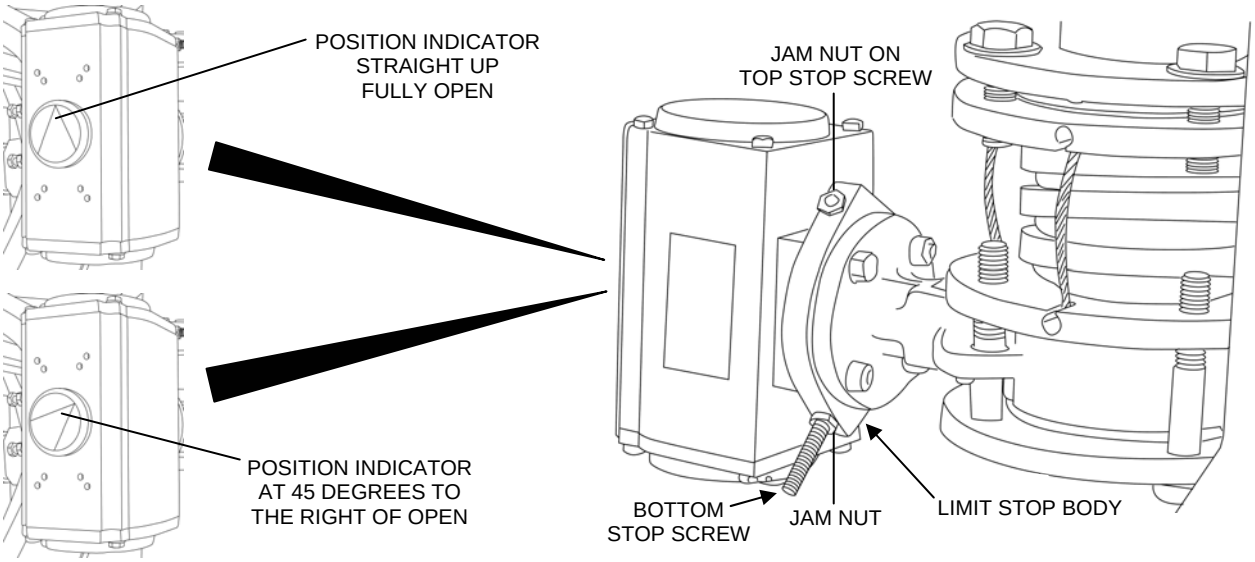

Figure 13. Limit Stop Stop-Screw Adjustment.

7. Check the butterfly valve for leaks and proper operation.

Actuator (with Mechanical Position Indicator) Replacement:

Parts (TM 10-4610-309-24P):
- Actuator P/N MRP-004U-K-S080 or MRP-004U-K-S081(on MF Lower Shell Out Valve V-402)
- Actuator P/N MRP-004U-K-S081 (on MF Upper Feed Inlet Valve V-112 and MF Upper Filtrate Valve V-201)
- Actuator P/N MRP-009U-K-S080 (on MF Lower Feed Inlet Valve V-113)
- Actuator P/N MRP-009U-K-S080 or MRP-009U-K-S081(on MF Upper Backwash Valve V-401)
- Actuator P/N MRP-009U-K-S081 (on MF Main Feed Valve V-111)

Materials:
- Clean, lint-free rags (WP 0079, Table 1, item 33)

Equipment Condition:
- TWPS in Standby Shutdown with Drain-Down

Replace any of the actuators with a mechanical position indicator as follows:

NOTE
Actuators with a mechanical position indicator comes in two sizes on the TWPS. Removal and replacement procedures are the same for both sizes.

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the butterfly valve assembly. Refer to **Butterfly Valve Replacement.**
3. Remove the actuator from the butterfly valve. Refer to **Butterfly Valve Replacement.**
4. Install the new actuator onto the valve and install the valve actuator assembly. Refer to **Butterfly Valve Replacement.**
5. Run the unit and check the actuator and valve for leaks and proper operation.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Actuator (with a Pneumatic Positioner) Replacement:

Parts (TM 10-4610-309-24P):
Actuator P/N MRP-004U-K-S081
Figure 7874, Pneumatic Positioner
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace the actuator with figure 7874 pneumatic positioner that are mounted on Valve V-202 as follows:

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Tag and disconnect the air tubes from the pneumatic position indicator and actuator.
3. Remove the butterfly valve assembly. Refer to **Butterfly Valve Replacement**.
4. Remove the actuator from the butterfly valve. Refer to **Butterfly Valve Replacement**.
5. Remove the positioner from the actuator as follows (see Figure 14):
    a. Remove the 4 screws from the cover of the pneumatic positioner and remove the cover.
    b. Remove the 4 screws and washers inside that positioner that secure the positioner to the actuator.
    c. Remove the old pneumatic positioner and the positioner shaft adapter and adapter sleeve from the actuator.

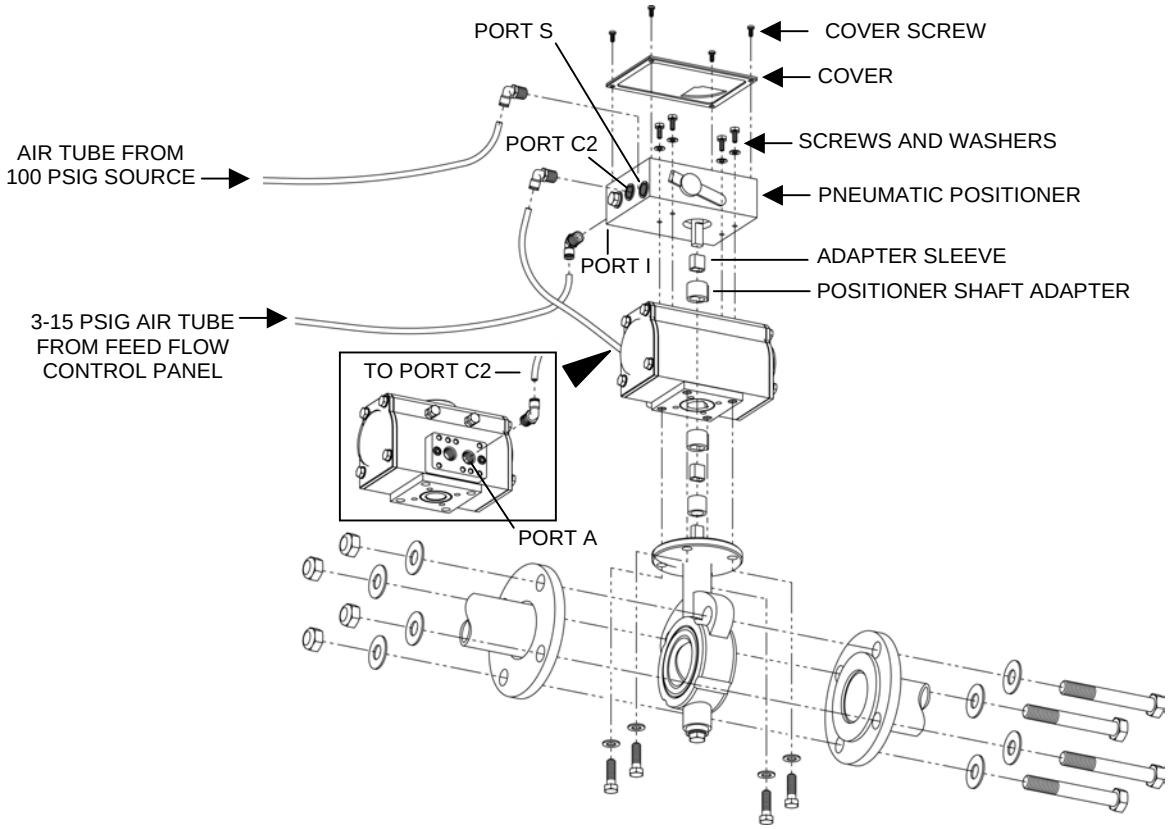

Figure 14. Pneumatic Positioner and Actuator.

6. Inspect and clean the actuator.
7. Install the new pneumatic positioner as follows:
    a. Remove the four screws on the new pneumatic positioner and open the cover.
    b. Secure the pneumatic positioner to the actuator using the 4 screws and washers.
    c. Reinstall the positioner cover using the four screws.
8. Install the actuator on the butterfly valve. Refer to **Butterfly Valve Replacement)**.
9. Install the positioner, actuator and valve assembly into the pipeline. Refer to **Butterfly Valve Replacement**.
10. Connect the air tubes to the positioner and actuator ports as marked.
11. Run the unit and check the positioner, actuator and valve for leaks and proper operation.

Grooved Coupling Replacement:

Parts (TM 10-4610-309-24P):
Grooved Coupling with Gasket System
Gasket System
Materials:
Clean, dry, lint-free rags (WP 0079, Table 1, item 33)
Glycerin (WP 0079, Table 1, item 21)
Five-gallon container or drip pan
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace a grooved coupling and gasket as follows:

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the grooved coupling as follows (see Figure 15):
    a. Place a fluid container under the coupling to catch any fluid in the line.
    b. Slowly loosen the nuts and bolts that hold the coupling in place.
    c. Completely remove the nuts and bolts and then remove the flexible coupling and gasket.

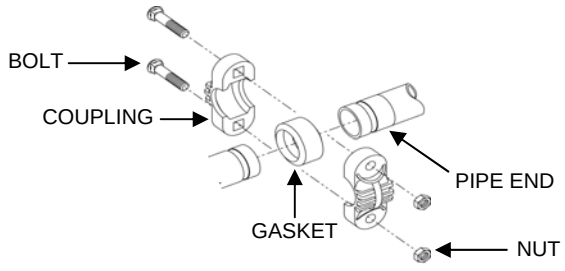

Figure 15. Grooved Coupling and Gasket.

3. Using clean, lint-free rags, clean and inspect the area where the coupling connects and check it for obvious signs of cracks and damage.
4. Install the new grooved coupling and gasket as follows:
    a. Lubricate the gasket and pipe ends with glycerin. Place the new gasket around the two pipe halves.
    b. Make sure that the gasket does not slide into the grooves on either of the pipe ends.

c. Install the flexible coupling over the gasket and install the bolts and nuts but do not tighten.
d. Inspect the coupling and gasket to make sure the gasket is fitted around the piping and not in the coupling grooves. Rotating the coupling back and forth will set the gasket.
e. Tighten the coupling nuts and bolts.

Flexi Joint Expansion Joint Replacement:

Parts (TM 10-4610-309-24P):
Flexi Joint Expansion Joint
Materials:
Clean, dry, lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

The instructions that follow describe the steps for replacing a flexi joint expansion joint (see Figure 16).

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the flexi joint expansion joint as follows:
   a. Remove the 8 bolts and 8 washers that secure the flexi joint to the piping flange.

NOTE
The flexi joint above V-113 will have only one gasket.

   b. Spread the piping apart just enough to remove the flexi joint and gaskets.

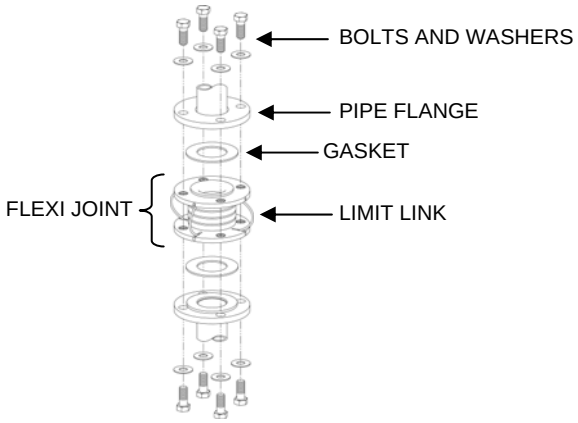

Figure 16. Flexi Joint Expansion Joint.

3. Clean the piping flanges with a clean, lint-free rag and inspect the piping and pipe flange connections for rust, corrosion and damage that would prevent the flexi joint from sealing.
4. Install the new flexi joint as follows:
   a. Ensure that the new flexi joint limit links are in place and not broken.
   b. Spread the piping apart and insert the new flexi joint and gaskets between the piping.
   c. Center the gaskets.
   d. Secure the piping flanges to each side of the flexi joint using the 8 bolts and 8 washers.
   e. Run the unit and check the joint for leaks.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Pipe Coupling Replacement:

Parts (TM 10-4610-309-24P):
Pipe Coupling
Materials:
Clean, dry lint-free rags (WP 0079, Table 1, item 33)
Corrosion preventive compound (WP 0079, Table 1, item 17)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace a pipe coupling (see Figure 17).

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the pipe coupling as follows:
   a. Remove the nuts and bolts that secure the clamps to the pipe joint at both ends of the pipe joint. Remove the clamps and set aside.
   b. With a screw driver and hammer, tap the gasket retainers loose from the gaskets at both ends. Push the pipe joint and gasket back onto one of the pipes until it clears the end of the other pipe.
   c. Remove pipe support clamps and loosen other connections as needed to free one or both pipes to move or rotate enough to move the ends clear of each other. Remove the gaskets, gasket retainers and pipe joint from the pipes.

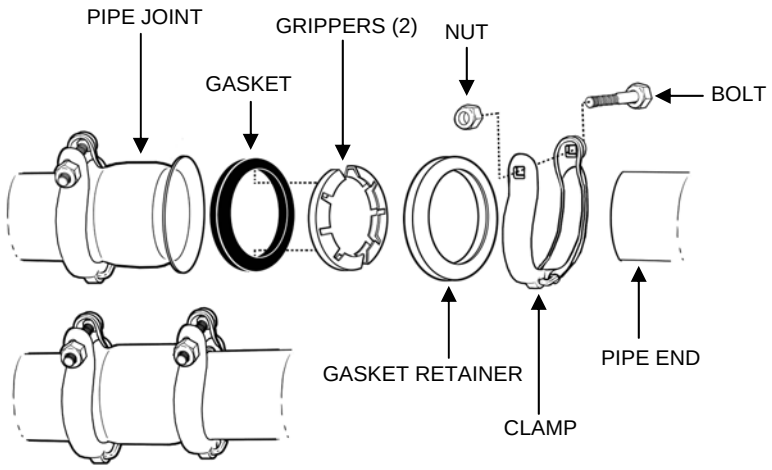

Figure 17. Pipe Coupling Replacement.

3. Clean the pipe ends with a clean, lint-free rag and inspect for rust, corrosion and damage that would prevent the pipe coupling from sealing.
4. Install a new pipe coupling as follows:
   a. Insert the two gripper sections into the inner diameter of a gasket.
   b. Insert the gasket into the gasket retainer.
   c. Slide the retainer, gasket, and gripper assembly over one of the two pipe ends (retainer side first).

d. Repeat a, b, and c for the other pipe end. One side must be pushed far enough on to allow the pipe joint to clear the other pipe end.
e. Fit the pipe joint onto one pipe end. Move the pipes back into alignment.
f. Slide the assemblies at both ends up to the pipe joint so that both gaskets fit up against the flanges of the pipe joint.
g. Position the clamps over the pipe joint flanges and gasket retainers and secure loosely with a bolt and nut. When both are installed loosely, tighten the bolt and nut on both clamps.
h. Tighten the pipe connections and pipe support clamps that were loosened to move the pipes.
i. Spray the gasket retainers and clamps with the corrosion preventive compound.
j. Run the unit and check the joint for leaks.

Sanitary Clamp Replacement:

Parts (TM 10-4610-309-24P):
Sanitary Clamp
Sanitary Clamp Gasket
Materials:
Clean, dry lint-free rags (WP 0079, Table 1, item 33)
Valve Seal Lubricant (WP 0079, Table 1, item 26)
Equipment Condition:
TWPS in Standby Shutdown with Drain-Down

Replace a sanitary clamp and gasket as follows (see Figure 18):

1. Make sure the TWPS is in Standby Shutdown with Drain-Down. Refer to WP 0017.
2. Remove the sanitary clamp as follows:
   a. Unscrew the wing nut.
   b. Lift the wing nut out of the notch in the clamp.
   c. Open and remove the clamp and gasket from the pipe ends.
3. Clean the pipe end flanges with a clean, lint-free rag and inspect the piping and pipe flange connections for rust, corrosion and damage that would prevent the sanitary clamp from sealing.
4. Install the sanitary clamp as follows:
   a. Apply a little valve seal lubricant to the gasket and insert it between the two pipe ends.
   b. Open the new sanitary clamp and place it around the pipe end flanges and gasket.
   c. Flip the wing nut over and insert it in the notch in the clamp.
   d. Tighten the wing nut. Use a screwdriver in the slot to tighten. Tap with the hammer all around and tighten again.
   e. Run the unit and check the joint for leaks.

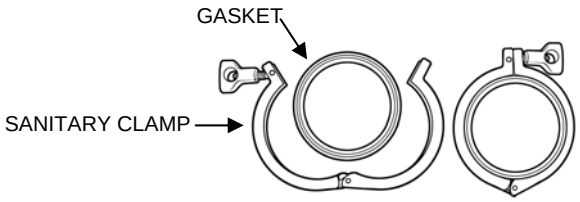

Figure 18. Sanitary Clamp and Gasket Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Locking Arm Assembly Replacement

Parts (TM 10-4610-309-24P):
Locking Arm Assembly
Equipment Condition:
TWPS in Standby Shutdown without Drain-Down

Replace the locking arm assembly on a 3-in x 10-ft raw water hoses as follows (see Figure 19):

NOTE

The shaft of the locking arm pin has ridges at one end and is smooth at the other end. To remove the pin, it must be pounded out from the smooth end. To install the pin, the smooth end of the shaft is inserted into the female hose fitting and arm and the pin is pounded in at the ridged end.

1. Place the round shaft end of a punch on the smooth end of the locking arm pin.
2. Using the punch and a hammer, pound the locking pin out of the hose fitting and the locking arm.
3. Remove the damaged locking arm.
4. Position a new locking arm in the hose fitting.
5. Insert the smooth shaft end of a new pin into the hose fitting and locking arm.
6. Place the round shaft end of the punch on the ridged end of the pin.
7. Using the punch and a hammer, pound the locking pin into the hose fitting and locking arm until the ridged end of the pin is securely wedged in the hose fitting.

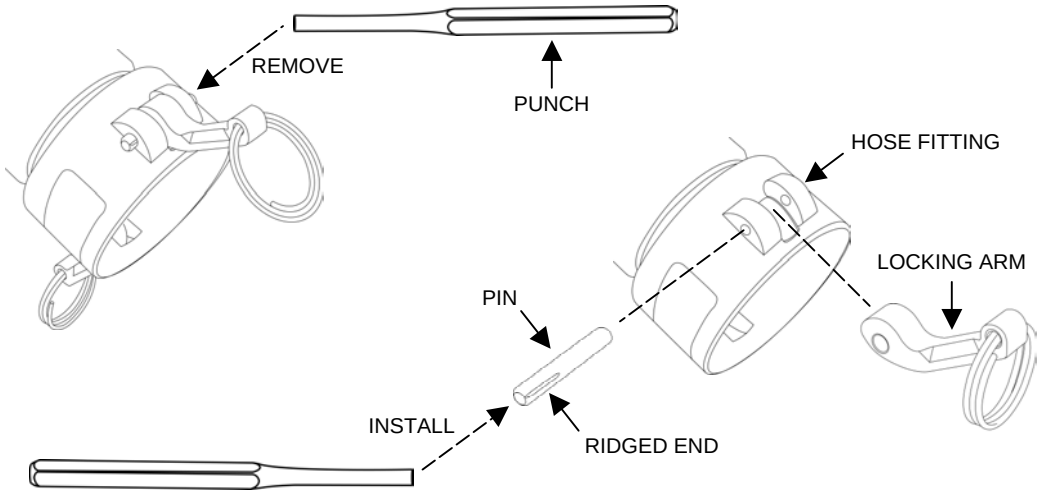

Figure 19. Locking Arm Assembly Replacement.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

REPAIR

Actuator Repair:

Parts (TM 10-4610-309-24P):
Actuator Repair Kit for actuator with a 3-inch valve
Actuator Repair Kit for actuator with a 2-inch valve
Material:
Grease, Molybdenum Disulfide (WP 0079, Table 1, item 23)
Equipment Condition:
Butterfly valve assembly removed from the TWPS and actuator removed from the butterfly valve. Refer to **Butterfly Valve Replacement**.

Repair a Actuator as follows:

1. Disassemble the actuator as follows (see Figure 20):
   a. Loosen the 2 travel stop lock nuts.
   b. Remove the 2 travel stop bolts, 2 lock nuts, and 2 sealing washers.

WARNING

Spring tension. There is spring tension against both actuator end caps. When removing an end cap, each of the four end cap bolts must be loosened a little at a time until there is no spring tension on the end cap. Failure to observe this warning may result in distortion of and damage to the bolts and possible injury due to the sudden release of the springs.

   c. Remove one of the two end caps as follows:
      1) Loosen each of the four end cap bolts a little at a time until there is no spring tension on the end cap.
      2) Finish removing the four end cap bolts and four flat washers.
      3) Lift the end cap and the spring assemblies out of the actuator body.
   d. Remove the other end cap in the same manner in which the first end cap was removed.
   e. Remove the pistons as follows:
      1) Set the actuator with the base plate facing up.
      2) Insert the shaft adapter into the pinion shaft.
      3) Insert a suitable tool (such as the nose of a needle nose pliers) into the shaft adapter and turn the pinion shaft clockwise to force the pistons out of the body.
      4) Pull the pistons out of the body.
   f. Remove the four base plate cap head bolts and spring washers from the bottom of the base plate and gently pull the base plate off the actuator body.
   g. Gently pry the position indicator cap off the top of the pinion shaft (a flat head screw-driver works well.)
   h. Withdraw the pinion shaft out the bottom of the actuator.
   i. Remove the two air connection plate cap head bolts and washers from the air connection plate and lift the connection plate off the actuator body.

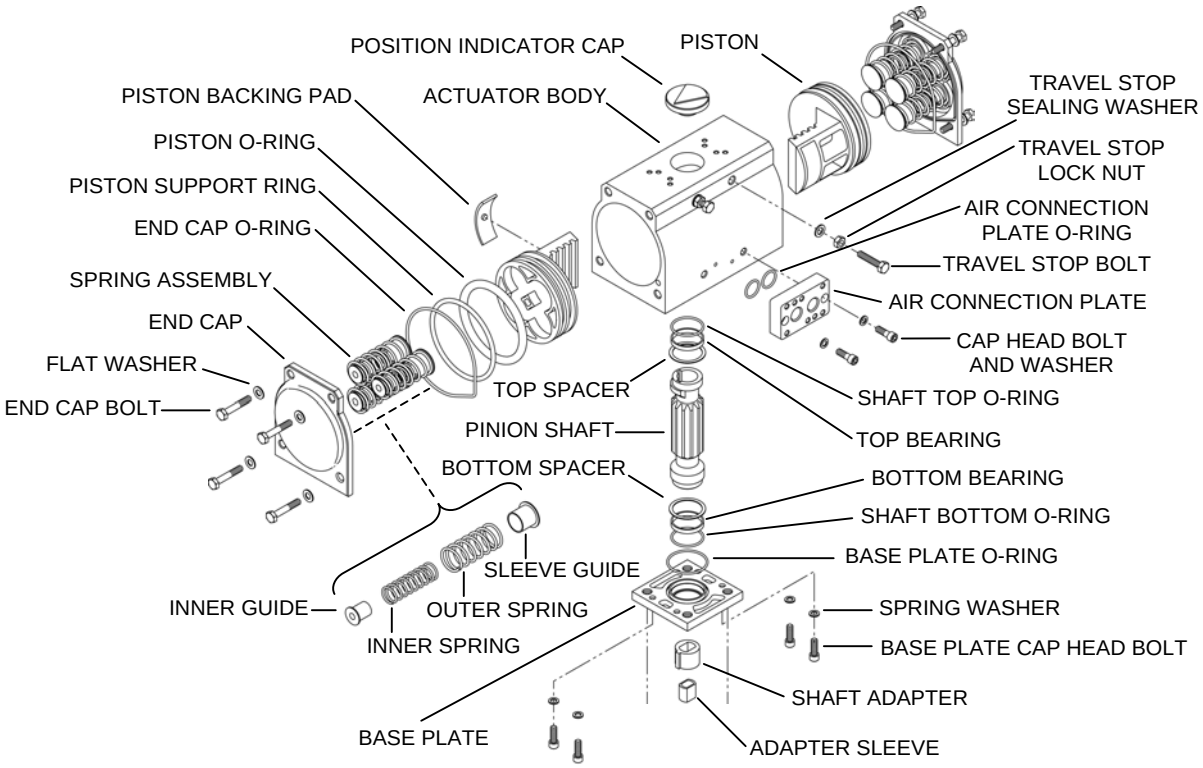

Figure 20. Actuator Disassembly.

2. Clean all the disassembled components.
3. Remove and replace the following components with new components (see Figure 20):
    a. Shaft top O-ring
    b. Top bearing
    c. Top spacer
    d. Shaft bottom O-ring
    e. Bottom bearing
    f. Bottom spacer
    g. Base plate O-ring
    h. Piston O-ring (one on both of the pistons)
    i. Piston support ring (one yellow green ring on both of the pistons)
    j. Piston backing pad (one on both of the pistons)
    k. End cap O-ring (one on both of the end caps)
    l. Air connection plate O-rings (two)
4. Reassemble the actuator as follows (see Figure 20):
    a. Lubricate the body bore (inside of the actuator body) with molybdenum disulfide grease.
    b. Lubricate all O-rings, bearings, and support rings with molybdenum disulfide grease.
    c. Assemble the pinion shaft and base plate to the actuator body as follows:
        1) Coat the bottom of the pinion shaft with molybdenum disulfide grease.
        2) Carefully insert the pinion shaft into the base plate bore, finishing with a firm push to make sure that the shaft is fully seated in the bore.

3) Check that the shaft bottom O-ring hasn't slipped out of position so that it sticks out the bottom of the base plate. If the O-ring is out of position, remove the shaft, replace the O-ring if damaged or reseat the O-ring on the shaft and reinsert the shaft in the base plate.
4) Carefully lower the body of the actuator over the top of the pinion shaft and onto the base plate, finishing with a firm push to make sure that the top of the shaft is fully seated in the body bore.
5) Check that the holes in the base plate line up with the holes in the bottom of the actuator body. If they do not, rotate the base plate 90º so that the holes do line up.
6) Secure the base plate to the body using the four cap head screws and spring washers.

d. Position the pinion shaft as follows:
1) Set the actuator on its base plate with the air connection plate facing you.
2) Insert the shaft adapter into the top of the pinion shaft.
3) If the actuator is for use on a normally open valve (V-111, V-112, V-201, or V-202) insert a suitable tool (such as the nose of a needle nose pliers) into the shaft adapter and turn the pinion shaft so that both pinion shaft keyways are at a 45º angle to the air connection plate (see Figure 21).
4) If the actuator is for use on a normally closed valve (V-113, V-401, or V-402) insert a suitable tool (such as the nose of a needle nose pliers) into the shaft adapter and turn the pinion shaft so that both pinion shaft keyways are at a 45º angle to the left end of the actuator body (see Figure 21).
5) Remove the shaft adapter from the top of the pinion shaft.

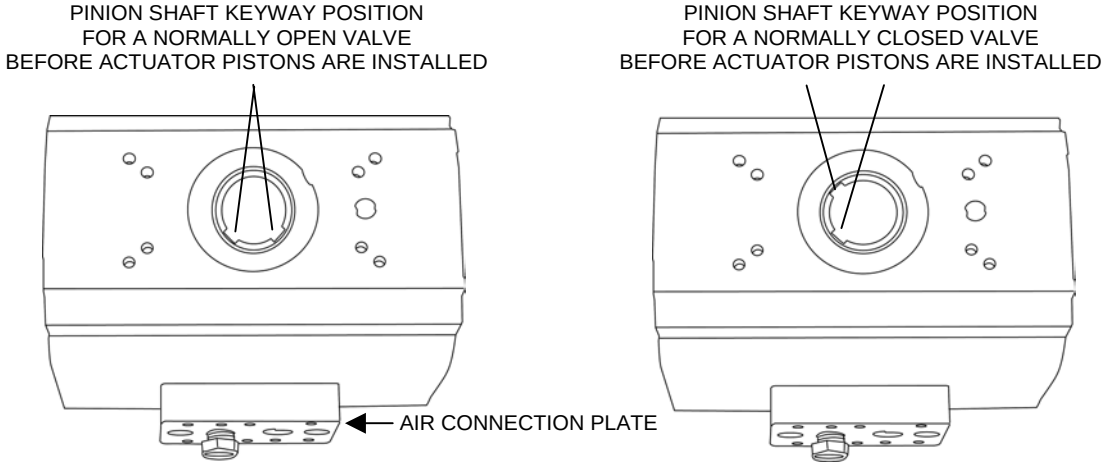

Figure 21. Position of Actuator Pinion Shaft Keyways Prior to Installing Pistons.

e. Lubricate the pinion shaft teeth with molybdenum disulfide grease.
f. Assemble the pistons to the actuator body as follows:
1) Lubricate the piston teeth with molybdenum disulfide grease.
2) With the air connection plate facing you, insert the right piston into the bore of the actuator body with its backing pad toward you and insert the left piston into the bore with its backing pad away from you (see Figure 20).

3) Holding the pistons in place so that they do not fall out of the actuator body, position the actuator body so that one piston head is on the working surface and the other piston head is facing up.
4) Push firmly on the top piston to push the pistons into the actuator body until both pistons engage with the teeth on the pinion shaft.
5) Check that the piston O-ring on both of the pistons has not slipped out of position so that it sticks out between the piston head and the end of the actuator body. If an O-ring is out of position, remove the pistons, replace the O-ring if damaged or reseat the existing O-ring on the piston head, and reinsert the pistons into the bore of the actuator.

g. Reposition the pinion shaft to fully retract the pistons into the body as follows:
1) Set the actuator body on the work surface with the base plate down.
2) Insert the shaft adapter into the top of the pinion shaft.
3) Insert a suitable tool (such as the nose of a needle nose pliers) into the shaft adapter and turn the pinion shaft clockwise as far as it will go.
4) Remove the shaft adapter from the top of the pinion shaft.

h. Assemble the springs as follows (see Figure 22):
1) Insert one inner guide into one end of an inner spring.
2) Insert the other end of the inner spring into the open end of a sleeve guide.
3) Insert the inner guide end of the inner spring into one end of an outer spring.
4) Repeat for each of the other seven spring assemblies.

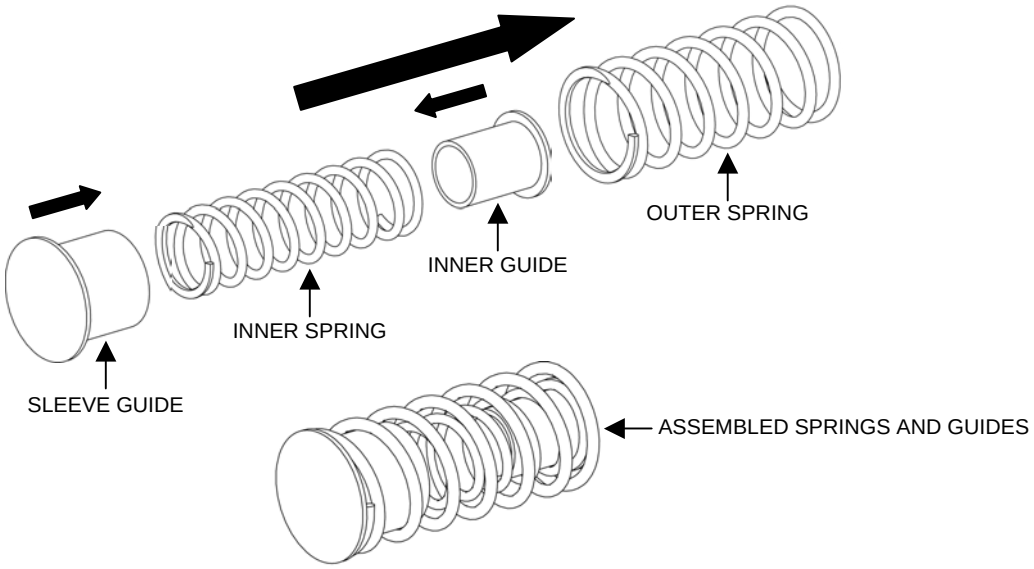

Figure 22. Actuator Spring Assembly.

i. Assemble the springs and end caps to the actuator body as follows (see Figure 23):
1) Set the actuator body up on one end of the body.
2) Set four assembled spring assemblies, sleeve guide down, into the cavity of the piston head.

3) Carefully align and set an end cap onto the spring assemblies so that the cone shaped projections of the end cap fit into the ends of the inner guides
4) Insert four end cap bolts with four flat washers through the holes in the end cap.
5) Push down on the end cap, compressing the springs enough to start threading the bolts into the actuator body.
6) Tighten each bolt a little at a time until the end cap is fully tightened down onto the actuator body.
7) Torque the bolts as follows:
    a) 51.5 in.-lbs. for the 4-inch (smaller) actuators
    b) 117.5 in.-lbs. for the 9-inch (larger) actuators
8) Repeat the previous 7 steps for the other end cap.

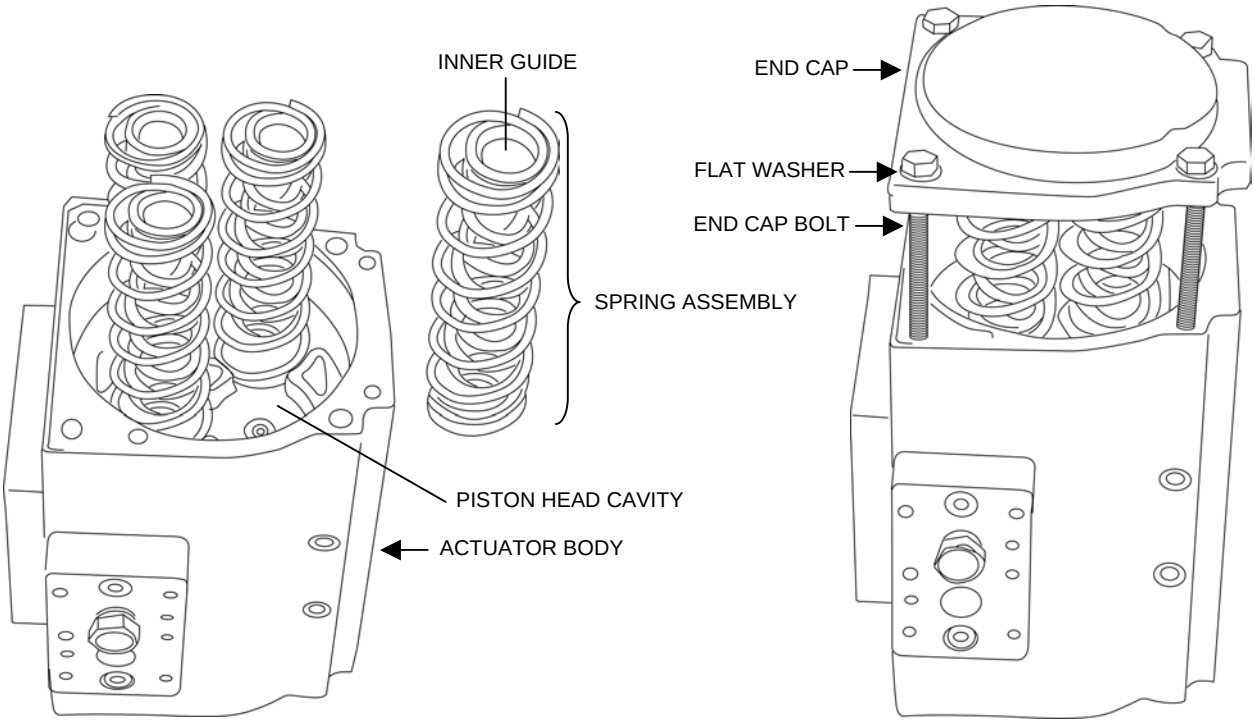

Figure 23. End Cap Assembly.

j. Align the position indicator keys with the keyways on top of the pinion shaft and push the position indictor fully onto the shaft.
k. Make sure the air connection plate O-rings are in place.
l. Position the plate on the actuator body with the silencer to the left and secure the plate using the two cap head bolts and washers (see Figure 23).

CAUTION

Do NOT use the travel stop screws to move or reposition the actuator pinion shaft. Failure to observe this caution will result in damage to cams on the pinion shaft or to the ends of the stop screws.

m. Set the actuator travel stops as follows (see Figure 24):
   1) Thread a lock nut onto both of the two travel stop screws.
   2) Fit a sealing washer onto both of the two travel stop screws.
   3) With the actuator setting on its baseplate and the air connection plate facing you, screw in the left travel stop screw to an estimated position.
   4) Apply 100-120 psig air to port “A” to fully operate the actuator.
   5) Check the position indicator. With the air connection plate facing you, release air pressure as necessary until the position indicator is pointing as follows:
      a) To the left end of the actuator with a normally closed valve.
      b) To the air connection plate with a normally open valve.
   6) Reset the travel stop screw then tighten the lock nut to secure the stop screw.
   7) Screw in the right travel stop screw to an estimated position.
   8) Apply 100-120 psig air to port “A” again to fully operate the actuator.
   9) With the air connection plate facing you, release air pressure as necessary until the position indicator is pointing as follows:
      a) To the left end of the actuator with a normally closed valve.
      b) To the air connection plate with a normally open valve.
   10) Reset the travel stop screw then tighten the lock nut to secure the stop screw.

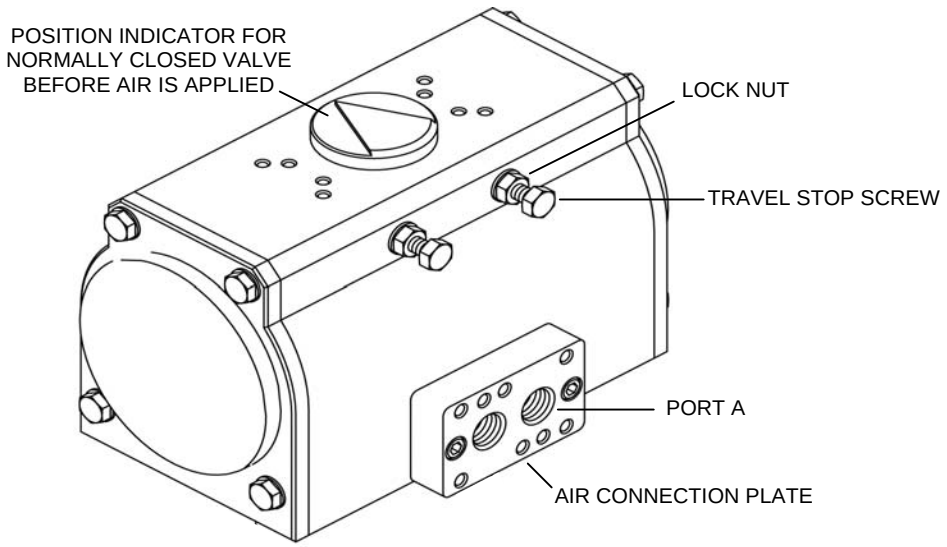

Figure 24. Actuator Travel Stops.

5. Secure the actuator to the butterfly valve. Refer to **Butterfly Valve Replacement**.
6. Secure the butterfly valve assembly to the TWPS. Refer to **Butterfly Valve Replacement**

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

Collapsible Fabric Tank Repair:

Materials:
Repair Kit, Collapsible Fabric Tank (COEI)

Refer to TM 10-5430-237-12&P (Marine Corps TM 01034E-12&P/1) for repair procedures for the collapsible product water distribution tank.

Repair the MF Feed Tank or the Cleaning Waste Storage Tank as follows:

1. Open up the collapsible fabric tank repair kit that was packed with the tank (see Figure 25).

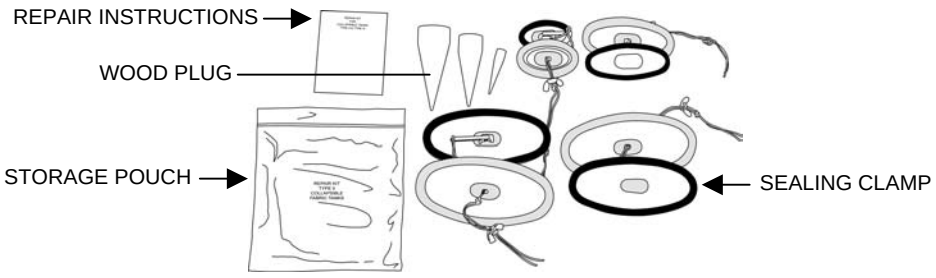

Figure 25. Collapsible Fabric Tank Repair Kit.

2. Follow the repair instructions contained in the repair kit (see Figure 26).

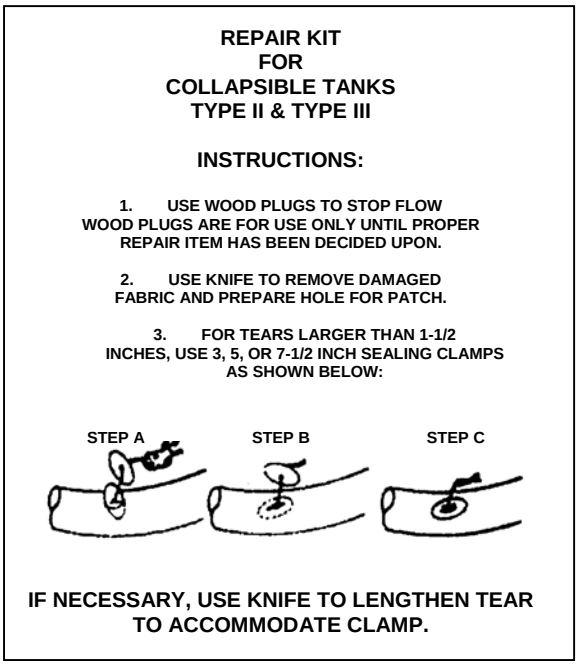

Figure 26. Collapsible Fabric Tank Repair Instructions.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0066 00**
UNIT MAINTENANCE PROCEDURES
GENERAL MAINTENANCE

ASSEMBLY

Antiseize Pipe Tape Installation:

Materials:
Antiseize pipe tape (BII) (WP 0079, Table 1, item 43, 44)

Install pipe tape on piping with external pipe thread as follows (see Figure 27):

1. Select the correct pipe tape using the chart below.

FOR THIS PIPE SIZE	USE THIS PIPE TAPE
$^{1}/_{4}$" – $^{3}/_{8}$"	¼: tape
½" or larger	½" tape

NOTE

When threading piping together to which teflon tape has been applied, check the final position of the component before tightening. Over-tightening then backing off taped components can break the seal provided by the tape and result in leaks.

2. Wrap the external pipe threads with pipe tape as follows:
   a. Start wrapping the threads one and a half threads back from the end of the pipe.
   b. Completely wrap the pipe tape around the pipe snug tight in a clockwise direction facing the end of the pipe.
   c. Continue a second complete turn around the pipe, but this time stretch the tape tight without breaking it.
   d. Continue with a third complete turn in the same manner.
   e. After completing the third turn, break off the tape and smooth the end against the threads.

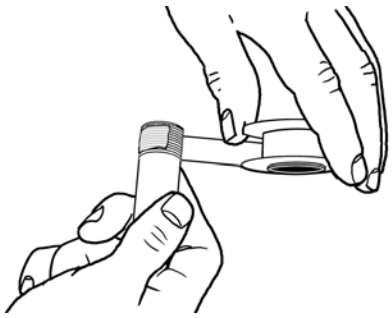

Figure 27. Installing Pipe Tape on External Pipe Threads.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0067 00**
UNIT MAINTENANCE PROCEDURES
WIRING DIAGRAMS

GENERAL

This work package contains wiring diagrams for all electrical systems and circuits in the Tactical Water Purification System (TWPS). The diagrams are on foldout sheets located at the end of this manual.

WIRE IDENTIFICATION

Wires are identified by number or letter and number designation.

ABBREVIATIONS

All abbreviations are in accordance with ASME-Y14.38M, except where the abbreviation stands for a marking actually found in the TWPS.

WIRING DIAGRAMS

Foldout pages 1 through 8 are reproductions of schematic diagrams for the TWPS.

Foldout pages 9 through 24 are point-to-point wiring diagrams for the TWPS.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) DIRECT SUPPORT MAINTENANCE PROCEDURES DIESEL ENGINE

0068 00

THIS SECTION COVERS
Inspect, Service, Replace

INITIAL SETUP

Maintenance Level
Direct Support
Tools
Valve Spring Compressor
Soft Brass Brush
Outside Micrometer
Depth Micrometer or Depth Gauge
Torque Wrench (minimum 0-250 in.-lbs)
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
Diesel engine out of service.

GENERAL

This work package contains information and instructions for performing maintenance on the P-1 or P-8 Pump Assembly diesel engine. The procedures covered in this work package include:

- Cylinder Head Maintenance
  - Cylinder Head Removal
  - Intake and Exhaust Valve Removal
  - Cleaning, Inspection, and Replacement
  - Reassembly
- Piston Ring Replacement

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0068 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
DIESEL ENGINE

CYLINDER HEAD MAINTENANCE

Parts (TM 10-4610-309-24P):
- Cylinder head
- Cylinder head gasket
- Cylinder head O-ring
- Cylinder head cover gasket
- Intake valve
- Exhaust valve
- Valve stem seal (2)

Material:
- Glycerin (WP 0079, Table1, item 21)

Cylinder Head Removal (see Figure 1):

1. Remove the engine and pump assembly from the pump skid frame (WP 0050)
2. Remove the following components from the engine/pump assembly (WP 0050):
   a. Fuel tank assembly
   b. Air cleaner assembly
   c. Air heaters
   d. Muffler assembly
   e. Fuel injection valve
3. Remove the rubber detent plunger from the oil port on the cylinder head cover.
4. Remove the three cylinder head cover bolts and lift the cover off the cylinder head. Remove and discard the cover gasket.
5. Remove the rocker arm assembly bolt and lift the rocker arm assembly off the cylinder head.
6. Remove the two valve caps.

NOTE

Tag or mark each push rod to indicate its location in the head. The push rods must be reinstalled in the same locations from which they were removed.

7. Pull the two push rods out of the cylinder head.
8. Remove the four cylinder head nuts and flat washers.

CAUTION

When setting the cylinder head down, place it with the combustion surface facing up. Failure to observe this caution may result in damage to the valves and combustion surface of the cylinder head.

9. Lift the cylinder head off the engine.
10. Remove and discard the cylinder head O-ring.
11. Remove the cylinder head gasket and set aside.

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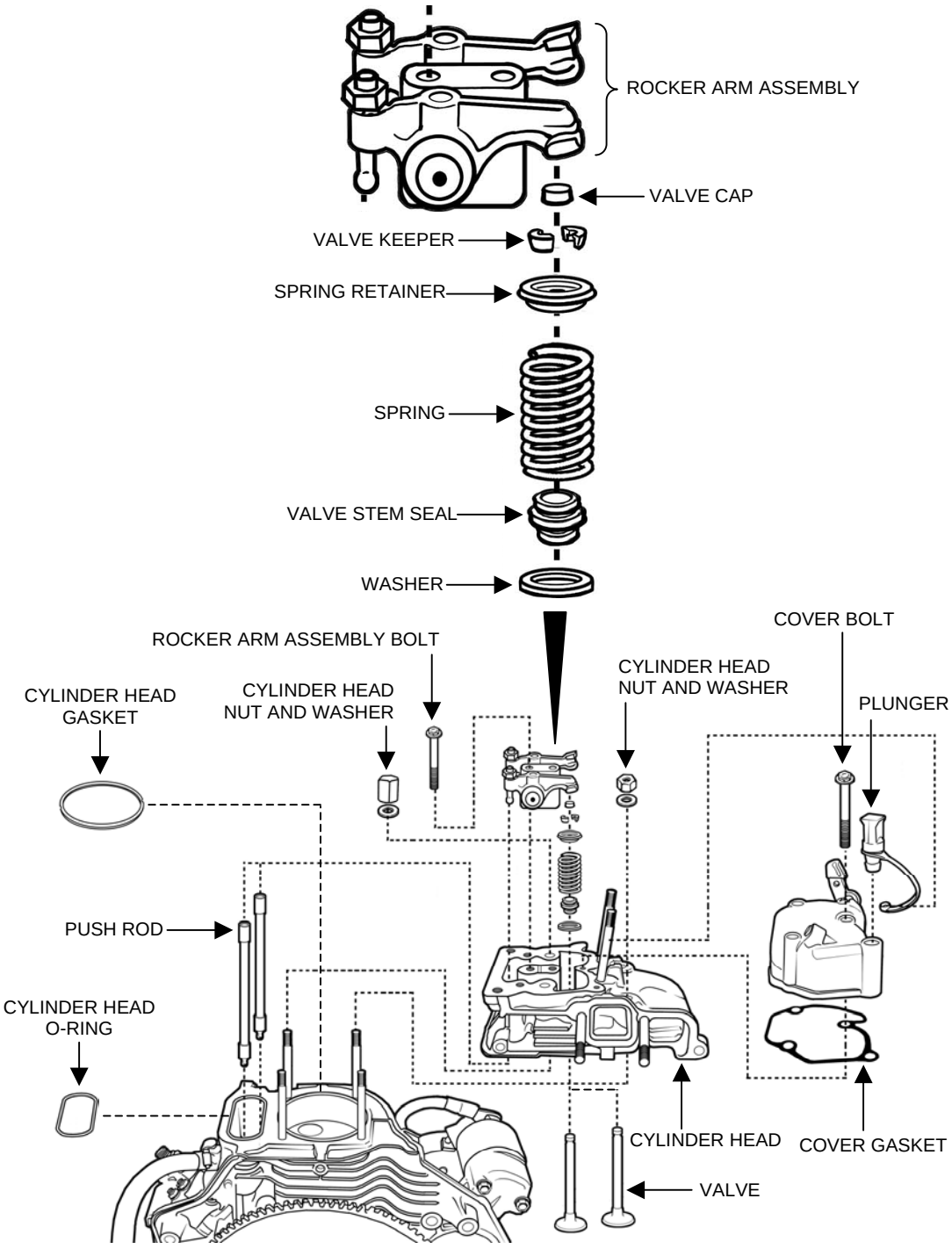

Figure 1. Cylinder Head Removal.

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Intake and Exhaust Valve Removal:

CAUTION

When a valve spring is compressed, the valve may drop out of the cylinder head. Do not allow the valves to drop onto a hard surface. Failure to observe this caution may result in damage to the valves.

1. Compress the intake valve spring (see Figure 2).
2. Remove the following components: valve keeper, spring retainer, spring, valve stem seal, washer, and intake valve (see Figure 1). Discard the valve stem seal.
3. Tag the intake valve and the other components so they can be reinstalled in the same location.
4. Repeat the above steps to remove the exhaust valve.

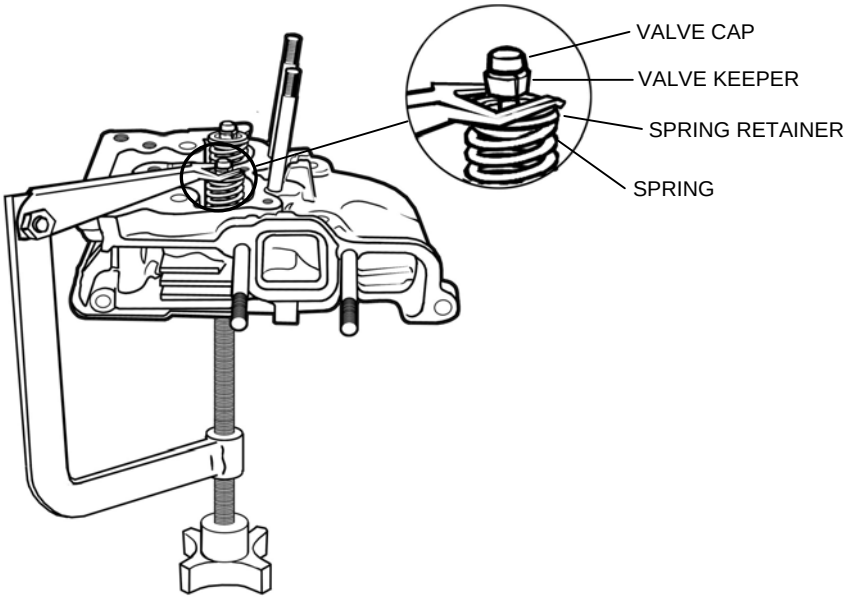

Figure 2. Compressing the Valve Spring

Cleaning, Inspection, and Replacement:

1. Using a soft brass brush, clean carbon off the valves, valve seats, and cylinder head combustion surface. Take care not to scratch or damage any of the surfaces.
2. Inspect the valves, valve seats, and valve head combustion surface for cracks or other damage.
3. Inspect the valve stems and seating surfaces for distortion or damage. If either valve is distorted or damaged, replace it.
4. Replace the cylinder head if it is cracked or if the valve seats or valve head combustion surface are damaged.
5. Check the outside diameter (O.D.) of both valve stems with a micrometer (see Figure 3). Replace a valve if its O.D. is 0.213 in. or less.

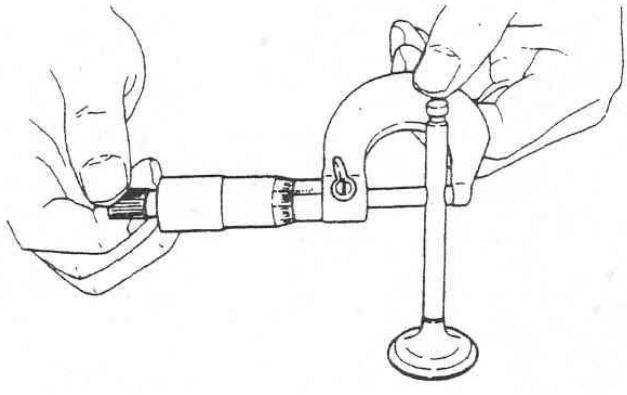

Figure 3. Checking Valve Stem O.D.

6. Check the valve sinkage using a depth micrometer (see Figure 4). Replace a valve if its sinkage is 0.047 in. or greater.

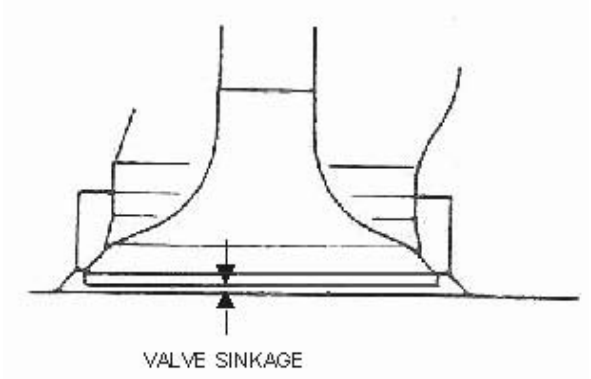

Figure 4. Valve Sinkage Measurement.

Reassembly (see Figure 5):

CAUTION

Do not mix up the intake and exhaust valves or other components – be sure to install them in the same location from which they were removed.

1. Apply a few drops of glycerin to the intake valve stem.
2. Insert the valve stem into the cylinder head.
3. Install the following components over the valve stem: washer, new valve stem seal, spring, and spring retainer.
4. Compress the intake valve spring.
5. Install the valve keeper onto the end of the valve stem and release the spring.
6. Repeat the above steps to reinstall the exhaust valve.
7. Install a new cylinder head O-ring onto the engine block.
8. Note the thickness identification mark on the old cylinder head gasket and select a replacement gasket with the same thickness identification mark. Discard the old gasket.
9. If the mark on the old gasket is not legible, determine the proper replacement gasket as follows:
    a. Measure on two sides of the piston how much the piston protrudes above the cylinder block or how much it is recessed into the cylinder block.
    b. Average the two measurements (h).
    c. Calculate the required gasket thickness (t) using the formula $\underline{0.546 - h < t < 0.596 - h}$
    d. Select the replacement gasket based on the calculation.
    e. Discard the old gasket.
10. Install the new cylinder head gasket onto the engine block.
11. Place the cylinder head on the engine and secure it with four washers and nuts. Torque all four nuts to 130 in.-lbs. Then torque all four nuts again to 260-295 in.-lbs.
12. Place the push rods into the cylinder head.

NOTE

Make sure the ends of the push rods sit in the concave ends of the tappets that are inside the engine.

13. Place the valve caps onto the ends of the valve stems.
14. Place the rocker arm assembly onto the cylinder head and secure with the bolt. Torque the bolt to 170-200 in.-lbs.
15. Check/adjust the intake and exhaust valve clearance. Refer to WP 0050.
16. Install the cylinder head cover using a new gasket and three bolts.
17. Insert the rubber detent plunger into the oil port on the cylinder head cover.
18. Reinstall the following components (refer to WP 0050):
    - Fuel injection valve – torque to 95-113 in.-lbs.
    - Fuel return line
    - Air heaters
    - Air cleaner assembly
    - Muffler assembly
    - Fuel tank assembly

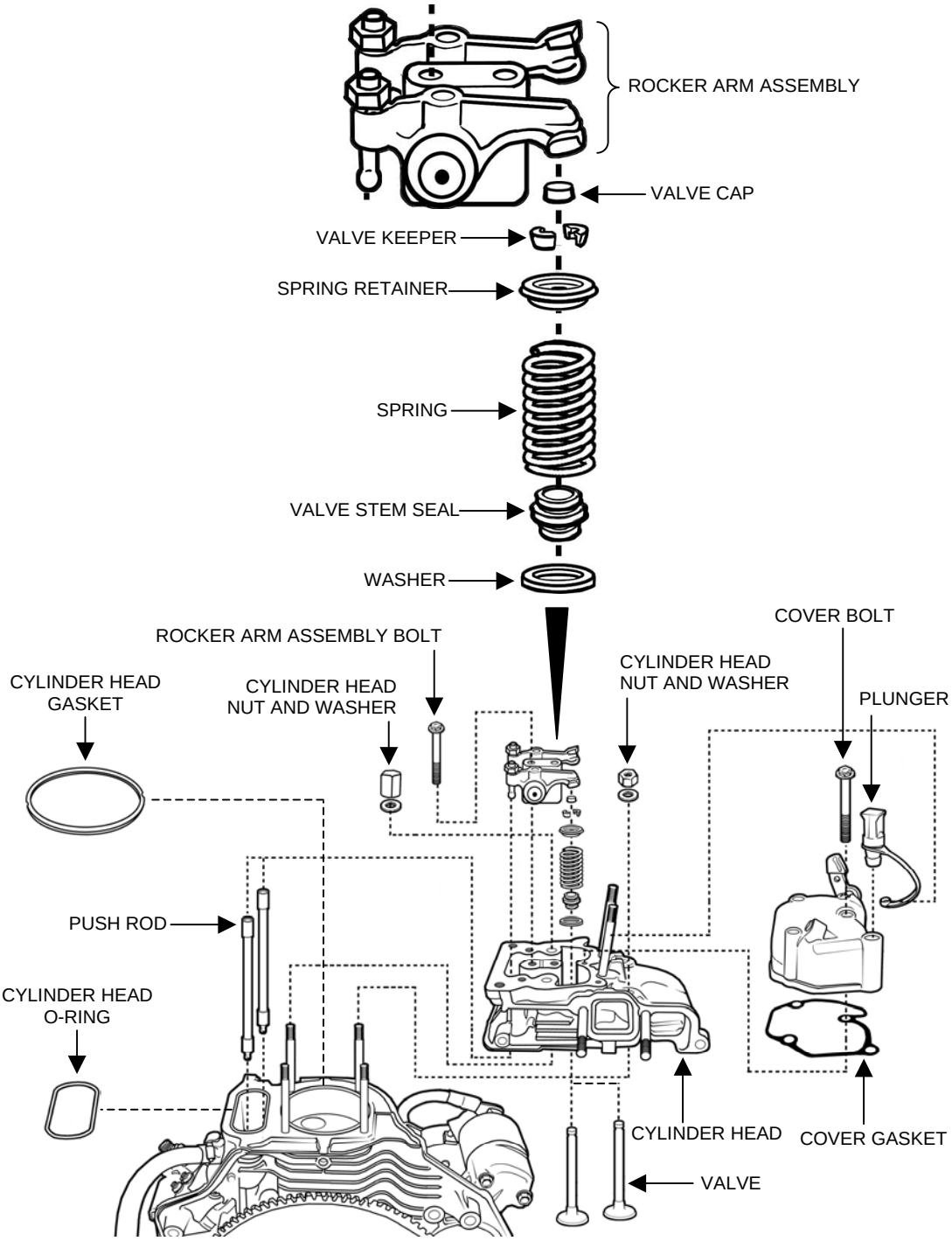

Figure 5. Cylinder Head Installation.

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PISTON RING REPLACEMENT

Parts (TM 10-4610-309-24P):
Crankcase gasket
Piston ring set
Material:
Lubricating Oil (WP 0079, Table1, item 27)

Disassemble the diesel engine as follows:

1. Remove the engine and pump assembly from the pump skid frame (WP 0050).
2. Remove the pump and adapter from the engine (WP 0050)
3. Remove the following components from the engine (WP 0050):
    a. Cooling fan case assembly
    b. Muffler assembly
    c. Fuel injection valve
    d. Fuel pump assembly
4. Remove the drain plug and drain the oil from the crankcase.
5. Remove the cylinder head from the engine as described earlier in this work package.
6. Remove the 15 cap screws identified in Figure 6 from the engine crankcase cover. (The cap screws do not need to be removed in any particular order.)
7. Remove the crankcase cover and gasket from the engine.

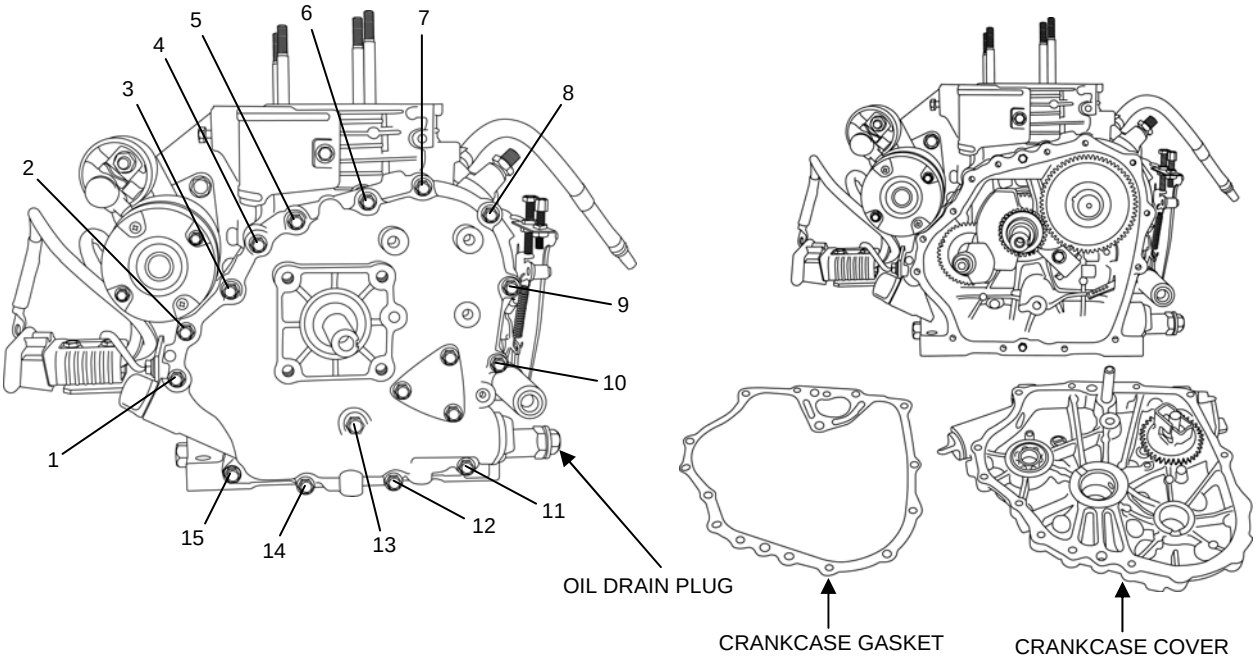

Figure 6. Crankcase Cover Cap Screw Removal.

8. Remove the following components from inside the engine in order (see Figure 7):

NOTE

The valve tappets are located behind the camshaft. If the valve tappets drop down, they may prevent the removal of the camshaft. If this happens, it will be necessary to push the tappets up into their sleeves while pulling the camshaft out.

a. Pull out the camshaft.
b. Remove the valve tappets.
c. If the fuel oil tappet slides out of its sleeve, remove the spring seat.

NOTE

If the cams on the crankshaft and the balancer shaft are overlapped, as shown in Figure 7, it will be necessary to turn the crankshaft until the cams are no longer overlapped before the balancer shaft can be removed.

d. Pull out the balancer shaft.

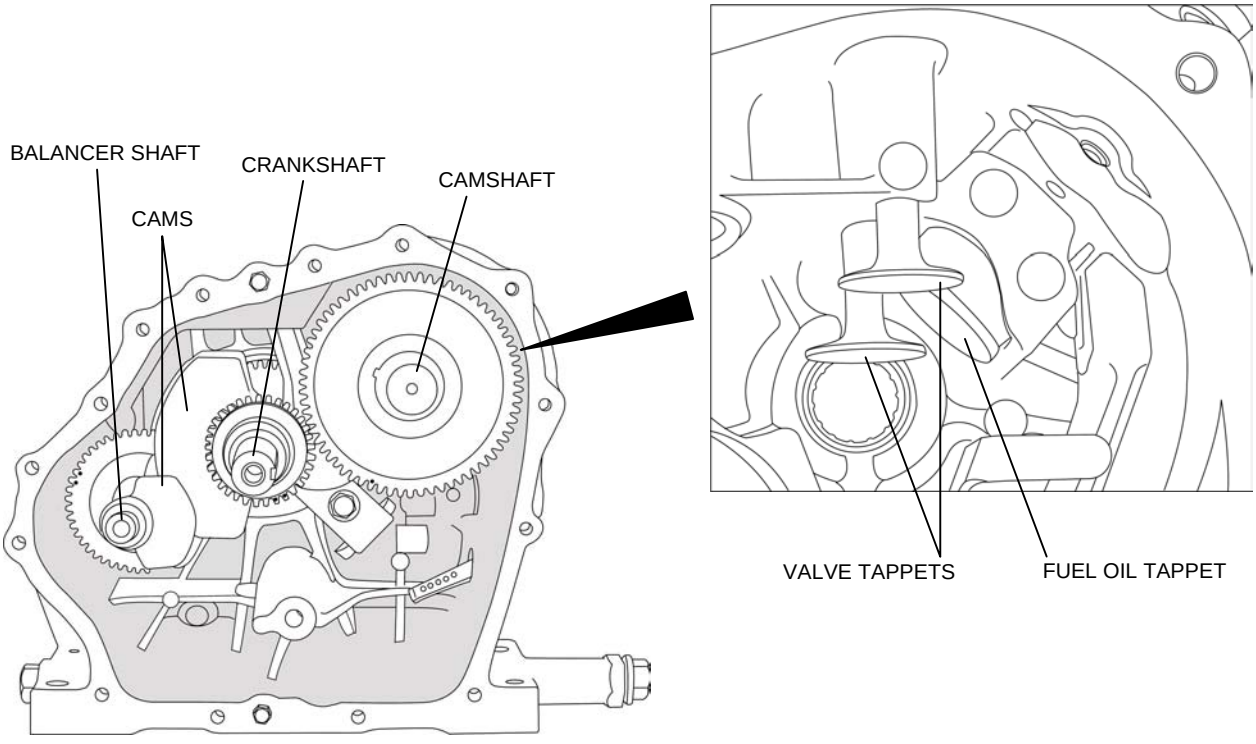

Figure 7. Camshaft, Valve and Fuel Oil Tappets, and Balancer Shaft Removal.

9. Remove the piston and connecting rod assembly from the engine as follows (see Figure 8):

NOTE

If the crankshaft is at the top of the stroke, the connecting rod tightening bolts will be difficult to access. Rotate the crankshaft to the bottom of the stroke so that the tightening bolts are accessible, as shown in Figure 8.

a. Remove the connecting rod tightening bolts.
b. Remove the connecting rod end cap.
c. Rotate the crankshaft to the top of the stroke and pull the piston out the top of the engine block.

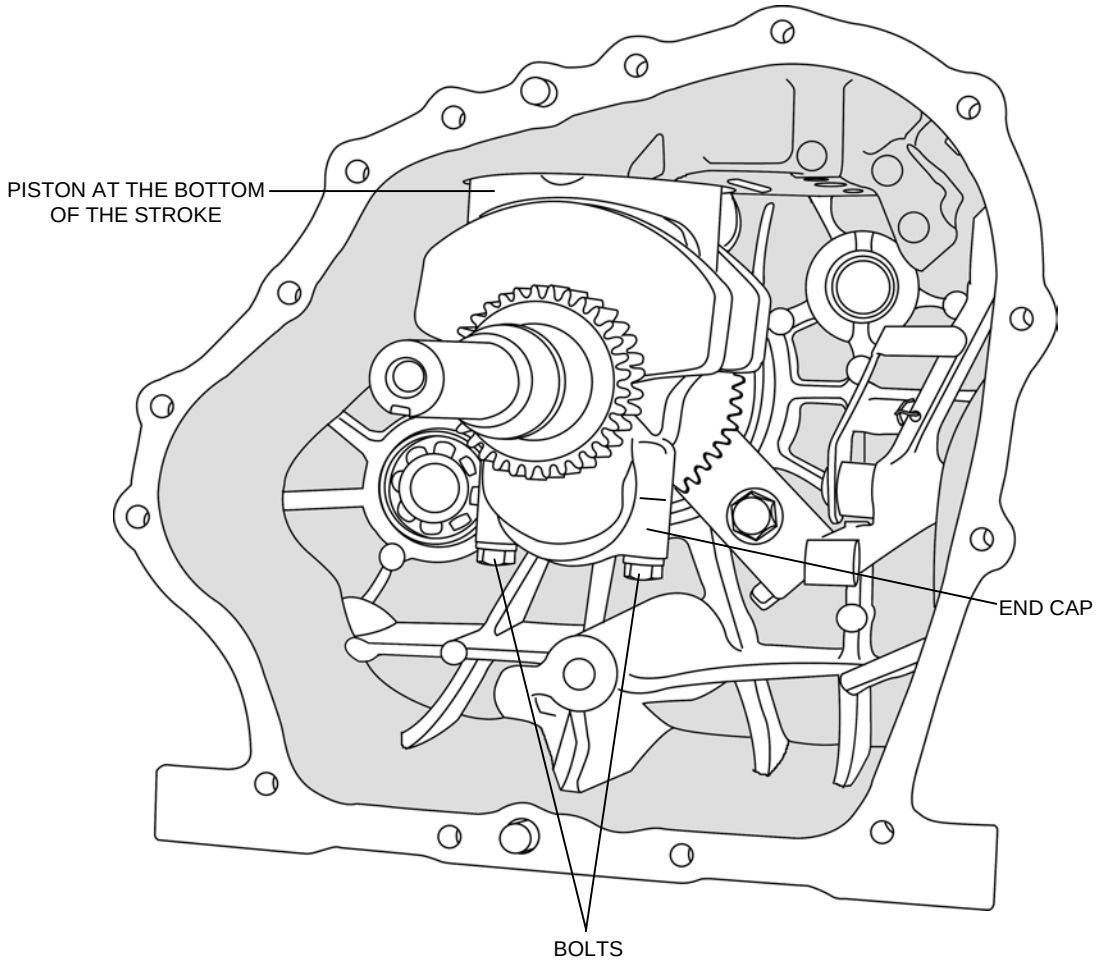

Figure 8. Piston and Connecting Rod Assembly Removal.

10. Using a ring spreader, remove the three piston rings from the piston (see Figure 9).

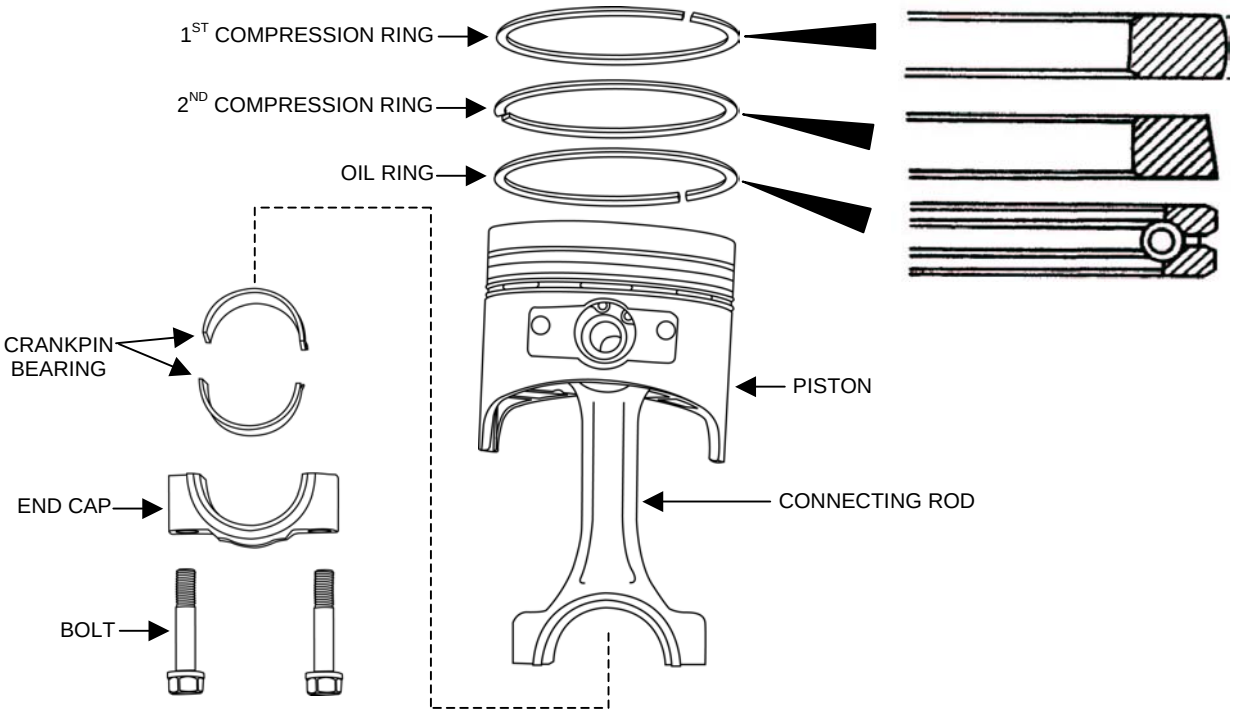

Figure 9. Piston Ring Removal.

Reassemble the diesel engine as follows:

1. Carefully clean each ring groove in the piston.
2. Using a ring spreader, install the new piston rings on the piston making sure each ring gap is offset 120º from the other ring gaps.
3. Thoroughly check and clean all parts.

NOTE

There is an orientation mark on the top of the piston. This mark must face the crankcase cover side of the engine when inserting the piston and connecting rod assembly into the top of the piston cylinder.

4. Apply oil to the outer surface of the piston and the inner surface of the cylinder.
5. Apply oil to the crank pin (the surface on the crankshaft to which the piston connecting rod is secured).
6. Insert the piston and connecting rod into the top of the piston cylinder.
7. Make sure the crankpin bearing halves are snapped into the connecting rod and the end cap.
8. Position the connecting rod onto the crank pin and install the end cap around the other side of the crank pin.
9. Secure the end cap to the connecting rod using the two connecting rod tightening bolts. Torque to 200 to 240 in-lbs.

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NOTE

The fuel oil tappet fit in the sleeve is very precise. It may be necessary to rotate the fuel oil tappet until you are able to find the exact position that will allow it to be easily inserted into the sleeve. Do not force the fuel oil tappet into the sleeve.

10. Insert the fuel oil tappet into its sleeve (see Figure 7).
11. Insert the two valve tappets into their sleeves and push all the way in (see Figure 7)
12. Insert the camshaft. Make sure the single alignment mark on the camshaft gear is positioned between the two alignment marks on the front crankshaft gear. Rotate the crankshaft if necessary to ensure the marks are properly matched (see Figure 10).
13. Insert the balancer shaft. Make sure the alignment mark on the balancer shaft gear matches the alignment marks on the back crankshaft gear. Rotate the crankshaft if necessary to ensure the marks are properly matched (see Figure 10).

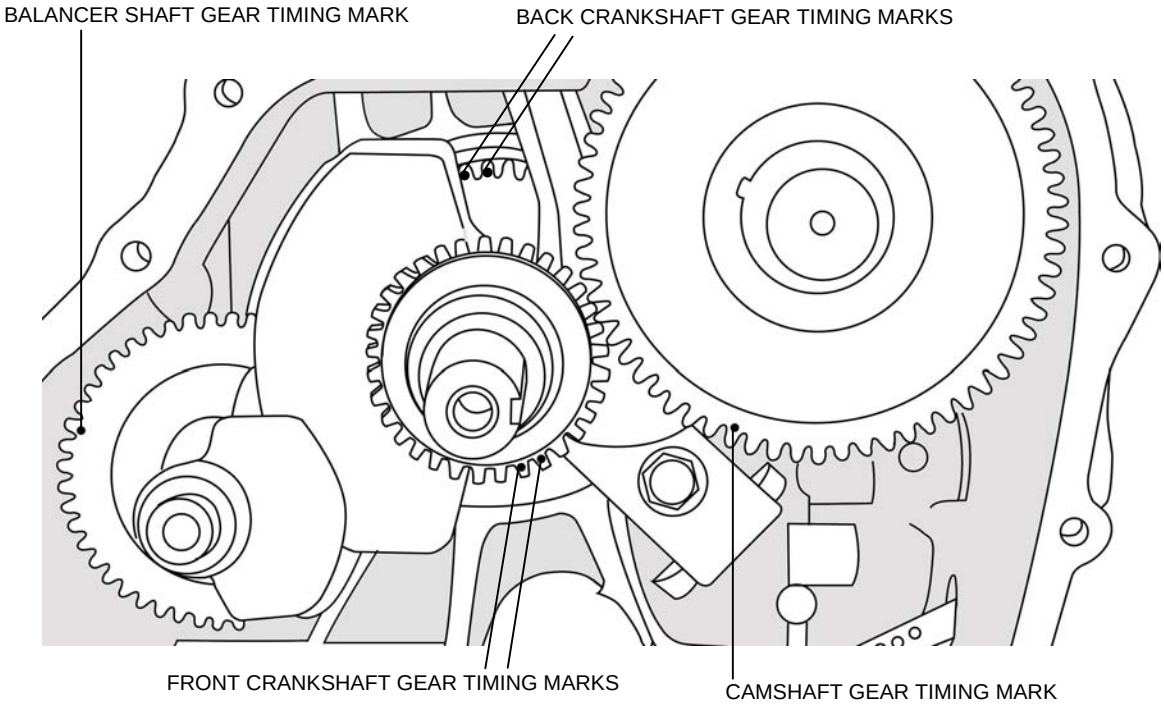

Figure 10. Crankshaft, Camshaft, and Balancer Shaft Timing Marks.

14. Install the new crankcase gasket and the crankcase cover on the engine.
15. Tighten the bolts in the sequence shown in Figure 11.
    a. Torque bolts 1 through 14 to 95-113 in-lbs.
    b. Torque bolt 15 last to 226-243 in.-lbs.

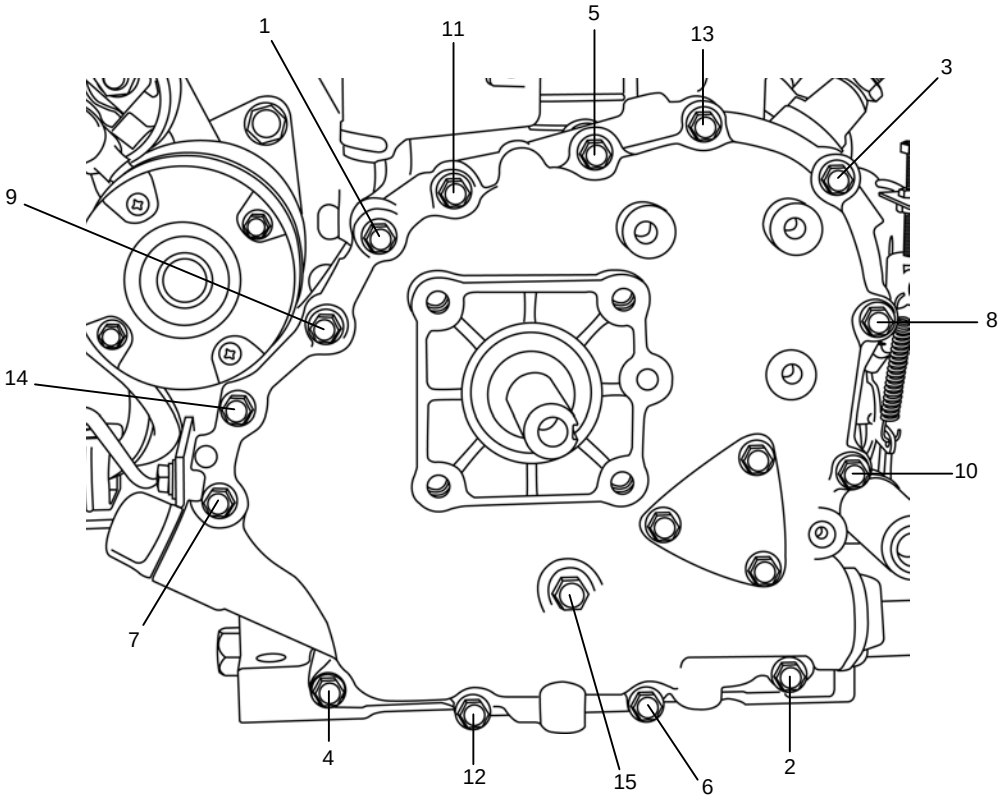

Figure 11. Crankcase Cover Bolt Tightening Sequence.

16. Install the cylinder head onto the engine as described earlier in this work package.
17. Install the following components onto the engine (WP 0050):
    a. Fuel pump assembly
    b. Fuel injection valve
    c. Muffler assembly
    d. Cooling fan case assembly
18. Make sure the oil drain plug is reinstalled.
19. Put approximately ¾ qt. oil in the engine.
20. Install the pump and adapter onto the engine (WP 0050).
21. Install the engine pump assembly onto the pump skid frame (WP 0050).
22. Slowly pull the recoil starter rope out past the skid frame and thread it through the rope guide.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) DIRECT SUPPORT MAINTENANCE PROCEDURES MICRO-FILTRATION SYSTEM

0069 00

THIS SECTION COVERS:
Repair

INITIAL SETUP:

Maintenance Level
Direct Support
Tools
Lifting Straps (2)
References:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
TWPS in short term shutdown
Entire air system bled down (WP 0054)

GENERAL:

This work package provides procedures for repairing components in the Micro-Filtration (MF) Assembly. The steps covered include:

- MF Assembly Removal
- MF Assembly Disassembly and Repair
- MF Assembly Reassembly
- MF Assembly Installation

MICRO-FILTRATION ASSEMBLY REPAIR:

Parts (TM 10-4610-309-24P):
O-Ring, 10540577
O-Ring, 10540578
Materials:
Lubricant, valve seal (WP 0079, Table 1, item 26)
Clean, dry lint-free rags (WP 0079, Table 1, item 33)
Equipment Condition:
TWPS in Short Term Shutdown, anticipated over 4 hours but less than 54 hours (WP 0017)
Entire air system bled down (WP 0054)

Repair the MF filter module assembly, including inspecting and replacing the module head O-rings, as follows:

NOTE

Tag each component as it is removed in the following steps, to make sure it is reinstalled in the same location.

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MICRO-FILTRATION SYSTEM

MF Assembly Removal:

1. Remove the following MF feed components from the MF assembly as follows (see Figure 1):
   a. Remove Upper Feed Inlet Valve V-112.
   b. Disconnect the 15 psig air hose from Check Valve V-911.
   c. Remove Check Valve V-911 and Vent Valve V-114 from the upper feed inlet.
   d. Disconnect the electrical cable connected to MF Feed Pressure Transmitter PT-101.
   e. Remove the sanitary clamp from the 3-in tee piping.
   f. Remove Lower Feed Inlet Valve V-113 and the expansion joint and 3-in. tee piping above the valve.

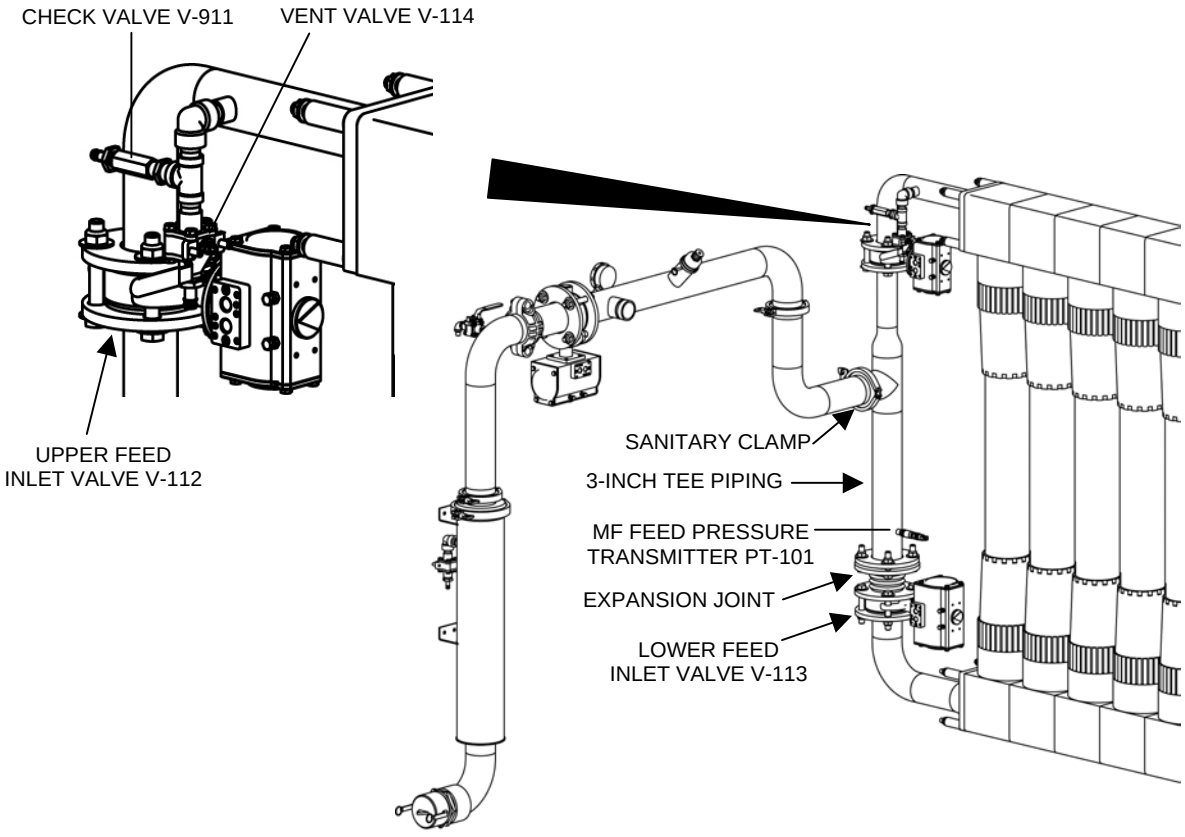

Figure 1. MF Feed Component Removal from the MF Assembly.

2. Remove the following MF backwash components from the MF assembly (see Figure 2):
    a. Tag and disconnect the air tubing from the actuator on Upper Backwash Out Valve V-401.
    b. Remove V-401.
    c. Remove the sanitary clamp, the flex strut pipe support, and the pipe section between the MF Assembly and valve V-401.
    d. Remove the expansion joint, the two sanitary clamps, and the pipe section between the MF Assembly and Lower Shell Out Valve V-402.
    e. Remove Shell Drain Valve V-403 and its extension pipe.

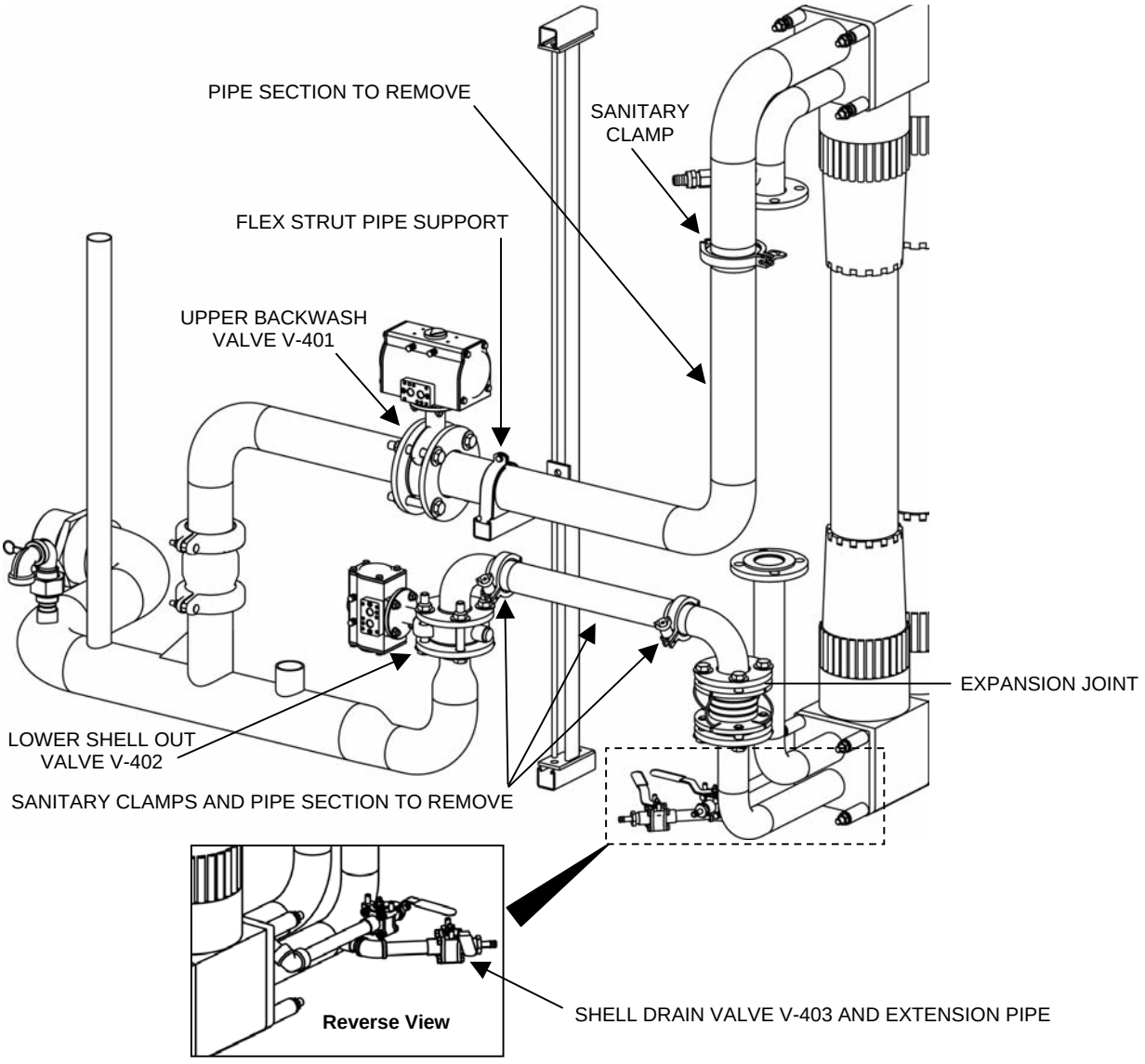

Figure 2. MF Backwash Component Removal from the MF Assembly.

3. Remove the following MF filtrate components from the MF assembly (see Figure 3):
    a. Tag and disconnect the air tubing from the actuator on Filtrate Flow Control Valve V-202
    b. Remove V-202.
    c. Tag and disconnect the electrical wire from Pressure Transmitter PT-102.
    d. Remove the flex strut pipe support between PT-102 and V-202.
    e. Remove the expansion joint below Upper Filtrate Valve V-201.
    f. Tag and disconnect tag the air tubing from the actuator on Upper Filtrate Valve V-201.
    g. Remove V-201 and the tee pipe section connected to it.
    h. Tag and remove the air hose connected to Check Valve V-912.
    i. Remove Check Valve V-912.
    j. Remove Filtrate Drain Valve V-203 and extension pipe.

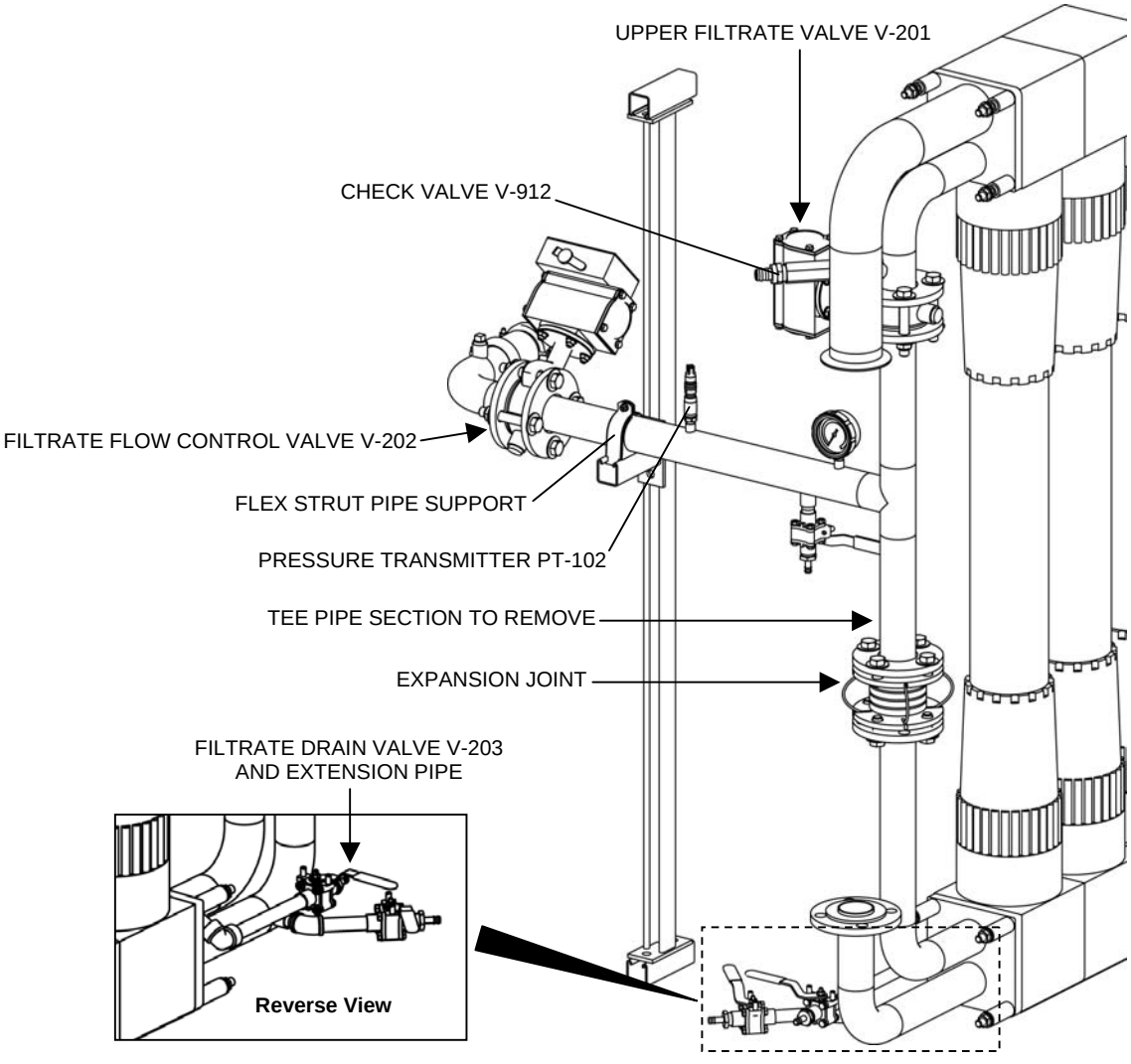

Figure 3. MF Filtrate Valve and Pipe Section Removal.

4. Remove the two vertical flat rack braces (3 hex cap screws, 3 lock washers, and 3 flat washers at the top and bottom of both braces) that are located in front of the MF filter assembly (A-TWPS only) (see Figure 4).

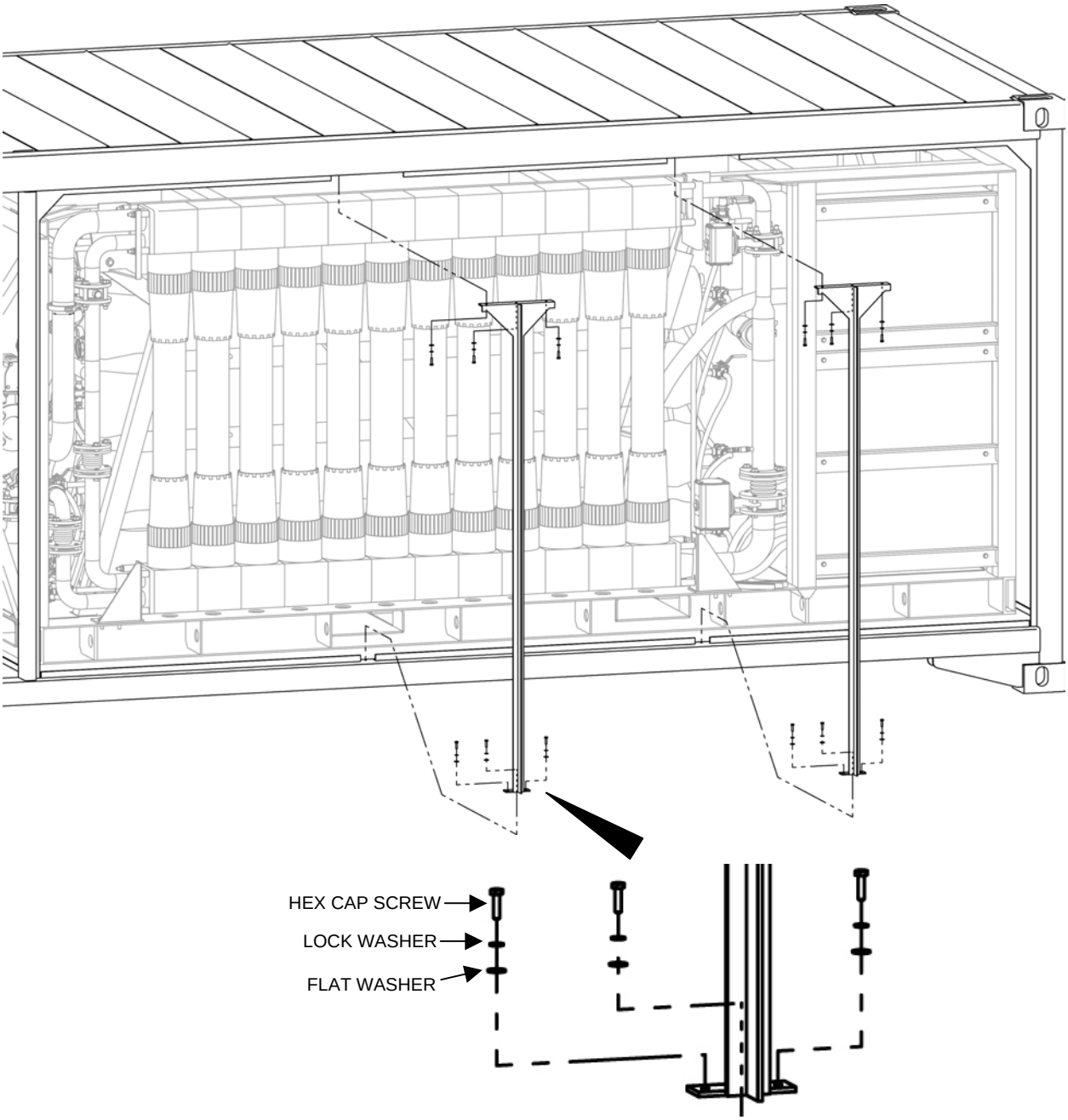

Figure 4. A-TWPS Vertical Flat Rack Brace Removal.

5. Remove the MF assembly from the TWPS as follows:

CAUTION

If the MF assembly is set down vertically when it is removed from the TWPS, the MF module tubes can compress down unless bracing is placed between the MF assembly headers. It is recommended that the MF assembly headers be braced before the assembly is removed.

a. Insert a brace, such as a 2x4 length of wood or metal, between the upper and lower MF assembly headers at both ends of the assembly and secure with duct tape, rope, or some other temporary means of keeping the brace in place (see Figure 5).

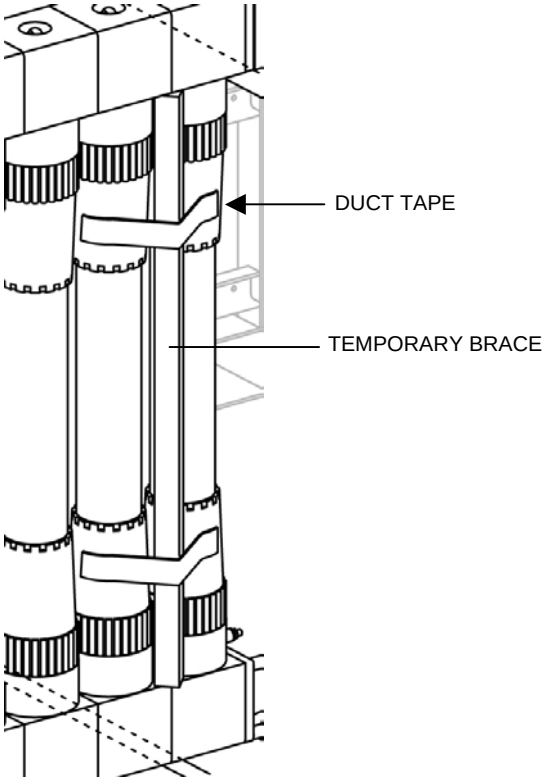

Figure 5. Temporary Bracing for MF Assembly Removal.

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MICRO-FILTRATION SYSTEM

CAUTION

Potential for damaging the MF assembly inlet and outlet pipes. Lifting straps should not be placed under the MF assembly inlet and outlet pipes. The pipes are not designed to support the weight of the MF assembly. Failure to observe this warning could result in damage to the pipes.

b. Attach one lifting strap under the lower spacers at the top ends of the MF assembly.
c. Remove the slack from the straps, but do not apply any lifting pressure.
d. Remove the two hex cap screws, four flat washers, and two nuts that secure the top left mounting bracket to the TWPS frame (as viewed from the back of the TWPS).
e. Remove the two hex cap screws, one lock washer, and three flat washers that secure the top right mounting bracket to the TWPS frame (as viewed from the back of the TWPS).
f. Remove the four hex cap screws, eight flat washers, and four nuts that secure the two bottom mounting brackets to the TWPS frame.
g. Slide the bottom mounting brackets off the MF assembly as the assembly is raised off the TWPS.

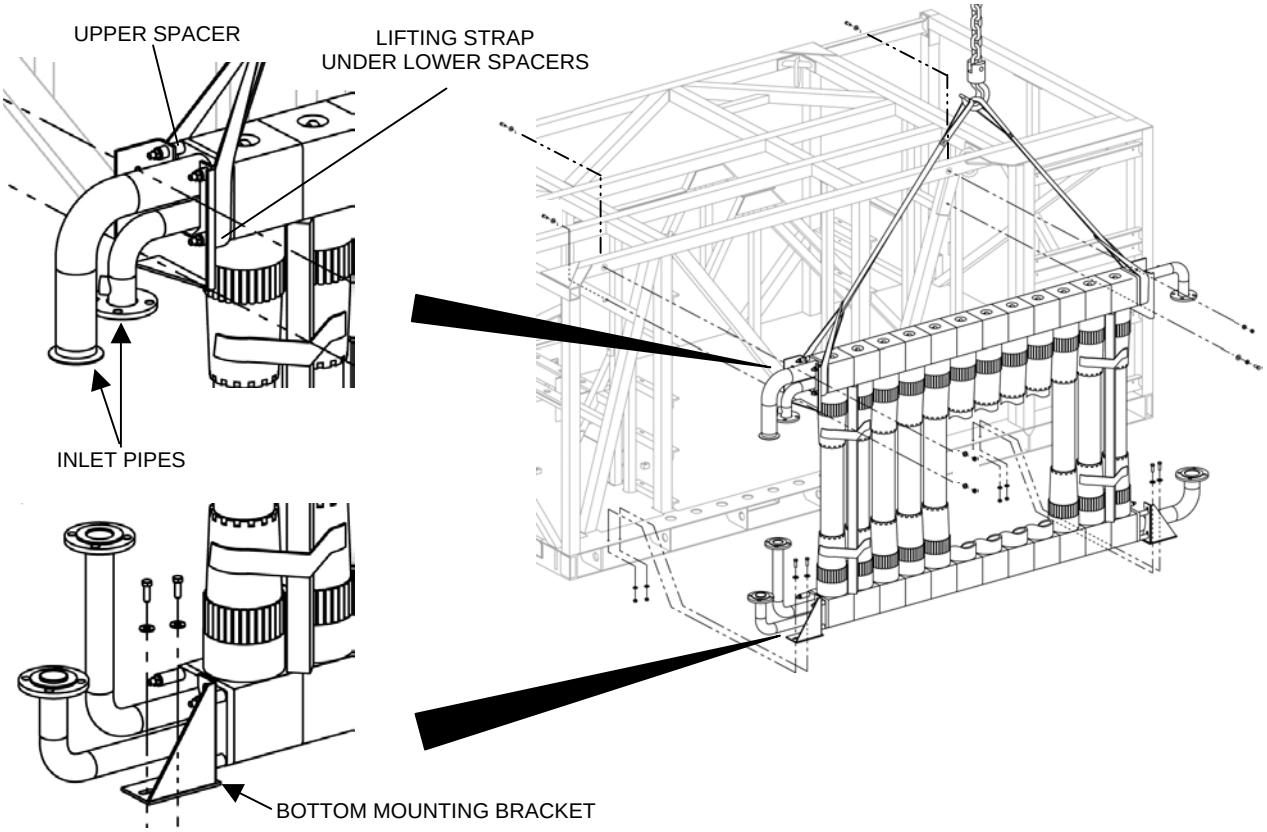

Figure 6. TWPS MF Assembly Removal.

h. Carefully move the MF assembly and lay it on a clean tarp on the ground.
i. Cover all open piping on the TWPS.

MF Assembly Disassembly and Repair:

1. Disassemble and repair the individual filter modules as follows (see Figure 7):
   a. From the feed end of the filter assembly, assign a number to each module.
   b. Remove the 4 nuts, lock washers, and flat washers from the 4 ends of the assembly.
   c. Remove the 4 mounting brackets, 8 shouldered spacers, and 8 long spacers.
   d. Label each bracket to indicate the location from which it was removed.
   e. Remove the 4 piping adapters.
   f. Remove the 8 short adapters from the module head pieces at the feed end of the assembly.
   g. Separate the first 4 modules by removing both the top and bottom rods; the separation must be wide enough to see the area where both inner and outer o-rings mount.
   h. Remove both inner and outer o-rings from the top and bottom of the modules.
   i. Using lint-free rags, clean the areas on both sides at the top and bottom of the module where the o-rings mount.
   j. Inspect the area for damage. If damage is discovered, replace the module.
   k. Lubricate the new o-rings using the valve seal lubricant and install the o-rings.
2. Move the four modules back together.
3. Repeat steps e through j for the rest of the modules in groups of four.

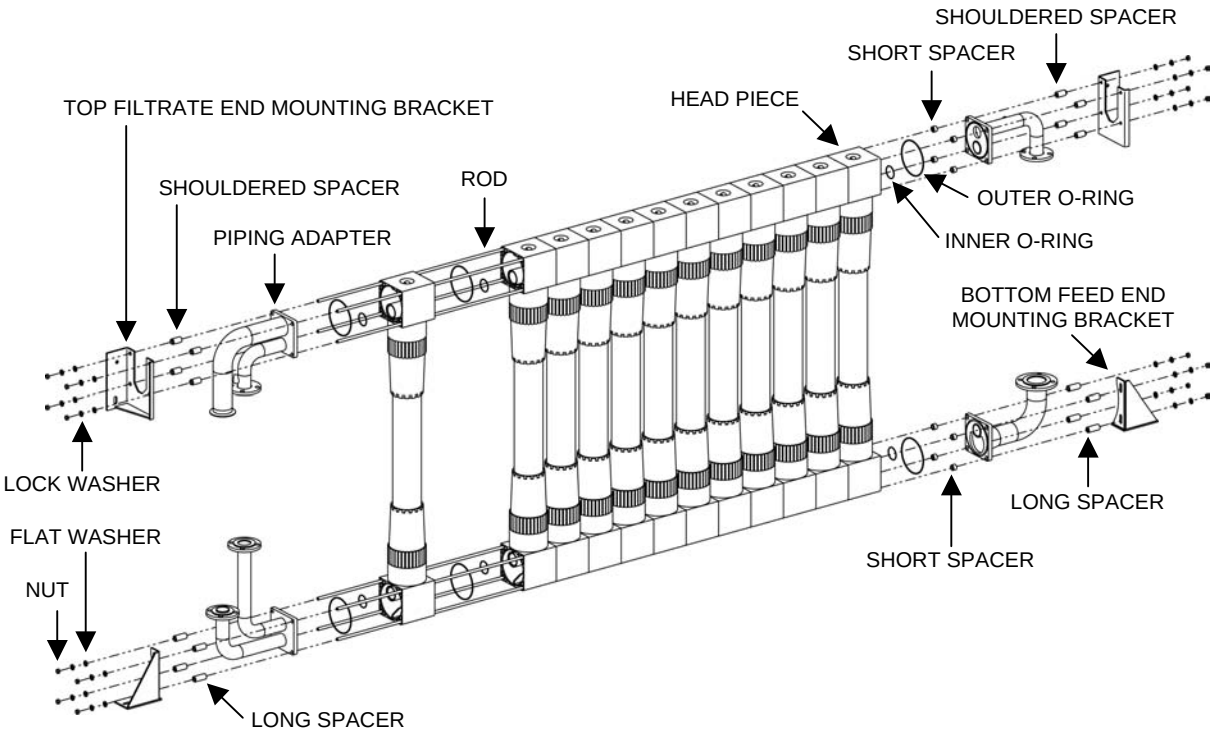

Figure 7. MF Assembly Module Repair.

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MICRO-FILTRATION SYSTEM

MF Assembly Reassembly:

1. Assemble the MF assembly as follows (see Figure 7):
   a. Make sure that the outer module o-rings have been replaced as described in the repair procedures.
   b. Insert the four small spacers in the four corner holes of the top and bottom MF module head pieces at the inlet end of the MF assembly (see Figure 8).
   c. Secure the two top piping adapters, shouldered spacers (see Figure 8 for proper shouldered spacer orientation), and mounting brackets to the top rods using the nuts and washers removed earlier. Tighten just snug tight until the bottom hardware is installed.
   d. Secure the two bottom piping adapters and long spacers to the bottom rods using the nuts and washers removed earlier. Tighten snug tight.
   e. Torque the nuts at one end of the top and bottom MF assembly rods to 45 to 50 ft. lbs.

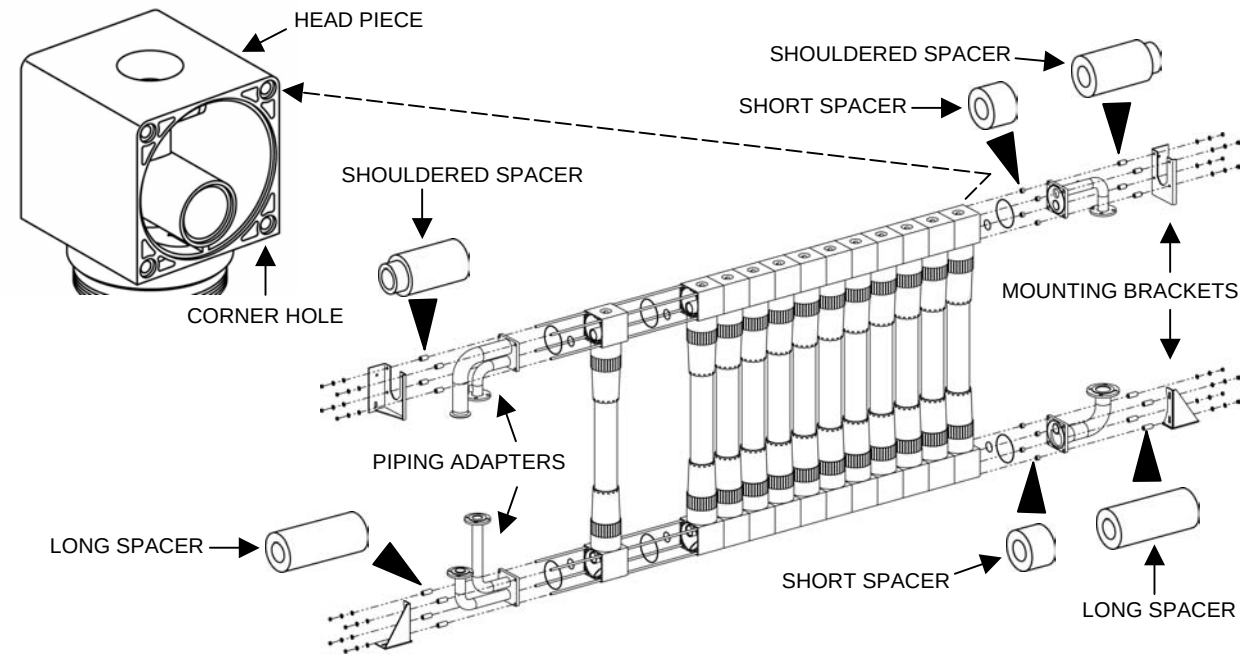

Figure 8. MF Assembly Spacer Installation Detail.

CAUTION

If the MF assembly is stood up vertically before it is lifted and installed on the TWPS, the MF module tubes can compress down unless bracing is placed between the MF assembly headers. It is recommended that the MF assembly headers be braced before the assembly is moved.

2. Insert a brace, such as a 2x4 length of wood or metal, between the upper and lower MF assembly headers at both ends of the assembly and secure with duct tape, rope, or some other temporary means of keeping the brace in place (see Figure 5).

MF Assembly Installation:

1. Install the MF assembly onto the TWPS as follows:
    a. Carefully lift the top end of the assembly up on end then move into position.
    b. Lift the assembly up onto the TWPS, position the bottom mounting brackets over the bottom spacers, and carefully set the assembly in place.
    c. Bolt both bottom mounting brackets to the TWPS frame, but do not tighten (see Figure 6).
    d. Bolt both top mounting brackets to the TWPS frame. Tighten the top bracket at the filtrate end of the MF assembly first, then tighten the top bracket at the feed end.
    e. Make sure that the top of the top mounting brackets are flush with the top of the frame.
    f. Tighten all remaining mounting bolts and remove the lifting straps.
    g. Remove the temporary bracing that was secured between the upper and lower MF assembly headers at both ends of the assembly.
2. Install the following MF filtrate out components (see Figure 3):
    a. Filtrate Drain Valve V-203 and its extension pipe.
    b. Check Valve V-912.
    c. Air Hose to Check Valve V-912.
    d. Upper Filtrate Valve V-201 and the tee pipe section.
    e. Air tubing to the actuator on V-201.
    f. The expansion joint below Upper Filtrate Valve V-201.
    g. The flex strut pipe support between PT-102 and V-202.
    h. Electrical wire to Pressure Transmitter PT-102.
    i. Filtrate Flow Control Valve V-202.
    j. Air tubing to the actuator on V-202.
3. Install the following MF backwash out components (see Figure 2):
    a. Shell Drain Valve V-403 and its extension pipe.
    b. The expansion joint, the two sanitary clamps, and the pipe section between the MF Assembly and Lower Shell Out Calve V-402.
    c. Upper Backwash Out Valve V-401.
    d. The sanitary clamp, flex strut pipe support, and pipe section between the MF Assembly and valve V-401.
    e. Air tubing to the actuator on Upper Backwash Out Valve V-401.
4. Install the following MF feed components (see Figure 1).
    a. Lower Feed Inlet Valve V-113 and the expansion joint and 3-in. tee piping above the valve.
    b. The sanitary clamp on the 3-in tee piping.
    c. Electrical wire to MF Feed Pressure Transmitter PT-101
    d. Check Valve V-911 and Vent Valve V-114 to the upper feed inlet.
    e. The 15 psig air hose to Check Valve V-911.
    f. Upper Feed Inlet Valve V-112.
5. Trace through the MF system piping to ensure all components are in place and that the connections are tight.
6. Follow the procedures for startup following a short-term shutdown (see WP 0015).
7. Run the TWPS and check for leaks.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0070 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Direct Support
Tools
Forklift or other suitable lifting device
Reference:
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
Two
Equipment Condition
Extended shut-down

GENERAL:

The procedures covered in this work package include:

- RO Feed Tank Replacement
- RO Vessel Replacement

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0070 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

REPLACE

RO Feed Tank Replacement:

Parts (TM 10-4610-309-24P):
- RO Feed Tank
- Pipe Coupling Gasket
- 4 In. Sanitary Clamp Gasket
- 2½ In. Sanitary Clamp Gasket
- 2 3/8 In. Expansion Joint Gasket
- 2 In. Rubber Hose
- 1 7/8 In. Rubber Hose

Material:
- Antiseizing tape (WP 0079, Table 1, item 43, 44)
- Soap water solution

Equipment Condition:
- TWPS in Short Term Shutdown with drain down (WP 0017)

Replace the RO feed tank as follows:

(Army only) Remove the TWPS skid from the flat rack. Refer to WP 0071.

Remove the RO feed tank as follows:

1. Remove the TWPS frame cross braces at the right end of the TWPS as follows:
   a. Remove the 4 bolts, 4 lock washers, and 4 flat washers from the 2 upper ends of the frame cross braces at the right end of the TWPS.
   b. Remove the 6 bolts, 12 flat washers, and 6 lock nuts from the middle of and the lower ends of the cross braces.
   c. Tag and remove the frame cross braces (see Figure 1).

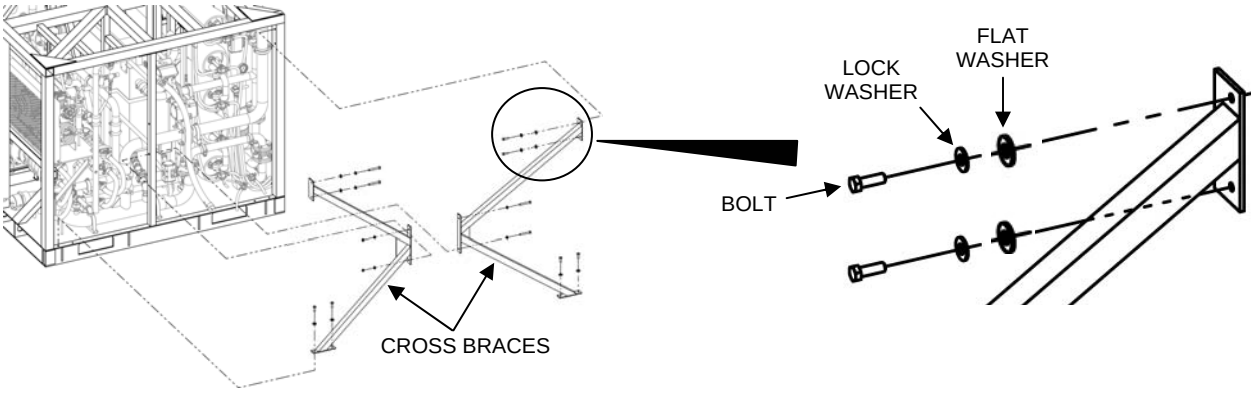

Figure 1. TWPS Frame Cross Brace Removal – Right End.

2. Remove the following connections from the front and bottom of the RO feed tank (see Figure 2):
    a. Unscrew and remove RO Feed Tank Auxiliary Drain Valve V-210 from the tank.
    b. Loosen the three hose clamps that secure a hose to the re-circulation pipe and the tank. Pull the re-circulation pipe and hose off the tank adapter. Inspect the hose for damage or deterioration and replace if needed.
    c. Disconnect the cable to Level Transmitter LT-201. Unscrew and remove the elbow pipe and transmitter from the tank.
    d. Loosen the four hose clamps that secure the cleaning return pipe to the tank adapter. Pull the cleaning return pipe and hose off the tank cleaning return inlet adapter. Inspect the hose for damage or deterioration and replace if needed.
    e. Loosen the four hose clamps that secure a hose to the tank outlet pipe and the RO feed pump suction pipe. If necessary, remove the four cap screws, washers, and nuts that secure the suction pipe to the inlet flange of the RO feed pump. Pull the hose off the tank outlet pipe. Inspect the hose for damage or deterioration and replace if needed.
    f. Remove the HP pump cooling water return tubing from the tee connection and unscrew the tee from the tank.

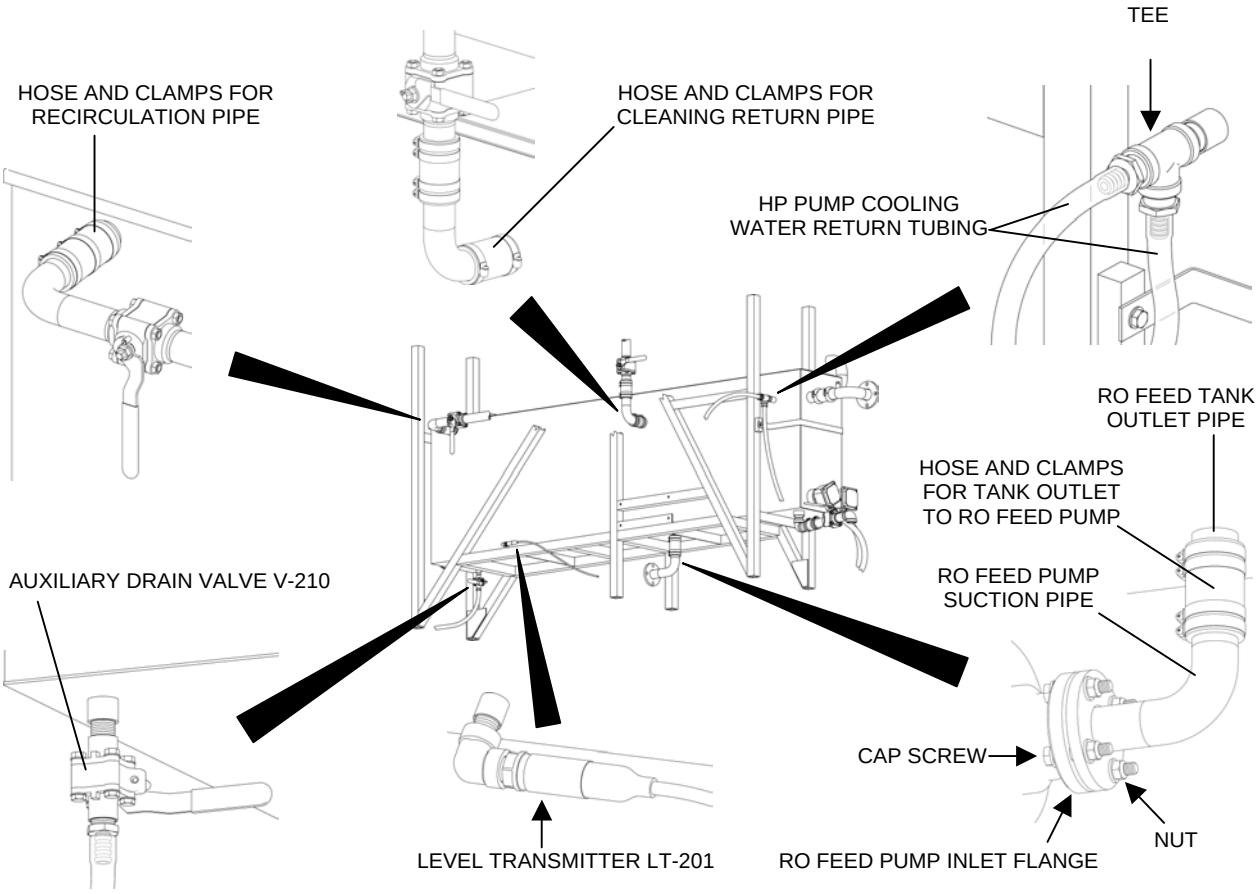

Figure 2. RO Feed Tank Front and Bottom Connections Removal.

3. Remove the MF filtrate pipe section at the right end of the RO feed tank as follows (see Figure 3):
    a. Tag and disconnect air tubing from the actuator for valve V-201 and from the positioner for valve V-202.
    b. Unscrew Filtrate Pressure Transmitter PT-102.
    c. Loosen the hose clamp on MF Filtrate Sample/Drain Valve V-204. Tag and remove the hose and clamp. Inspect the hose for damage or deterioration and replace if needed.
    d. Remove Filtrate Flow Control Valve and Actuator V-202.
    e. Remove the pipe coupling from the MF inlet to the RO feed tank and lift out the elbow pipe section.
    f. Inspect the pipe coupling gasket for damage or deterioration and replace if needed.
    g. Unbolt and remove the expansion joint from the bottom of the MF filtrate pipe section.
    h. Inspect the expansion joint gasket for damage or deterioration and replace if needed.
    i. While one person supports the MF filtrate pipe section, remove Upper Filtrate Outlet Valve and Actuator V-201.
    j. Unclamp the flex strut pipe support in the middle of the MF filtrate pipe section.
    k. Lift the MF filtrate pipe section out.

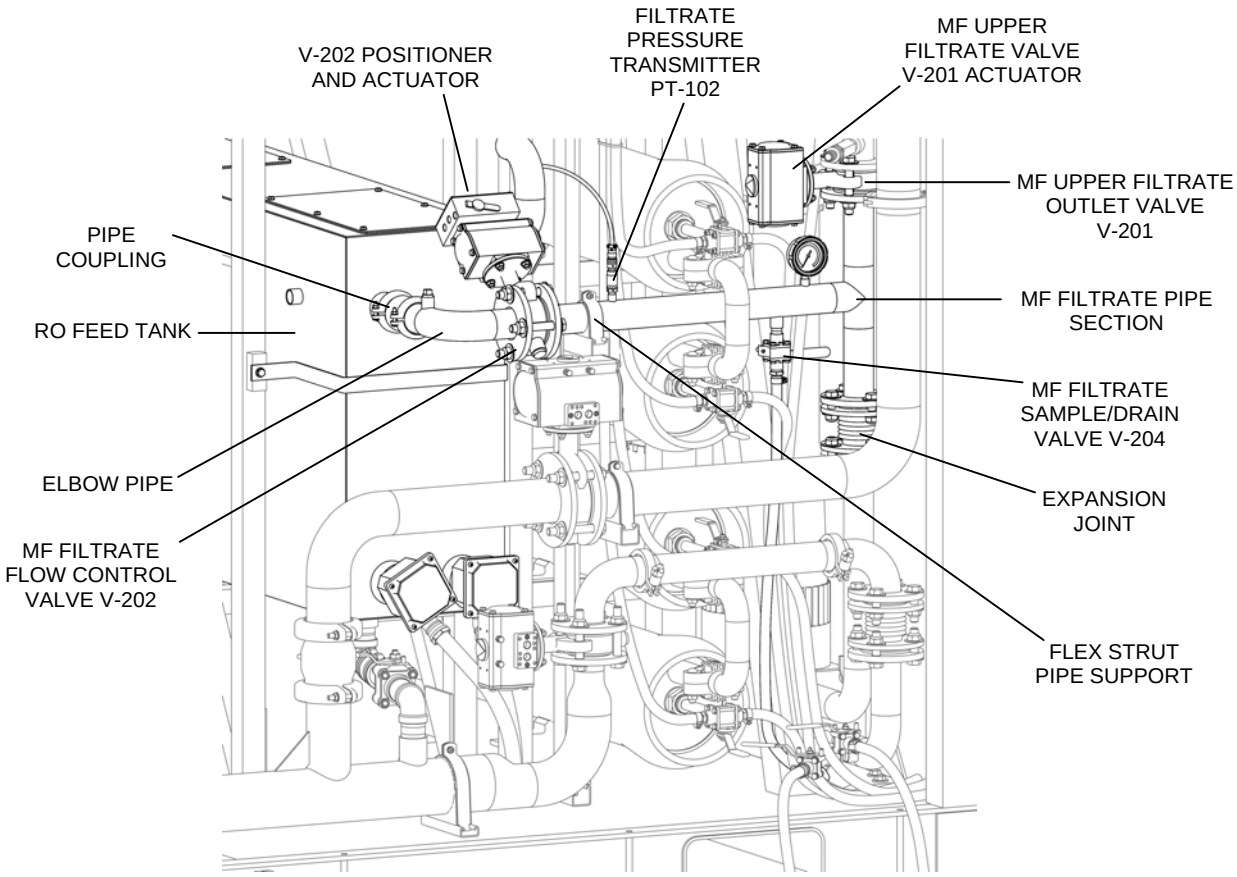

Figure 3. MF-Filtrate-to-RO Feed Tank Pipe Section Removal.

4. Remove the upper MF backwash pipe section as follows (see Figure 4):
    a. While one person supports the upper MF backwash pipe section, remove the following components from the pipe section:
        1) Tag and disconnect the air tubing from the actuator for Valve V-401.
        2) Remove the pipe coupling that connects the upper MF backwash pipe section to the waste out pipe section.
        3) Inspect the pipe coupling gasket for damage or deterioration and replace if needed.
        4) Remove the sanitary clamp at the top right end of the upper MF backwash pipe section.
        5) Inspect the sanitary clamp gasket for damage or deterioration and replace if needed.
        6) Unclamp the flex strut pipe support in the middle of the upper MF backwash pipe section.
    b. Lift the upper MF backwash pipe section out.

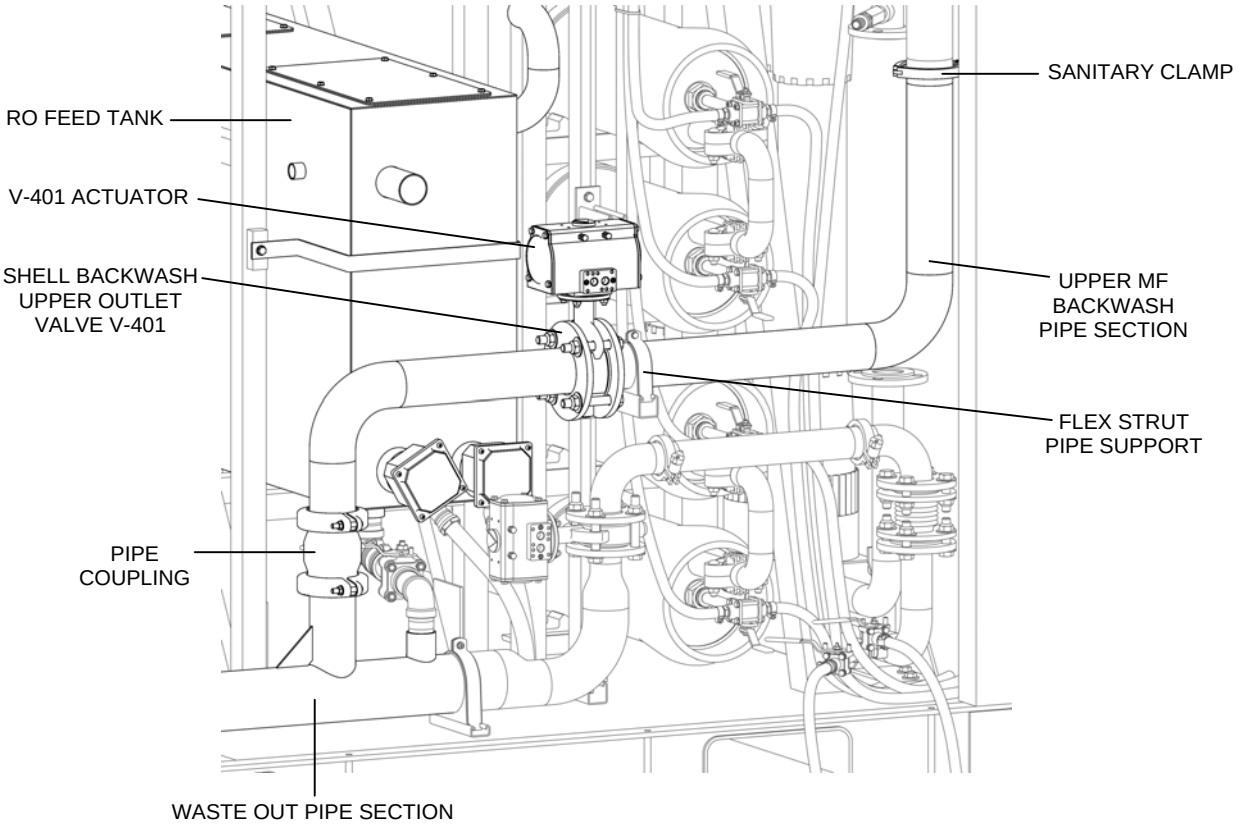

Figure 4. Upper MF Backwash Pipe Section Removal.

5. Remove the lower MF backwash pipe section as follows (see Figure 5):
    a. Tag and disconnect the air tubing from the actuator for Valve V-402.
    b. Remove the Shell Backwash Lower Outlet Valve and Actuator V-402.
    c. Remove the far right sanitary clamp and lift out the elbow pipe and the short pipe section that remain connected by another sanitary clamp.
    d. Inspect the sanitary clamp gasket for damage or deterioration and replace if needed.

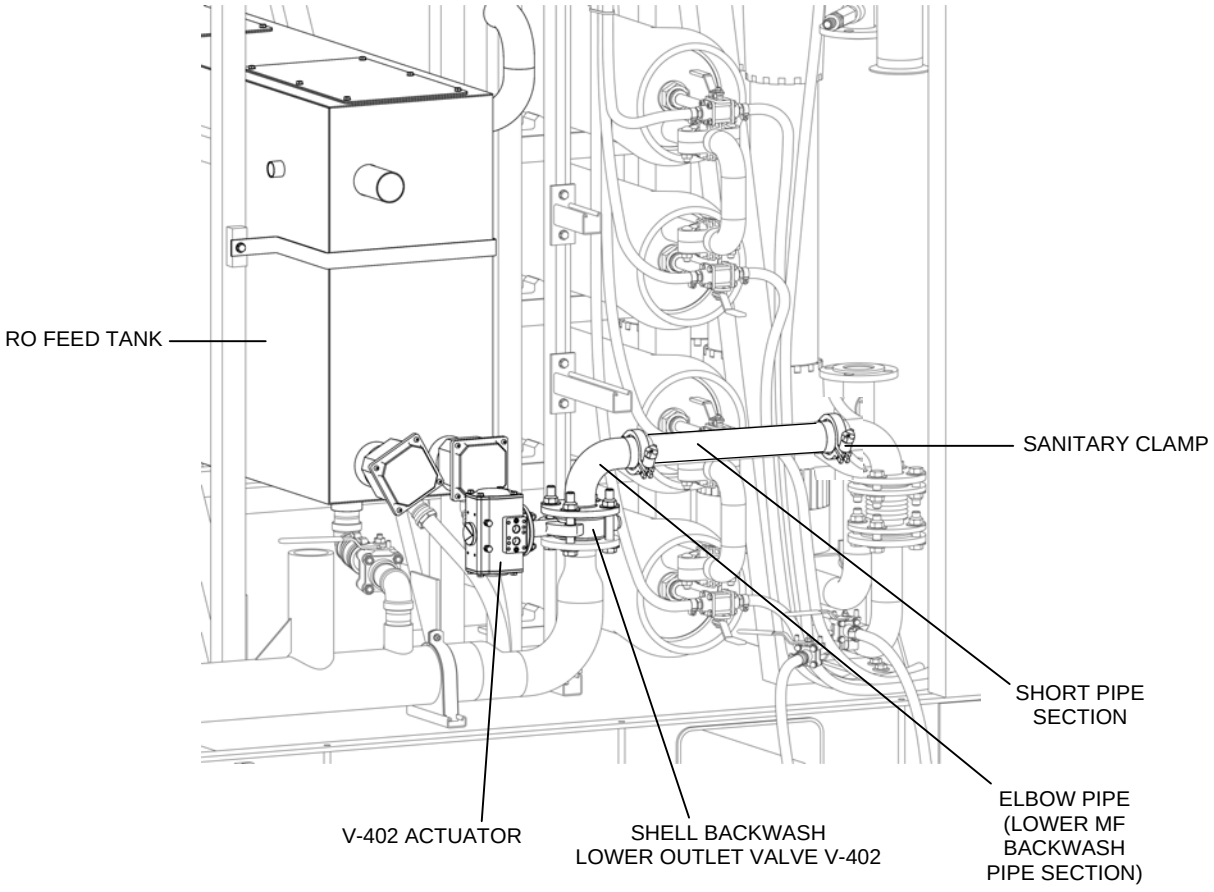

Figure 5. Lower MF Backwash Pipe Section Removal.

6. Disconnect the power cables from RO Feed Tank Heaters H-1 and H-2 as follows (see Figure 6):
   a. Remove the four screws from the heater cap and remove the cap from the terminal box.
   b. Tag and disconnect the 3 phase-wires and the ground wire from the heater terminals.
   c. Unscrew the lock nut inside the terminal box from the 45-degree box connector.
   d. Pull the connector and conduit as an assembly out of the terminal box. Retain the packing/retainer.

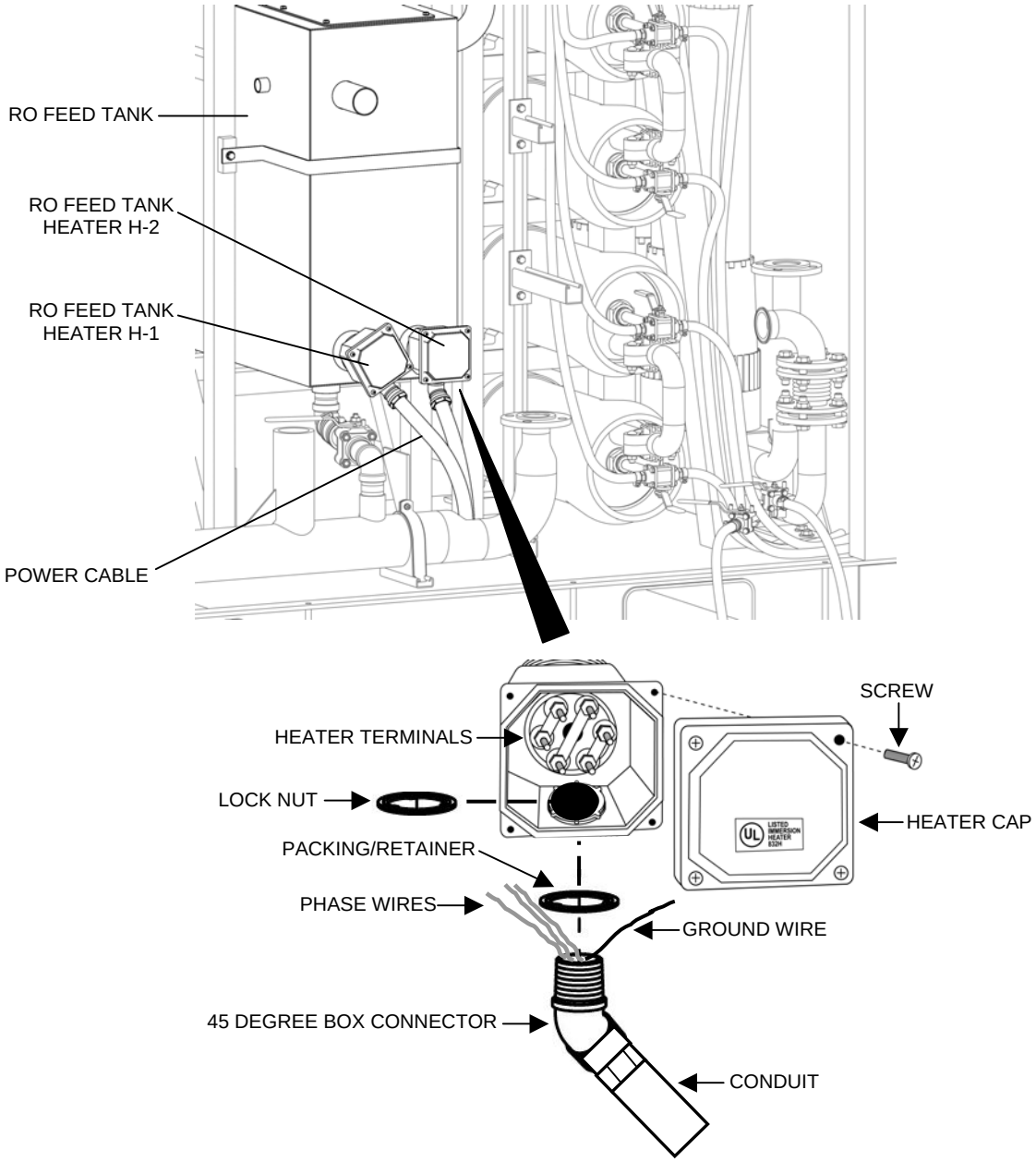

Figure 6. Heater Cable Removal.

7. Remove RO Feed Tank Drain Valve V-412 and pipe assembly from the RO feed tank to the waste out pipe spool as follows (see Figure 7):
    a. Remove the 4 hose clamps from the hose in the RO feed tank drain pipe.
    b. Unthread and remove the pipe section containing RO Feed Tank Main Drain Valve V-412 from the pipe elbow at the waste out pipe.
    c. Remove the hose from the RO feed tank drain pipe. Inspect the hose for damage or deterioration and replace if needed.
    d. Remove the pipe nipple, pipe elbow, and straight pipe from the RO feed tank drain as an assembly.

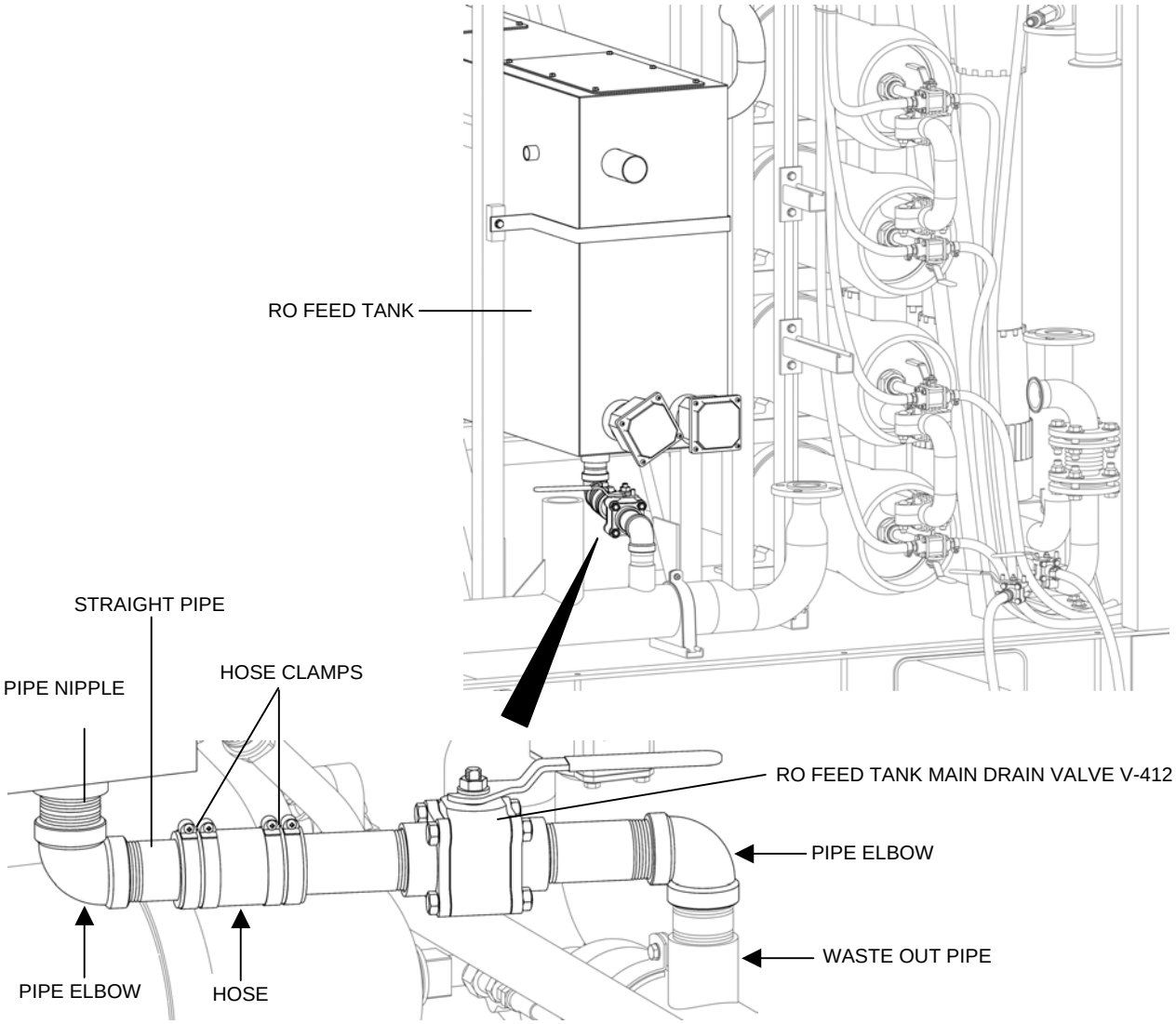

Figure 7. RO Feed Tank Drain Pipe Assembly Removal.

8. Remove the RO feed tank from the TWPS frame as follows (see Figure 8):
    a. Remove the bolt, lock washer, and flat washer that secure the tank tab to the TWPS frame at the temperature gauge end of the tank.
    b. Remove the 2 bolts, 2 lock washers, 2 flat washers, and retaining strap that secure the tank to the TWPS frame at the tank heater end of the tank.

WARNING

The RO feed tank is heavy. Use an appropriate lifting device to lift and remove the RO feed tank. Failure to observe this warning may result in back injury.

    c. Lift and move the RO feed tank out of the right end of the frame, taking care that the drain fittings and outlet tube at the bottom of the RO feed tank clear the TWPS frame.
    d. Remove RO Feed Pump Inlet Strainer S-4 from inside the tank. Refer to WP 0052.
    e. Remove the two heaters from the tank. Refer to WP 0052.

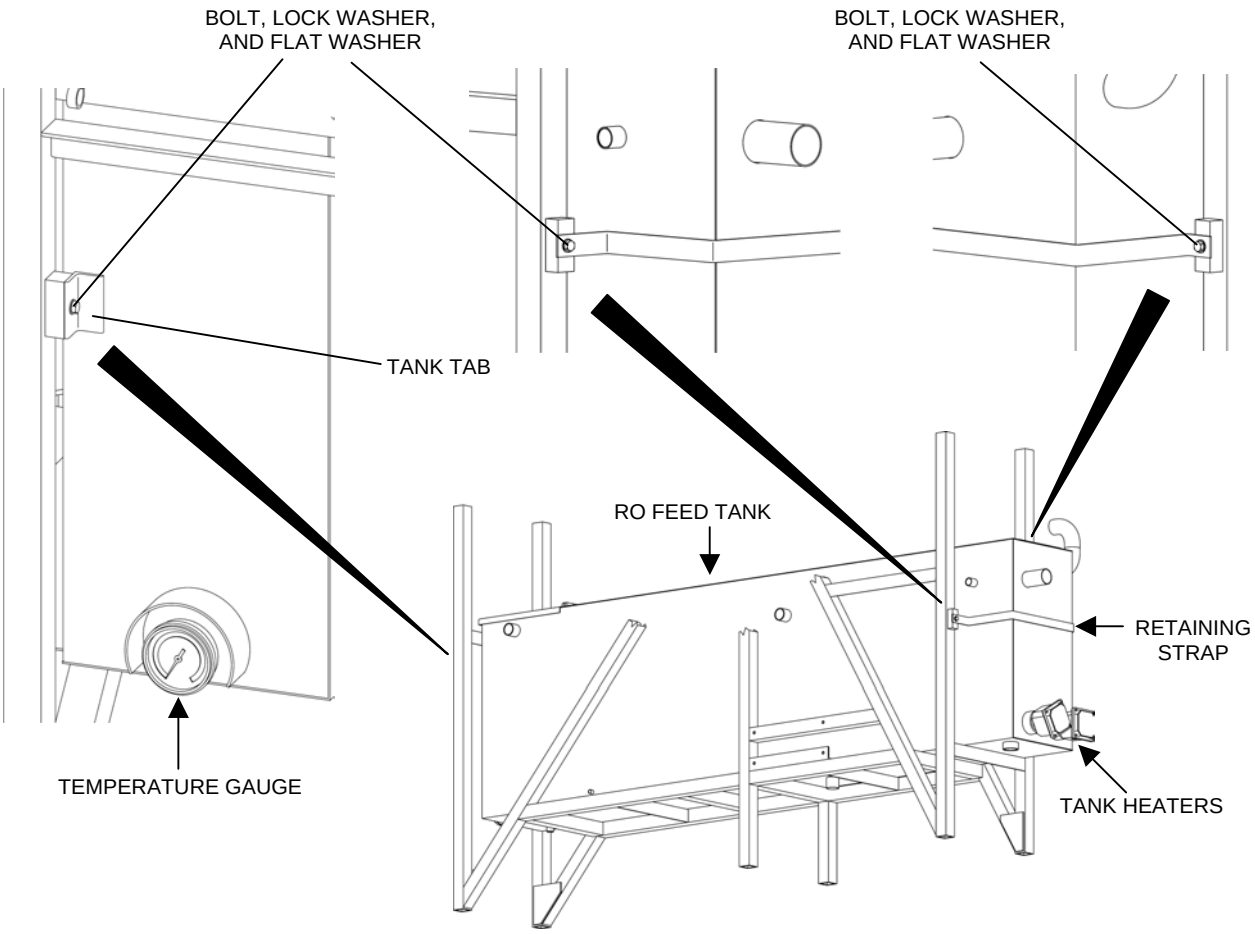

Figure 8. RO Feed Tank Removal from TWPS Frame.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0070 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

Install a new RO feed tank as follows:

1. Install a secure the new RO feed tank to the TWPS frame as follows (see Figure 8):
    a. Install the two heaters in the new tank. Refer to WP 0052.
    b. Install the RO Feed Pump Inlet Strainer S-4 in the new tank. Refer to WP 0052.

WARNING

The RO feed tank is heavy. Use an appropriate lifting device to lift and remove the RO feed tank. Failure to observe this warning may result in back injury.

    c. Lift and move the RO feed tank into the right end of the frame, taking care that the drain fittings and outlet tube at the bottom of the RO feed tank clear the TWPS frame.
    d. Secure the tab at the temperature gauge end of the tank to the TWPS frame using the flat washer, lock washer, and bolt removed earlier.
    e. Secure the tank heater end of the tank to the TWPS frame using the retaining strap, 2 flat washers, 2 lock washers, and 2 bolts removed earlier.
2. Clean the external threads on all threaded components that were removed from the old RO feed tank.
3. Install RO Feed Tank Main Drain Valve V-412 and the pipe run from the RO feed tank to the waste out pipe as follows (see Figure 7):
    a. Apply antiseizing tape to the external threads of the pipe nipple on the elbow that was removed from the drain of the old tank. Thread the pipe assembly into the drain of the new tank. Make sure the pipe assembly is positioned as shown in Figure 7.
    b. Apply soapy water to the straight pipe on the RO feed tank drain and the end of the pipe section containing RO Feed Tank Drain Valve V-412.
    c. Slide the hose clamps and hose over the two pipe ends. Do not tighten the hose clamps yet.
    d. Apply antiseizing tape to the external threads of the pipe section containing RO Feed Tank Drain Valve V-412. Thread the pipe onto the pipe elbow at the waste out pipe.
    e. Position the hose and hose clamps, then tighten the hose clamps.
4. Connect the power cables to both RO feed tank heaters H-1 and H-2 as follows (see Figure 6):
    a. Make sure the packing/retainer is over the threads of the 45 degree box connector.
    b. Insert the 45-degree box connector, with the conduit attached, through the hole in the bottom of the terminal box.
    c. Thread the lock nut onto the box connector inside the terminal box and tighten to secure the connector to the box.
    d. Connect the heater cable wires to the heater terminals in accordance with the wire tags.
    e. Secure the heater cap onto the heater using the four screws..
5. Install the lower MF backwash pipe section at the right end of the tank as follows (see Figure 5):
    a. Position the left elbow pipe and short pipe section assembly.
    b. Secure the right end of the short pipe to the right elbow pipe using the sanitary clamp.
    c. Install Shell Backwash Lower Outlet Valve and Actuator V-402.
    d. Connect the air tubing to the actuator for Valve V-402 in accordance to the tags.
6. Install the upper MF backwash pipe section at the right end of the tank as follows (see Figure 4):
    a. Position the upper MF backwash pipe section as shown in Figure 4.
    b. While one person supports the upper MF backwash pipe section, secure the pipe section into place as follows:

1) Clamp the flex strut pipe support to the middle of the horizontal pipe.
2) Secure the top right end of the upper MF backwash pipe section using the sanitary clamp that was removed earlier.
3) Secure the upper MF backwash pipe section to the lower MF backwash pipe section using the pipe coupling that was removed earlier.

c. Connect the air tubing to the actuator for Valve V-401 in accordance to the tags.

7. Install the MF filtrate pipe section at the right end of the tank as follows (see Figure 3):
   a. Position the MF filtrate pipe section as shown in Figure 3.
   b. While one person supports the MF filtrate pipe section, secure the pipe section into place as follows:
      1) Loosely clamp the flex strut pipe support to the middle of the MF filtrate pipe.
      2) Install Upper Filtrate Outlet Valve and Actuator V-201.
      3) Bolt the expansion joint to the bottom of the MF filtrate pipe section.
      4) Position the elbow pipe section as shown in Figure 3.
      5) Connect the elbow pipe section to the RO tank using the pipe coupling that was removed earlier.
      6) Install Filtrate Flow Control Valve and Actuator V-202.
      7) Tighten the flex strut pipe support.
   c. Secure the sample/drain hose to MF Filtrate Sample/Drain Valve V-204.
   d. Wrap antiseizing tape onto the threads of Pressure Transmitter PT-102 and thread the transmitter into its fitting on the horizontal pipe section.
   e. Connect the air tubing to the actuators for Valve V-201 and V-202 in accordance to the tags.
8. Make all connections to the bottom and front of the RO feed tank as follows (see Figure 2):
   a. Wrap antiseizing tape on the threads of the tee coupling for the HP pump cooling water return tubes and thread the coupling into the tank fitting.
   b. Connect the HP pump cooling water return tubes to the tee.
   c. Wrap antiseizing tape on the threads of Level Transmitter LT-201 and thread the transmitter into the elbow on the tank. Connect the cable to the transmitter.
   d. Apply soapy water to the RO feed pump suction pipe and slide half of the hose over the pipe.
   e. Slide the 4 hose clamps over the hose.
   f. Apply soapy water to the RO feed tank outlet pipe and slide the other end of the hose over the outlet pipe.
   g. Secure the RO feed pump suction pipe to the inlet flange of the RO feed pump using the four cap screws, washers, and nuts that were removed earlier.
   h. Position and tighten the 4 hose clamps to secure the hose to the suction pipe and the RO feed tank outlet pipe.
   i. Apply soapy water to the cleaning return pipe and the cleaning return inlet on the tank. Slide the 2 hose clamps and hose over the ends of both.
   j. Secure the cleaning return pipe to the cleaning return inlet using the hose clamps.
   k. Apply soapy water to the re-circulation pipe and the re-circulation inlet on the RO feed tank and slide the 3 hose clamps and hose over the ends of both.
   l. Secure the re-circulation pipe to the re-circulation inlet adapter using the hose clamps.
   m. Wrap antiseizing tape on the threads of RO Feed Tank Auxiliary Drain Valve V-210 and thread the drain valve into its fitting under the left end of the RO feed tank.
9. (Army only) Install the TWPS skid onto the flat rack. Refer to WP 0071.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0070 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
REVERSE OSMOSIS SYSTEM

RO Vessel Replacement:

Parts:
RO Vessel Shell (TM 10-4610-309-24P)
Materials:
Abrasive cloth (WP 0079, Table 1, item 15)
Mild soap solution
Glycerin (WP 0079, Table 1, item 21)
Clean water
Corrosion preventive compound (WP 0079, Table 1, item 17)
Antiseizing tape (WP 0079, Table 1, item 43, 44)
Tools:
Small wire brush
Element pusher (TM 10-4610-309-24P)
Equipment Condition:
TWPS in Short Term Shutdown with Drain Down (WP 0017)

WARNING

High pressure. During operation the RO vessels and RO system may be pressurized up to 1200 psig. Make sure that the RO system pressure has been relieved prior to working on any part of the system. Failure to observe this warning can result in an explosive release of parts that can cause injury or death to personnel and damage to equipment.

Potential for catastrophic failure. Damage or scratches to the shell of an RO vessel that are deeper than the paint can result in failure of the vessel wall during operation. Vessel shells with such damage must be replaced. Failure to observe this warning can result in catastrophic failure of the vessel during operation and serious injury or death.

Replace the shell of an RO vessel while keeping all other parts of the RO vessel as follows:

1. Make sure that the RO system is in Short Term Shutdown with Drain Down. Refer to WP 0017.
2. Remove the RO elements from the RO vessels. Refer to WP 0041.
3. Remove the MF assembly. Refer to WP 0069.

WARNING

The RO vessels are heavy. Use an appropriate lifting device to lift and remove the vessels. Failure to observe this warning may result in back injury.

NOTE

RO vessel #1 cannot be removed unless RO vessel #2 is removed first. RO vessels 2, 3, 4, and 5 can be removed without having to remove any of the other vessels.

4. Remove RO vessel #2, 3, 4, or 5 as follows (see Figure 9):
    a. Remove the 2 nuts, 2 flat washers, 2 J-bolts, U-clamp, and pad at both ends of the vessel.
    b. Using an appropriate lifting device, lift the vessel slightly and maneuver it out the high pressure pump end of the TWPS.
    c. Remove the 2 mounting blocks on which the vessel rested.
5. Remove RO vessel #1 (the top RO vessel) as follows (see Figure 9):
    a. Remove RO vessel #2 if not already removed.
    b. Using an appropriate lifting device, support RO vessel #2.
    c. Remove the 2 nuts, 2 flat washers, 2 J-bolts, U-clamp, and pad at both ends of the vessel.
    d. Remove the 2 cap screws, 1 lock washer, three flat washers, and removable support beam under the vessel at both ends of the vessel.
    e. Lower the vessel and maneuver it out the high-pressure pump end of the TWPS.

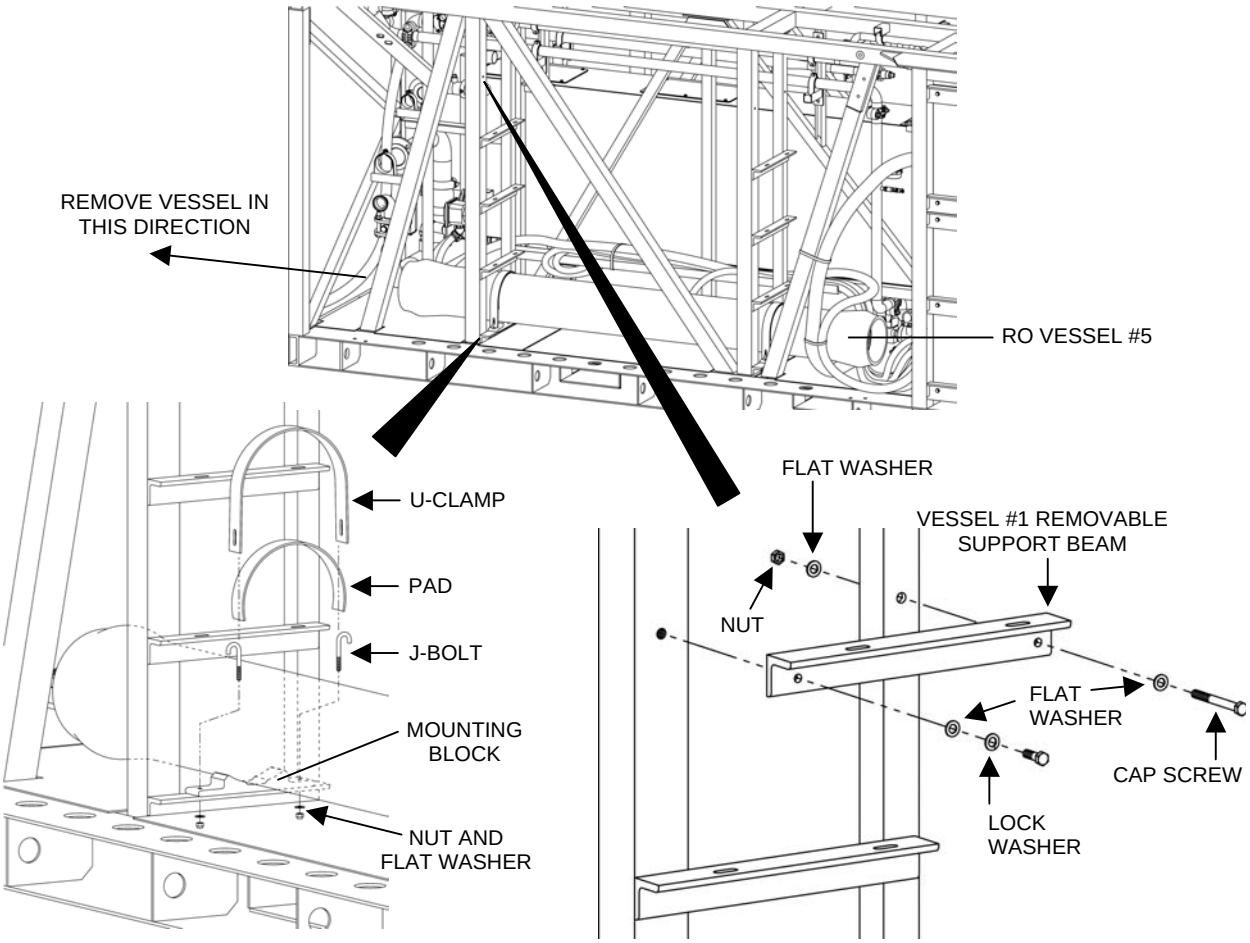

Figure 9. RO Vessel Replacement.

NOTE

RO vessel #1 cannot be installed unless RO vessel #2 is removed from the system.

6. Install new RO vessel #1 as follows (see Figure 9):
   a. Using an appropriate lifting device, lift the vessel and maneuver it into position in the TWPS frame. Raise the vessel high enough so that the removable support beams can be installed under the vessel.
   b. Install the removable support beam under the vessel at both ends of the vessel using the lock washer, flat washers, and cap screws removed earlier.
   c. Position the mounting blocks on the support beams and lower the vessel onto the blocks. Maintain support of the vessel with the lifting device.

NOTE

The RO vessels must be positioned precisely so that all connecting pipes match properly when assembled to the vessels.

   d. Position the RO vessel as follows:
      1) The end of the vessel nearest the electrical system panel box must be 14¼ in. from the outside edge of the vertical beam next to the panel box (see Figure 10).
      2) The back side of the vessel must be ¾ in. from the back vertical RO vessel support beam at both ends of the vessel (see Figure 10).

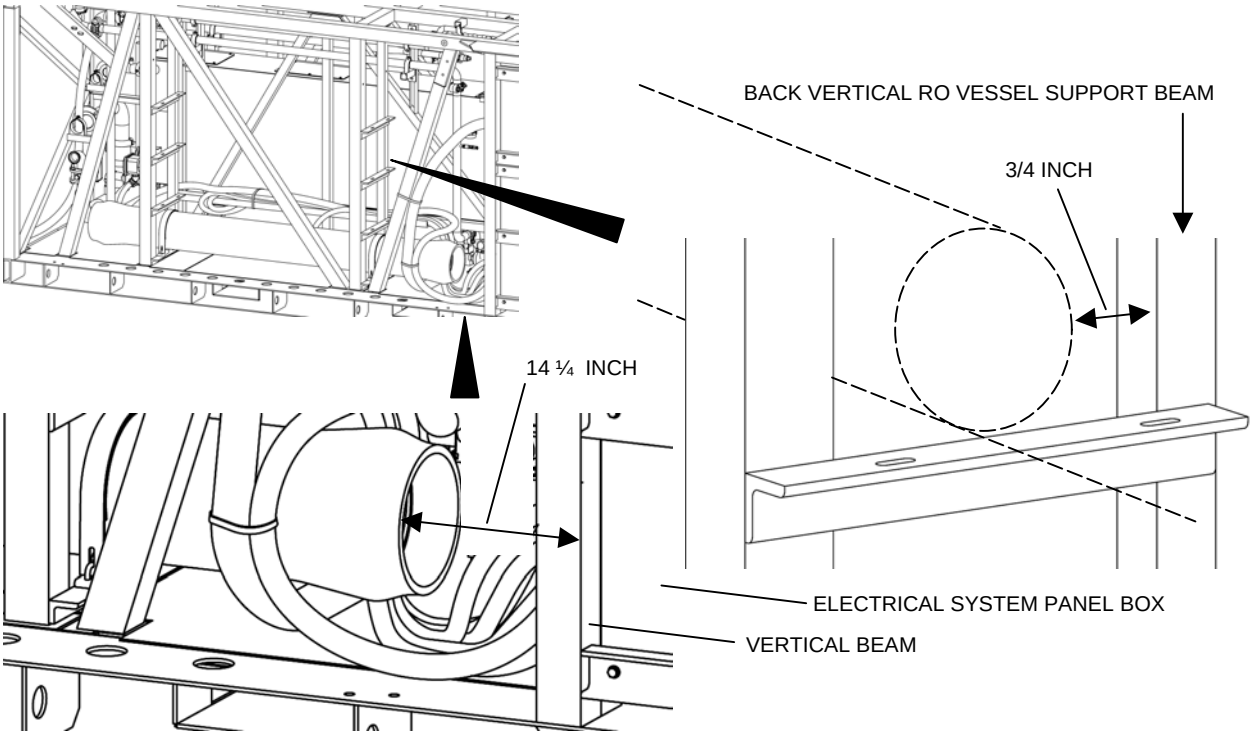

Figure 10. RO Vessel Positioning Dimensions.

e. Install the pad, U-clamp, 2 J-bolts, 2 flat washers, and 2 nuts at both ends of the vessel and tighten hand tight.
f. Remove the lifting device and, using a wrench, turn the nuts **one** additional full turn.

7. Install new RO vessel #5, 4, 3, or 2 as follows (see Figure 9):

NOTE

RO vessels 2, 3, 4, and 5 can be installed in any order, although it is generally easier to install the RO vessels from the bottom up when more than one vessel is to be installed.

a. Using an appropriate lifting device, lift the vessel and maneuver it into position in the TWPS frame.
b. Position the mounting blocks on the support beams and lower the vessel onto the blocks. Maintain support of the vessel with the lifting device.

NOTE

The RO vessels must be positioned precisely so that all connecting pipes match properly when assembled to the vessels.

c. Position the RO vessel as follows:
   1) The end of the vessel nearest the electrical system panel box must be 14¼ in. from the outside edge of the vertical beam next to the panel box (see Figure 10).
   2) The back side of the vessel must be ¾ in. from the back vertical RO vessel support beam at both ends of the vessel (see Figure 10).
d. Install the pad, U-clamp, 2 J-bolts, 2 flat washers, and 2 nuts at both ends of the vessel and tighten hand tight.
e. Remove the lifting device and, using a wrench, turn the nuts **one** additional full turn.

8. Install the RO elements in the new vessel. Refer to WP 0041.
9. Reinstall the MF Assembly. Refer to WP 0069.

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) DIRECT SUPPORT MAINTENANCE PROCEDURES TACTICAL WATER PURIFICATION SYSTEM (TWPS) SKID, FLAT RACK, AND TACTICAL QUIET GENERATOR (TQG)

0071 00

THIS SECTION COVERS:
Remove, Install, Replace, Repair

INITIAL SETUP:

Maintenance Level
Direct Support
References
TM 5-6115-545-12 – Tactical Quiet Generator
TM 9-237 Welding Theory and Application
TM 43-0139 Painting Instructions
Personnel Required
Two
Equipment Condition
TWPS in extended shutdown

GENERAL:

The procedures covered in this work package include:

- TWPS Removal from and Installation into the Flat Rack (A-TWPS Only)
- TQG Replacement (A-TWPS Only)
- Frame, Tie-Down, and Lift Provision Repair

REMOVE AND INSTALL

TWPS Removal from and Installation into the Flat Rack (A-TWPS Only):

Parts:
Horseshoe shim (TM 10-4610-309-24P or TM 10802A-24P/2)
Materials:
Sealing Compound PR-1440 B-2 (WP 0079, Table 1, item 37)
Equipment Condition:
TWPS in Extended Shutdown (WP 0018)

Remove and reinstall the A-TWPS unit from and into the flat rack as follows:

NOTE

The A-TWPS flat rack and TWPS unit are serialized together as a unit. The TWPS unit would not typically be removed from the flat rack and replaced with another TWPS unit.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0071 00
DIRECT SUPPORT MAINTENANCE PROCEDURES
TACTICAL WATER PURIFICATION SYSTEM (TWPS) SKID, FLAT RACK, AND TACTICAL QUIET GENERATOR (TQG)

1. Remove the TWPS Unit from the flat rack as follows (see Figure 1):
    a. Remove the side and back panels from the flat rack.
    b. Remove the channel seals from the flat rack framing at the back of the flat rack only.
    c. Remove the two vertical flat rack braces from the back of the flat rack (3 bolts, 3 lock washers, and 3 washers at the top and bottom of both braces).
    d. Remove the three angle bars from the floor at the back of the flat rack (5 bolts, 5 lock washers, and 5 flat washers for each of the three bars).
    e. Remove the through-bolts, washers, and nuts that secure the TWPS unit to the floor of the flat rack (3 bolts, 6 flat washers, 3 lock washers, and 3 nuts at the front; 4 bolts, 8 flat washers, 4 lock washers, and 4 nuts at the back; and 2 bolts, 2 flat washers, 2 beveled washers, 2 lock washers, and 2 nuts at both ends).
    f. Mark for location any horseshoe shims that may be installed between the TWPS and the floor of the flat rack.
    g. Remove the shims if possible, otherwise collect and retain the shims after the TWPS unit has been removed from the flat rack.

CAUTION

Potential damage to Micro-Filtration Assembly. Do not tip the TWPS unit back against the vertical supports of the forklift. The micro-filtration assembly is not designed to support the weight of the rest of the TWPS unit pushing against it. Failure to observe this caution will result in significant damage to the micro-filtration assembly.

    h. Using appropriate lifting equipment, lift and remove the TWPS unit out through the back of the flat rack.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0071 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
TACTICAL WATER PURIFICATION SYSTEM (TWPS) SKID, FLAT RACK, AND TACTICAL QUIET GENERATOR (TQG)

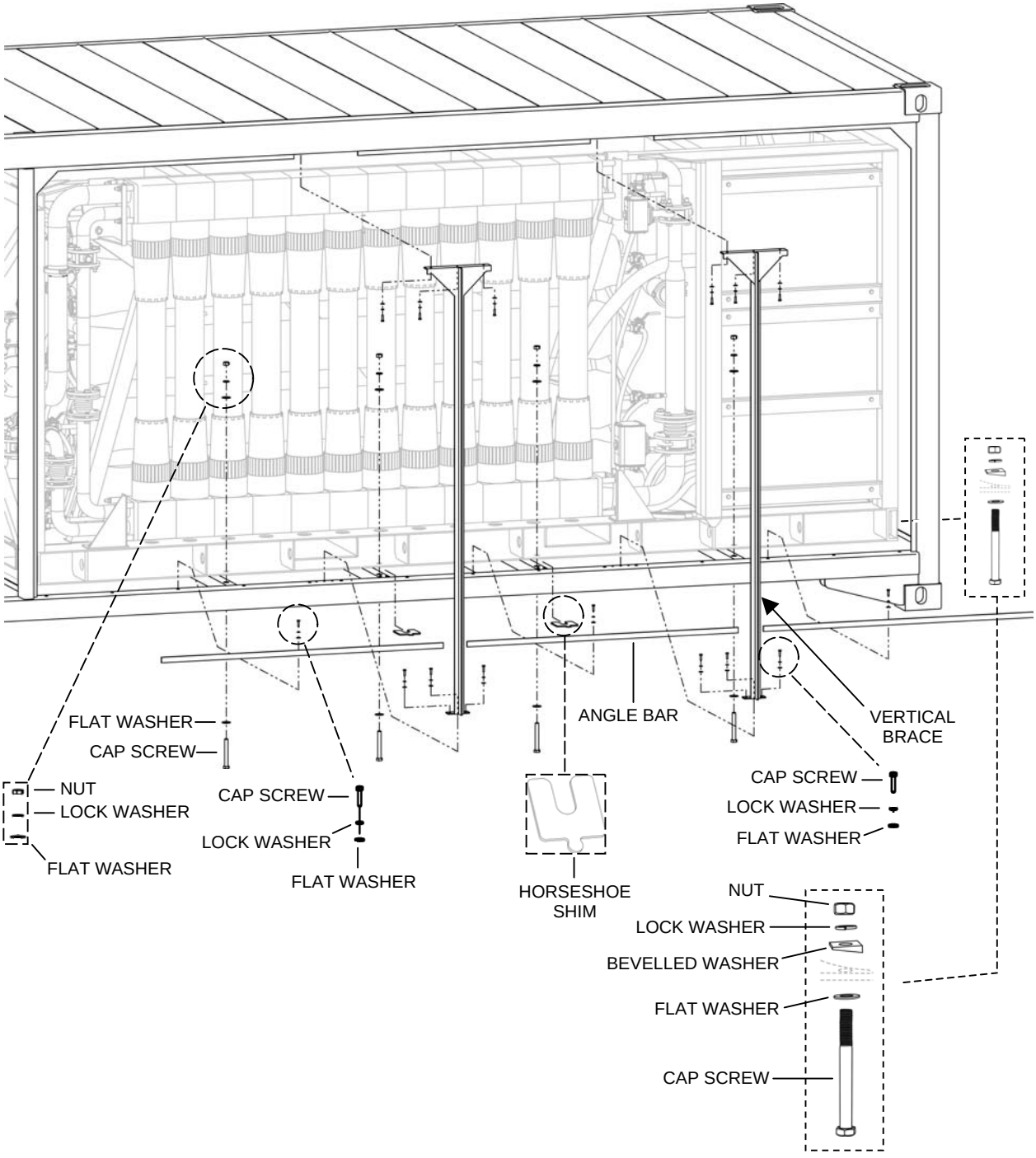

Figure 1. A-TWPS Removal from the Flat Rack.

2. Reinstall the TWPS Unit into the flat rack as follows (see Figure 1):

CAUTION

Potential damage to Micro-Filtration Assembly. Do not tip the TWPS unit back against the vertical supports of the forklift. The micro-filtration assembly is not designed to support the weight of the rest of the TWPS unit pushing against it. Failure to observe this caution will result in significant damage to the micro-filtration assembly.

a. Using appropriate lifting equipment, lift and carefully insert the TWPS unit, front first, into the back of the flat rack.
b. Make sure that the holes in the bottom framing of the TWPS unit align with the holes in the floor of the flat rack.
c. Reinsert the horseshoe shims in their same locations between the TWPS and flat rack floor or replace with same thickness shims if necessary.
d. Secure the TWPS unit to the floor of the flat rack using the through-bolts and nuts that were removed earlier. Insert the bolts up through the bottom of the flat rack (3 bolts, 6 flat washers, 3 lock washers, and 3 nuts at the front; 4 bolts, 8 flat washers, 4 lock washers, and 4 nuts at the back; and 2 bolts, 2 flat washers, 2 beveled washers, 2 lock washers, and 2 nuts at both ends).
e. Apply sealing compound to the TWPS frame where the bottom seal bars and vertical braces are to be installed.
f. Secure the two vertical flat rack braces to the back of the flat rack (3 bolts, 3 lock washers, and 3 flat washers at the top and bottom of both braces).
g. Secure the three angle bars to the floor at the back of the flat rack (5 bolts, 5 lock washers, and 5 flat washers for each of the three bars).
h. Reinstall the channel seals to the flat rack framing at the back of the flat rack.
i. Reinstall all of the panels on the flat rack.

TQG Replacement (A-TWPS Only):

Equipment Condition:
TWPS in Extended Shutdown (WP 0018)

Replace the A-TWPS TQG as follows:

1. Disconnect all power connections from the TQG as follows:

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0071 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
TACTICAL WATER PURIFICATION SYSTEM (TWPS) SKID, FLAT RACK, AND TACTICAL QUIET GENERATOR (TQG)

WARNING

High voltage electrical hazard. High voltage is produced when the generator set is in operation. Make sure that the Tactical Quiet Generator has been properly shut down before attempting to remove the ground from the TQG. Failure to observe this warning could result in injury or death from electrical shock.

NOTE
Refer to TM 5-6115-545-12 for generator operation.

a. Disconnect the TWPS power cable leads from the generator lugs labeled L1, L2, and L3.
b. Disconnect the TWPS power cable white lead from the generator neutral lug and the green lead from the generator ground lug.
c. Tuck the TWPS power cable end inside the TWPS frame.
d. Disconnect the ground cable from the generator ground lug.

2. Remove the TQG from the flat rack as follows (see Figure 2):
   a. Remove the hardware that secures the TQG to the floor of the flat rack (4 bolts, 8 flat washers, 4 lock washers, and 4 nuts).

NOTE
The TQG can be removed out through either the front or the back of the flat rack.

b. Using appropriate lifting equipment, lift and remove the TQG off of the flat rack.

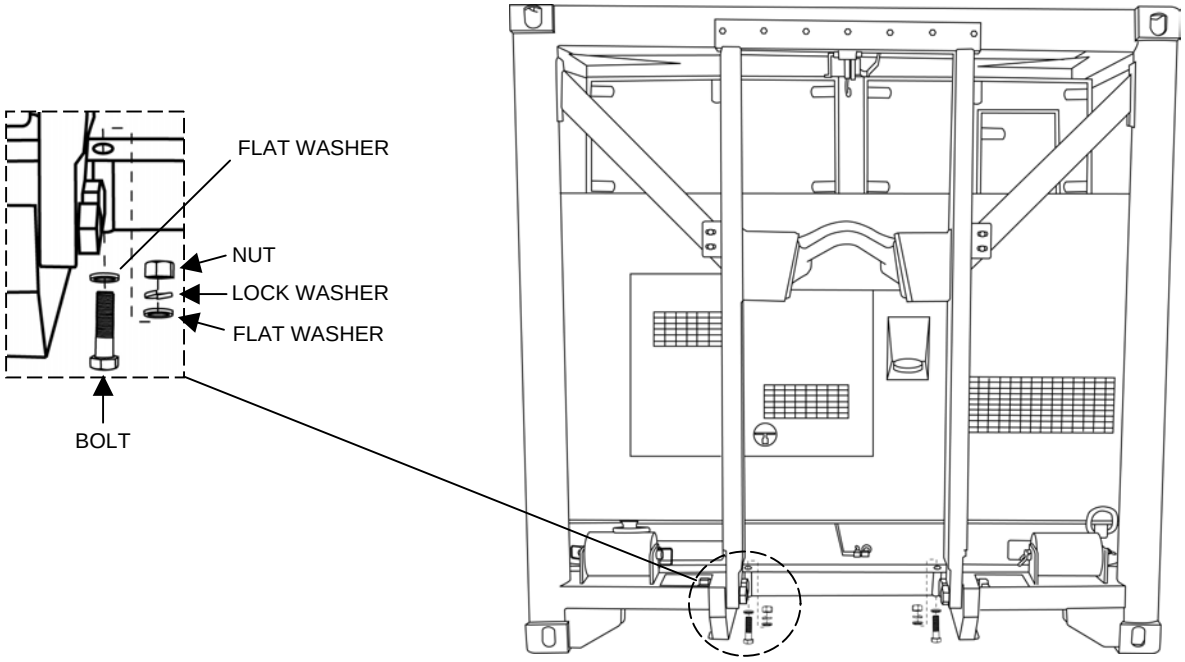

Figure 2. TQG Removal from the Flat Rack.

3. Install a TQG onto a flat rack as follows:

NOTE

When inserting a TQG onto the A-TWPS flat rack, make sure that the terminal compartment of the TQG is facing into the flat rack toward the TWPS unit.

a. Using appropriate lifting equipment, lift and carefully insert the TQG onto the flat rack.
b. Make sure that the holes in the bottom framing of the TQG align with the holes in the floor of the flat rack.
c. Secure the TQG to the floor of the flat rack using the through-bolts and nuts that were removed earlier. Insert the bolts up through the bottom of the flat rack. (4 bolts, 8 flat washers, 4 lock washers, and 4 nuts).

Frame, Tie-Down, and Lift Provision Repair:

Equipment Condition:
TWPS in Extended Shutdown (WP 0018)

1. For repairs to the A-TWPS flat rack, remove the TPWS unit and TQG from the flat rack. Refer to **TWPS Removal from and Installation into the Flat Rack (A-TWPS Only)** and **TQG Replacement (A-TWPS Only)** in this work package.
2. For repairs to the TWPS frame, tie-down, or lift provisions perform the following:
    a. (A-TWPS only) Remove the TWPS unit from the flat rack. Refer to **TWPS Removal from and Installation into the Flat Rack (A-TWPS Only)**.
    b. Remove or protect components of the TWPS as necessary to perform required repairs.
3. For welding procedures, refer to TM 9-237 to weld damaged areas.
4. For painting of repaired areas, refer to TM 43-0139.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0072 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

THIS SECTION COVERS:
Repair

INITIAL SETUP:

Maintenance Level
Direct Support
Tools
Sewing Equipment per FM 10-16, Fabric Repair
Materials/Parts:
Water Repellent Solution
Reference:
FM 10-16, Fabric Repair
Personnel Required
One
Equipment Condition
Hose heating blankets, adaptor heating blanket, pump covers, fabric wall, or winter cover taken out of service

GENERAL:
This procedure contains information and instructions for repairing surface damage to a hose cover, a pump cover, the fabric wall (A-TWPS), the general purpose cover (MC-TWPS), or the winter cover (MC-TWPS) in the Cold Weather System of the TWPS.

REPAIR

Hose Heating Blankets, Adaptor Heating Blanket, Pump Covers, Fabric Wall, or Winter Cover Repair:

The instructions that follow describe the steps for repairing surface damage to hose heating blankets, Adaptor heating blanket, pump covers, the fabric wall (A-TWPS), or the winter cover (MC-TWPS). (See Figure 1 through Figure 5)

1. Refer to FM 10-16 and sew patches on tears.
2. Refer to FM 10-16 and sew loose rim strip or webbing straps.
3. Refer to FM 10-16 and replace damaged or missing grommets and worn or frayed laces.
4. Refer to FM 10-16 and apply water repellant solution.

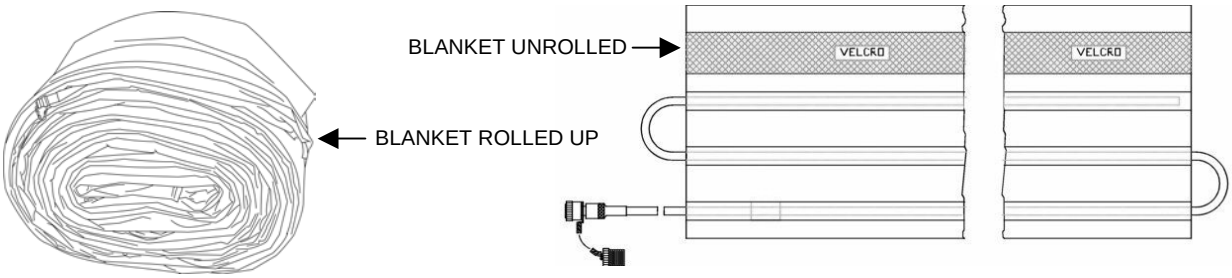

Figure 1. Hose Heating Blankets.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0072 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

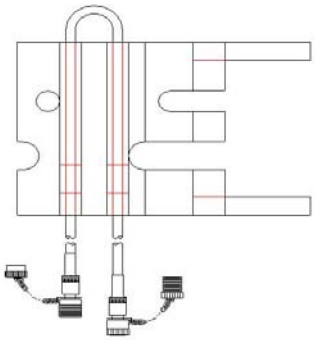

Figure 2. Adaptor A-02 Heating Blanket.

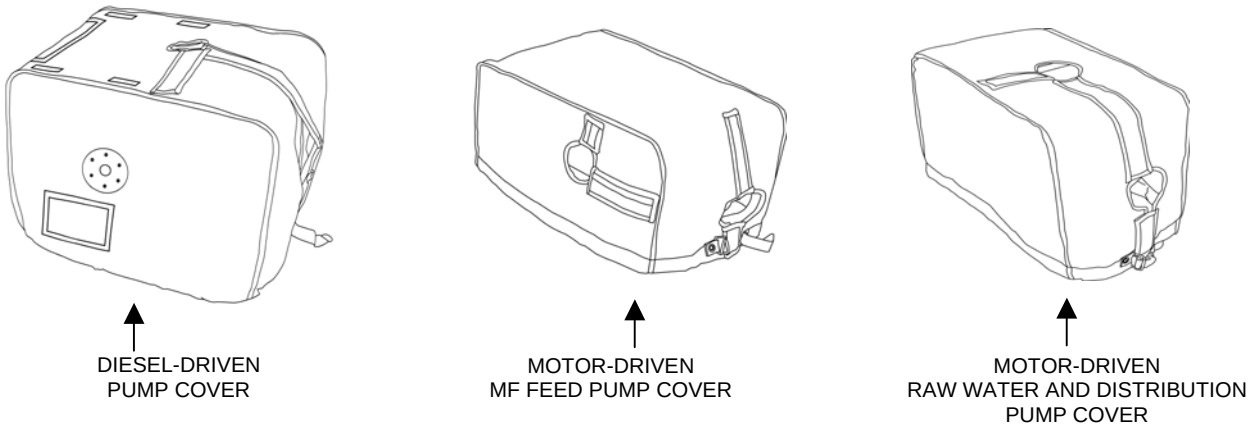

Figure 3. Pump Covers.

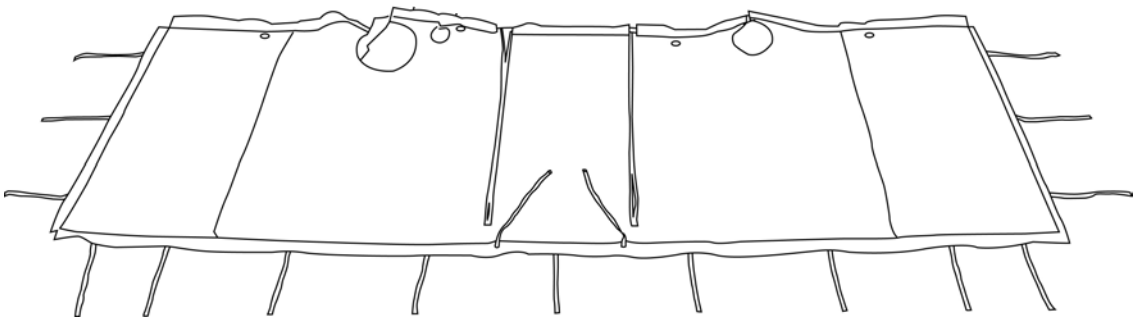

Figure 4. Fabric Wall (A-TWPS).

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0072 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
COLD WEATHER SYSTEM

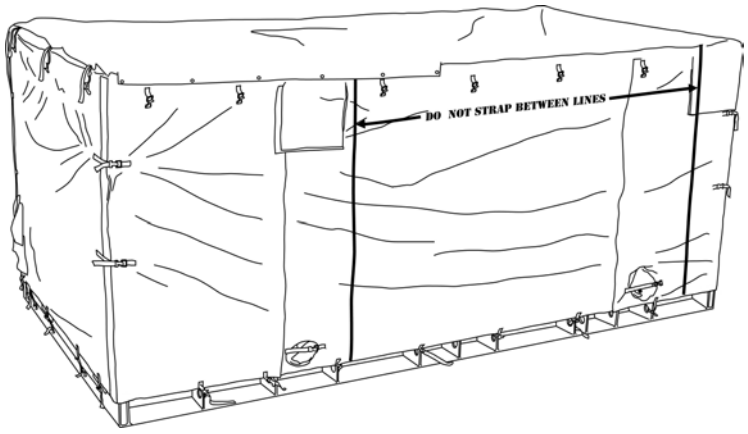

Figure 5. General Purpose Cover (MC-TWPS).

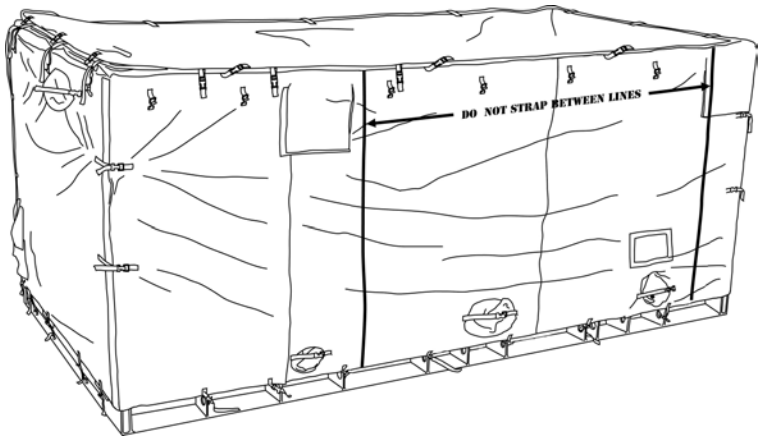

Figure 6. Winter Cover (MC-TWPS).

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0073 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
GENERAL DIRECT SUPPORT MAINTENANCE PROCEDURES

THIS SECTION COVERS:
Replace

INITIAL SETUP:

Maintenance Level
Direct Support
References
Refer to TM 10-4610-309-24P for repair parts information
Personnel Required
One
Equipment Condition
TWPS removed from service.

GENERAL:

The procedure covered in this work package includes:

- Cable connector replacement

Cable Connector Replacement:

Tools:
Multi-meter
Stripper, Wire
Heater, Air
Soldering Gun
Parts (TM 10-4610-309-24P):
Connector Assembly
Material:
Heat Shrink Tubing
Solder
Tape, Antiseizing (WP 0079, Table 1, item 43, 44)
Personnel Required:
One
Equipment Condition:
TWPS removed from service. Cable to be repaired, removed.

Replace a cable connector as follows (see Figure 1):

NOTE
Except where noted, this procedure applies to both straight and 90˚ connectors and is applicable regardless of the number of wires in the cable.

1. Cut the cable at the connector or before the point of damage if both the cable end and connector are damaged.

2. Disassemble the new connector.
3. Slide the new connector parts over the end of the cable in the following order:
    a. Strain relief, saddle and screws end first.
    b. Follower, flat edge first (beveled edge out).
    c. Grommet
    d. Back adapter, external threaded end first.
    e. Outer ground ring, thick edge first.
    f. Inner ground ring, smaller diameter end first.

NOTE

Elbow backshells are difficult to slide over stiff cables. Spraying WD-40 or a similar lubricant on the exterior of the cable will make it easier to slide the elbow backshell over the cable.

Make sure a gasket is in place over the male end and inside the female end of the backshell.

    g. Elbow (or straight) backshell, threaded end first.

NOTE

Make sure a gasket is in place inside the female end of the front adapter.

    h. Front adapter, external threaded end first.
    i. Dust cap ring.
    j. Coupling nut, end with narrow lip first.

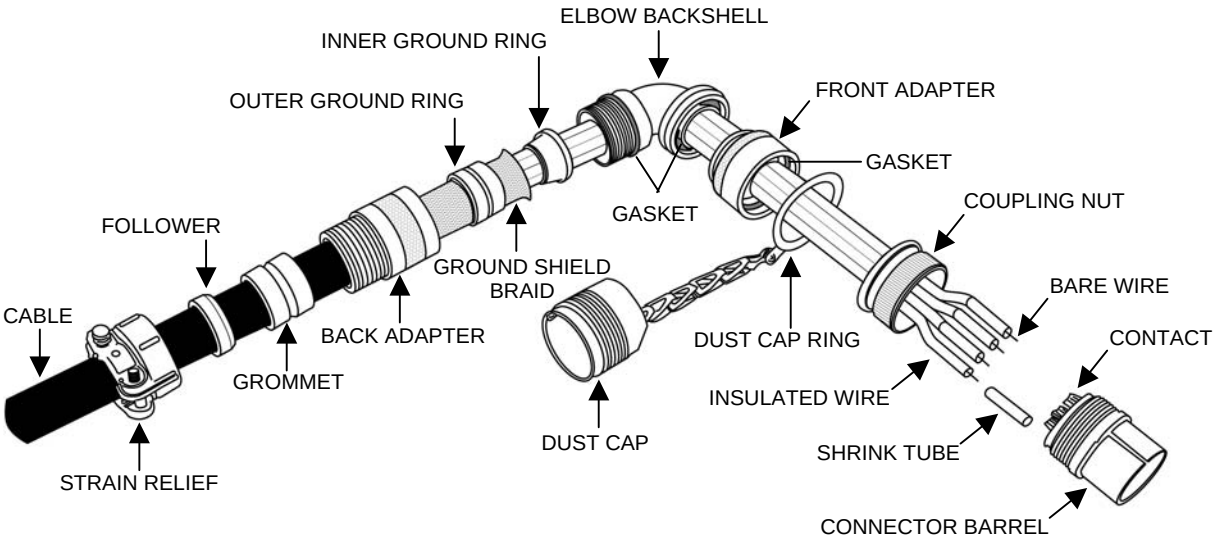

Figure 1. Cable Connector Replacement.

4. Prepare the cable for installation onto the new connector as follows:
    a. Temporarily assemble the backshell, front adapter, dust cap ring, coupling nut, and connector barrel with the cable end against the connector.
    b. Mark the outer sheathing of the cable about 1-inch down from the threaded end of the backshell.
    c. Remove the connector barrel and slide the rest of the parts down the cable past the mark made on the cable sheathing.

NOTE

Be careful not to cut the ground shield braid under the cable sheathing when stripping the sheathing off the cable.

    d. Strip the sheathing off the cable from the mark to the end of the cable.
    e. Leave about 1-inch of exposed ground shield braid from the end of the cable sheathing and cut the rest off.
    f. Strip about ½ inch of insulation off the ends of each of the individually insulated cable wires.
    g. Slide a 1-inch long shrink tube over each wire so that they clear the stripped portions of the wires.

NOTE

Contact numbers are marked on the flat end of the connector.

5. Install the cable to the new connector as follows:
    a. Disassemble the old connector and note the wire colors and the number of the contact to which each wire is connected.

CAUTION

Installation of wires into the wrong contacts will result in malfunctions of damage to equipment. Be sure the wires are installed into the correct contacts.

    b. Insert a stripped cable wire into its respective contact on the new connector barrel and solder the wire in place. Repeat this step for each of the wires in the cable.
    c. Brush the soldered connections with a small brush.
    d. Spray the connection with a degreaser.
    e. Blow the connections dry with air.
    f. Using a multimeter or comparable device, check across each of the terminals to ensure that there is no current flow between contacts.
    g. Slide the shrink tubes over each of the soldered connections.
    h. Using a heat gun, shrink the shrink tubes onto the connections.
6. Assemble the new connector as follows:
    a. Slip the coupling nut over the threads of the connector barrel.
    b. Slip the dust cap ring over the threads of the connector barrel.
    c. Apply antiseizing tape to the threads of the connector barrel and thread the connector into the front adapter.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0073 00**
DIRECT SUPPORT MAINTENANCE PROCEDURES
GENERAL DIRECT SUPPORT MAINTENANCE PROCEDURES

NOTE

(For an elbow backshell) When threading the backshell onto the front adapter, hold the connector so that the connector barrel key is positioned at the top of the backshell. The bottom of the backshell is the threaded end of the backshell. The top of the backshell is opposite the bottom. Make sure the barrel key stays at the top until the backshell is threaded completely onto the front adapter.

d. Apply antiseizing tape to the threads of the front adapter and thread the backshell onto the front adapter.
e. Slide the inner ground ring into the threaded end of the backshell.
f. Slide the shield braid over the tapered end of the inner ground ring until it reaches all the way up to the wide end of the taper.
g. Slide the outer ground ring over the inner ground ring.
h. Apply antiseizing tape to the threads of the backshell.
i. Slide the back adapter over both ground rings and thread the adapter onto the backshell.

NOTE

When sliding the grommet into the back adapter, make sure that the cable sheathing passes through the grommet. If it does not, and the exposed shield braid braid extends back into the grommet, the connection must be taken apart and remade.

j. Slide the grommet into the threaded end of the back adapter.
k. Slide the follower onto the rear of the grommet.
l. Apply antiseizing tape to the threads of the back adapter and thread the strain relief onto the adapter.
m. Tighten the screws on the saddles of the strain relief securely onto the cable.

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION REFERENCES

0074 00

SCOPE

This work package lists field manuals, forms, technical manuals, and miscellaneous publications that are referenced in this manual or are otherwise applicable to the operation and maintenance of the Tactical Water Purification System (TWPS).

FIELD MANUALS

Chemical and Biological Contamination Avoidance ..... FM 3-3
Nuclear Contamination Avoidance ..... FM 3-3-1
NBC Protection ..... FM 3-4
NBC Decontamination ..... FM 3-5
General Fabric Repair ..... FM 10-16
Water Supply in Theaters of Operations ..... FM 10-52
Water Supply Point Equipment and Operations ..... FM 10-52-1
First Aid for Soldiers ..... FM 21-11
Basic Cold Weather Manual ..... FM 31-70

FORMS

Equipment Inspection and Maintenance Worksheet ..... DA 2404
Equipment Control Record ..... DA 2408-9
Hand Receipt/Annex Number ..... DA 2062
Recommended Changes to Publications and Blank Forms ..... DA 2028
Transportation Discrepancy Report ..... SF 361
Product Quality Deficiency Report ..... SF 368

TECHNICAL MANUALS

Procedures for the Destruction of Army Equipment to Prevent Enemy Use (Mobility Equipment Command) ..... TM 750-244-3
Administrative Storage of Equipment ..... TM 740-90-1
Preservation, Packaging, and Packing of Military Supplies and Equipment ..... TM 38-230-2
Painting Instructions for Army Materiel ..... TM 43-0139
Welding Theory and Application ..... TM 9-237
Operator's Manual for Generator Set, Skid Mounted, Tactical Quiet, 60 kW, 50/60 Hz ... TM 9-6115-645-10
Unit, Direct Support, and General Support Maintenance Manual for Generator Set, Skid Mounted, Tactical Quiet, 60 KW, 50/60 Hz ..... TM 9-6115-645-24
Unit, Direct Support and General Support Maintenance Repair Parts and Special Tools List for Generator, Skid Mounted, Tactical Quiet, 60 KW, 50/60 Hz ..... TM 9-6115-645-24P
Operator and Unit Maintenance Manual (Including Repair Parts & Special Tools List) for Water Quality Analysis Set: Purification (WQAS-P) ..... TM 10-6630-222-12&P
Operator's and Unit Maintenance Manual (Including Repair Parts & Special Tools List) for Tank, Fabric, Collapsible, Water Storage, 3,000 Gallons ..... TM 10-5430-237-12&P
Repair Parts and Special Tools List for Tactical Water Purification System ..... TM 10-4610-309-24P

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0074 00**
SUPPORTING INFORMATION
REFERENCES

MISCELLANEOUS

Lubrication Order for Generator, Skid Mounted, Tactical Quiet, 60 KW, 50/60 Hz .....LO 9-6115-645-12
The Army Maintenance Management System (TAMMS) .....DA PAM 738-750
Sanitary Control and Surveillance of Field Water Supplies ..... TB MED 577
Expendable/Durable Items (Except Medical, Class V Repair Parts, and Heraldic Items).....CTA 50-970

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION MAINTENANCE ALLOCATION CHART (MAC)

0075 00

INTRODUCTION

This Work Package provides the Maintenance Allocation Chart (MAC) for the TWPS, excluding the Government-furnished equipment (GFE). Refer to TM 9-6115-645-24 (Marine Corps TM 09244A/09245A-24/2) for the MAC and other maintenance information for the Tactical Quiet Generator (TQG). Refer to TM 10-6630-222-12&P for the MAC and other maintenance information for the Water Quality Analysis Set: Purification (WQAS-P) (Army only).

The Army Maintenance System MAC

This introduction provides a general explanation of all maintenance and repair functions authorized at various maintenance levels under the standard Army Maintenance System concept.

The MAC (immediately following this introduction) designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component shall be consistent with the capacities and capabilities of the designated maintenance levels, which are shown on the MAC in column (4) as:

Field – includes two columns, Unit maintenance and Direct Support maintenance. The Unit maintenance column is divided again into two more subcolumns, C for Operator or Crew and O for Unit maintenance.

Sustainment – includes two subcolumns, general support (H) and depot (D)

The tools and test equipment requirements (immediately following the MAC) list the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from the MAC.

The remarks (immediately following the tools and test equipment requirements) contain supplemental instructions and explanatory notes for a particular maintenance function.

Maintenance Functions

Maintenance functions are limited to and defined as follows:

1. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel). This includes scheduled inspection and gagings and evaluation of cannon tubes.

2. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards on a scheduled basis (e.g., load testing of lift devices and hydrostatic testing of pressure hoses).

3. Service. Operations required periodically to keep an item in proper operating condition; e.g., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases. This includes scheduled exercising and purging of recoil mechanisms.

4. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper position, or by setting the operating characteristics to specified parameters.

5. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

6. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments of test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

7. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

8. Replace. To remove an unserviceable item and install a serviceable counterpart in its place. "Replace" is authorized by the MAC and assigned maintenance level is shown as the third position code of the Source, Maintenance and Recoverability (SMR) code.

9. Repair. The application of maintenance services, including fault location and troubleshooting, removal and installation, disassembly and assembly procedures, and maintenance actions to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

NOTE

The following definitions are applicable to the "repair" maintenance function:

Services – Inspect, test, service, adjust, align, calibrate, and/or replace.

Fault location/troubleshooting – The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or Unit Under Test (UUT).

Disassembly/assembly – The step-by-step breakdown (taking apart) of a spare/functional group coded item to the level of its least component, that is assigned an SMR code for the level of maintenance under consideration (i.e., identified as maintenance significant).

Actions – Welding, grinding, riveting, straightening, facing, machining, and/or resurfacing.

10. Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

11. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (e.g., hours/miles) considered in classifying Army equipment/components.

Explanation of Columns in the MAC

Column (1) – Group Number. Column (1) lists Functional Group Code (FGC) numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the Next Higher Assembly (NHA).

Column (2) – Component/Assembly. Column (2) contains the item names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

Column (3) – Maintenance Function. Column (3) lists the functions to be performed on the item listed in column (2). (For a detailed explanation of these functions refer to “Maintenance Functions” outlined above).

Column (4) – Maintenance Level. Column (4) specifies each level of maintenance authorized to perform each function listed in column (3), by indicating work time required (expressed as man hours in whole hours or decimals) in the appropriate subcolumn. This work figure represents the active time required to perform that maintenance function at the indicated level of maintenance. If the number or complexity of the tasks within the listed maintenance function varies at different maintenance levels, appropriate work time figures are to be shown for each level. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the MAC. The symbol designations for the various maintenance levels are as follows:

Field:

C Operator or Crew maintenance

O Unit maintenance

F Direct Support maintenance

Sustainment:

L Specialized Repair Activity

H General Support maintenance

D Depot maintenance

NOTE

The “L” maintenance level is not included in column (4) of the MAC. Functions to this level of maintenance are identified by a work time figure in the “H” column of column (4), and an associated reference code is used in the REMARKS column (6). This code is keyed to the remarks and the SRA complete repair application is explained there.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0075 00**
SUPPORTING INFORMATION
MAINTENANCE ALLOCATION CHART (MAC)

Column (5) – Tools and Equipment Reference Code. Column (5) specifies, by code, those common tool sets (not individual tools), common Test, Measurement and Diagnostic Equipment (TMDE), and special tools, special TMDE and special support equipment required to perform the designated function. Codes are keyed to the entries in the tools and test equipment table.

Column (6) – Remarks Code. When applicable, this column contains a letter code, in alphabetical order, which is keyed to the remarks table entries.

Explanation of Columns in the Tools and Test Equipment Requirements

Column (1) – Tool or Test Equipment Reference Code. The tool or test equipment reference code correlates with a code used in column (5) of the MAC.

Column (2) – Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.

Column (3) – Nomenclature. Name or identification of the tool or test equipment.

Column (4) – National Stock Number (NSN). The NSN of the tool or test equipment.

Column (5) – Tool Number. The manufacturer's part number, model number, or type number.

Explanation of Columns in the Remarks

Column (1) – Remarks Code. The code recorded in column (6) of the MAC.

Column (2) – Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION MAINTENANCE ALLOCATION CHART (MAC)

0075 00

Table 1. MAC for TWPS.

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REFERENCE CODE	(6) REMARKS CODE
			Field			Sustainment			
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
00	TWPS								
01	RAW WATER SUBSYSTEM	Inspect	0.5						A
0101	Anchor Assembly	Inspect	0.1						
		Repair		0.3				2, 3	B
0102	Floating Inlet Strainer S1	Inspect	0.1						
		Repair		0.1				1	C
0103	Hose Assemblies and Adaptors	Inspect	0.3						
		Repair	0.1	0.3				1, 2, 3	C, Q
0104	Diesel-driven Pump Assembly P1	Inspect	0.1	0.2					
		Repair		1.0				2, 3	B, G
010401	Diesel Engine	Inspect	0.1	0.2					
		Service	0.1	0.5				1, 2, 3	D,N
		Repair		0.5				2, 3	B, G
		Replace		1.0				2, 3	
010402	Pump	Inspect	0.1	0.1					
		Repair		1.0				2, 3	E
		Replace		0.5				2, 3	
010403	Skid Frame	Inspect	0.1	0.1					
		Repair			1.0			4	F
		Replace		1.0				2, 3	
010404	Junction Box	Inspect	0.1	0.1					
		Repair		0.5				2, 3	B, G
		Replace		0.5				2, 3	
0105	Motor-driven Pump Assembly P-2	Inspect	0.1	0.2					
		Repair		0.5				2, 3	B, G
010501	Pump	Inspect	0.1	0.1					
		Repair		1.0				2, 3	E
		Replace		0.5				2, 3	
010502	Electric Motor	Inspect	0.1	0.1					
		Replace		1.0				2, 3	
010503	Motor Pigtail	Inspect	0.1	0.1					
		Replace		0.5				2, 3	
010504	Skid Frame	Inspect	0.1	0.1					
		Repair			1.0			4	
		Replace		1.0				2, 3	
010505	Junction Box	Inspect	0.1						
		Repair		0.5				2, 3	B, G
		Replace		0.5					
02	PRODUCT WATER DISTRIBUTION SUBSYSTEM	Inspect	0.3						A
0201	Storage Tanks T-3 and T-4	Inspect	0.1	0.5					
		Repair		0.5					H

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0075 00
SUPPORTING INFORMATION
MAINTENANCE ALLOCATION CHART (MAC)

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REFERENCE CODE	(6) REMARKS CODE
			Field			Sustainment			
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
0202	Hose Assemblies and Adaptors	Inspect Repair	0.3 0.1					 1	 C
0203	Motor-driven Pump Assembly P7	Inspect Repair	0.1	0.2 1.0				 2, 3	 B, G
020301	Pump	Inspect Repair Replace	0.1	0.1 1.0 0.5				 2, 3 2, 3	 E
020302	Electric Motor	Inspect Replace	0.1	0.1 1.0				 2, 3	
020303	Motor Pigtail	Inspect Replace	0.1	0.1 0.5				 2, 3	
020304	Skid Frame	Inspect Repair Replace	0.1	0.1 1.0	 1.0			 4 2, 3	 F
020305	Junction Box	Inspect Repair Replace	0.1	0.1 0.5 0.5				 2, 3	 G
03	MICRO-FILTRATION SUBSYSTEM	Inspect	0.6						A
0301	Feed Tank T1	Inspect Repair	0.1	0.2 0.5					 H
0302	Feed Pump Assembly P3	Inspect Repair	0.1	0.1 1.0				 2, 3	 B, G
030201	Pump	Inspect Repair Replace	0.1	0.1 1.0 0.5				 2, 3 2, 3	 E
030202	Electric Motor	Inspect Replace	0.1	0.1 1.0				 2, 3	
030203	Motor Pigtail	Inspect Replace	0.1	0.1 0.5				 2, 3	
030204	Skid Frame	Inspect Repair Replace	0.1	0.1 1.0	 1.0			 4	 F
030205	Junction Box	Inspect Repair Replace	0.1	0.1 0.5 0.5				 2, 3	 B, G
0303	Micro-filtration Modules	Inspect Repair Replace	0.1 0.5	 0.5	 2.0			 6	 R
0304	Piping, Valves, and Instrumentation	Inspect Repair Replace	0.1	0.5 1.0 1.0				 2, 3 2, 3	 B, G
0305	Hose Assemblies and Adaptors	Inspect Repair	0.2 0.1					 1	A C

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0075 00
SUPPORTING INFORMATION
MAINTENANCE ALLOCATION CHART (MAC)

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REFERENCE CODE	(6) REMARKS CODE
			Field			Sustainment			
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
04	REVERSE OSMOSIS SUBSYSTEM	Inspect	0.5						A
0401	Feed Tank Assembly	Inspect	0.1	0.2					
		Repair		0.5				2, 3	B, G
		Replace			4.0			2, 3	
0402	Feed Pump Assembly P4	Inspect	0.1	0.2					
		Repair		1.0					B, G
		Replace		1.0					
040201	Pump	Inspect	0.1	0.1					
		Repair		1.0				2, 3	E
		Replace		1.0				2, 3	
040202	Electric Motor	Inspect	0.1	0.1					
		Replace		0.5				2, 3	
0403	High Pressure Pump Assembly P5, P6	Inspect	0.1	0.2					
		Repair		1.0				11, 12	
		Replace		1.0				11, 12	
040301	Pump	Inspect	0.1	0.1					
		Service		2.0				2, 3	I
		Repair		2.0				2, 3	E
		Replace		1.0				2, 3	
040302	Electric Motor	Inspect	0.1	0.1					
		Replace		1.0				2, 3	
0404	Turbocharger Assembly PRT1	Inspect	0.1	0.1					
		Repair		1.0				2, 3	
		Replace		1.0				2, 3	
0405	RO Vessels ROV-1 through ROV-5	Inspect	0.2						
		Repair	1.0	1.0				1, 5	J
		Replace	1.0		2.0			1	
0406	Piping, Valves, and Instrumentation	Inspect	0.1	0.3					
		Replace		1.0				2, 3	B, G
05	CHEMICAL INJECTION SUBSYSTEM	Inspect	0.2						A
0501	Injection Pump CP1, CP2, CP3	Inspect	0.1	0.1					
		Repair		1.0				2, 3	B, G
		Replace		0.5				2, 3	
0502	Tubing Assemblies	Inspect	0.1						
		Repair	0.1					1	C
		Repair		0.5				2, 3	B, G
		Replace		0.5				2, 3	

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0075 00
SUPPORTING INFORMATION
MAINTENANCE ALLOCATION CHART (MAC)

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REFERENCE CODE	(6) REMARKS CODE
			Field			Sustainment			
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
06	AIR SUBSYSTEM	Inspect	0.3						A
		Adjust	0.1					1	O
		Service	0.5					1	L
0601	Air Compressor AC1	Inspect	0.1	0.1					
		Adjust	0.3					1	P, K
		Service		0.5				2, 3	K
		Repair		1.0				2, 3, 6	B, G
		Replace		1.0				2, 3	
0602	Air Compressor Drive Motor	Inspect	0.1	0.1					
		Replace		0.5				2, 3	
0603	Valves and Instrumentation	Inspect	0.1	0.3					
		Replace		0.5				2, 3	
0604	Tubing and Hoses	Inspect	0.1	0.5					
		Replace		0.3				2, 3	
07	ELECTRICAL SUBSYSTEM	Inspect	0.2						A
0701	Operator Control Panel	Inspect	0.1	0.2					
		Repair		0.5				2, 3, 10	B, G
0702	Power Distribution Panel	Inspect	0.1	0.2					
		Repair		0.5				2, 3, 10	B, G
0703	Power Cables	Inspect	0.1	0.2					
		Repair		0.5				2, 3, 10	G
08	SKID	Inspect	0.5						A
		Inspect		0.5					
		Repair			3.0			4	F
09	NBC SUBSYSTEM	Inspect	0.2						A
0901	NBC Tank	Inspect	0.1						
		Replace		0.2					B
0902	Injection Assembly	Inspect	0.1						
		Replace	0.1						
10	NBC SURVIVABILITY	Inspect	0.2						
1001	Contamination Avoidance Cover	Inspect	0.2						
		Replace							
1002	Rope, NBC Cover	Inspect	0.1						
		Replace							

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0075 00
SUPPORTING INFORMATION
MAINTENANCE ALLOCATION CHART (MAC)

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REFERENCE CODE	(6) REMARKS CODE
			Field			Sustainment			
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
11	COLD WEATHER SUBSYSTEM	Inspect	0.5						A
1101	Space Heater	Inspect Service Repair	0.1	0.2 0.5 1.0				2, 3, 9	B, G, S
1102	Ice Hole Strainer S2	Inspect Repair	0.1 0.1					1	
1103	Pump Covers	Inspect Repair	0.1		1.0			7	M
1104	Hose Heating Blankets	Inspect Repair	0.1		1.0			7	M
1105	Winter Cover (Marine Corps only)	Inspect Repair	1.0		1.0			7	M
1106	Fabric Wall (Marine Corps only)	Inspect Repair	0.1		1.0			7	M
1107	Transformer Assembly	Inspect Repair	0.1	0.1 0.3				2, 3	
12	CLEANING WASTE STORAGE SUBSYSTEM	Inspect	0.1						A
1201	Wastewater Tanks	Inspect Repair	0.1	0.1 0.5					H
1202	Assembly, Adaptor A16	Inspect Repair	0.1 0.1					1	C
13	OCEAN INTAKE STRUCTURE SYSTEM (OISS)	Inspect Inspect Repair	0.2 0.1	0.3 0.5				2, 3	A B, C
14	EXTENDED DISTRIBUTION SYSTEM	Inspect	0.3						
1401	Storage Tanks T-5 through T-7	Inspect Repair	0.1	0.5 0.5					H
1402	Hose Assemblies and Adaptors	Inspect Repair	0.3 0.1					1	C
1403	Diesel-driven Pump Assembly P8	Inspect Repair	0.1	0.2 1.0				2, 3	B, G
140301	Diesel Engine	Inspect Service Repair Replace	0.1	0.2 0.5 1.0 1.0				1, 2, 3 2, 3 2, 3	D, N B, G

TACTICAL WATER PURIFICATION SYSTEM (TWPS) 0075 00
SUPPORTING INFORMATION
MAINTENANCE ALLOCATION CHART (MAC)

(1) GROUP NO.	(2) COMPONENT/ ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE LEVEL					(5) TOOLS AND EQUIPMENT REFERENCE CODE	(6) REMARKS CODE
			Field			Sustainment			
			UNIT		DS	GS	DEPOT		
			C	O	F	H	D		
140302	Pump	Inspect Repair Replace	0.1	0.1 1.0 0.5				 2, 3 2, 3	 E
140303	Skid Frame	Inspect Repair Replace	0.1	0.1 1.0	 1.0			 4	 F
140304	Junction Box	Inspect Replace	0.1	0.1 0.5				 2, 3	 B, G
15	FLAT RACK ASSEMBLY	Inspect	0.3						
1501	Frame Assembly and Panels	Inspect Repair	0.1	0.2 0.3				 2, 3	
1502	Support Stand Assembly	Inspect Repair	0.1	0.1 0.3				 2, 3	
1503	Fabric Wall	Inspect Repair	0.1	0.2 0.3					
16	WASTE DISCHARGE SYSTEM	Inspect	0.3						
1601	Hose Assemblies and Adaptors	Inspect Repair	0.3 0.1						 C

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION MAINTENANCE ALLOCATION CHART (MAC)

0075 00

Table 2. Tools and Test Equipment for TWPS.

TOOL OR TEST EQUIPMENT REFERENCE CODE	MAINTENANCE LEVEL	NOMENCLATURE	NATIONAL STOCK NUMBER	TOOL NUMBER
1	C	Tool Kit, TWPS Operator's (BII)		33901161
2	O	Tool Kit, General Mechanic's, Automotive (Army)	5180-01-454-3787	SC 5180-95-B47
3	O	Tool Set, Common No. 1 (Marine Corps)	4910-01-238-8115	0213SL86
4	F	Shop Equipment, Welding	4940-01-090-1231	SC 3431-95-CL-A04
5	C	Pusher, RO Element (BII)		33901029
6	O	Gauge, Pressure, 0-1000 psig		45-1082AS-02L-1000
7	F	Sewing Machine, Industrial	3530-00-892-4631	251-12
8	C	C-Spanner (BII)		33902284
9	O	Gauge, Pressure, 0-10 psig		
10	O	Multimeter, Digital		IDEAL61420
11	O	Tool, High Pressure Pump Cylinder Liner Removal		P502704
12	O	Tool, High Pressure Pump Bearing Removal / Installation		P502677

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0075 00**
SUPPORTING INFORMATION
MAINTENANCE ALLOCATION CHART (MAC)

Table 3. Remarks for TWPS.

REMARKS CODE	REMARKS
A	Crew/Operator Preventive Maintenance Checks and Services (PMCS)
B	Unit level maintenance repairs by component replacement
C	Crew/Operator replaces gaskets
D	Unit maintenance changes oil, oil filter, fuel filter, adjusts valve clearance
E	Unit maintenance replaces pump internal parts (impeller, wear plate, seals)
F	Direct Support maintenance weld and metal repairs.
G	Unit level maintenance performs minor mechanical and electrical repairs
H	Refer to TM 10-5430-237-12&P for repair procedures
I	Unit maintenance performs 1000-hr and 2000-hr pump overhauls
J	Crew/Operator replaces O-rings, RO elements
K	Unit maintenance changes oil, oil filter, adjusts belt tension, replaces belt
L	Crew/Operator replaces purification cartridge
M	Direct Support maintenance fabric repairs
N	Crew/Operator replaces air filter
O	Crew/Operator adjusts pressure switch assembly PSL/PSH-901 and pressure control valves PRV-901 and PRV-902
P	Crew/Operator replaces air filter
Q	Unit level maintenance replaces locking arm assembly on 3 x 10 raw water hoses
R	Crew/Operator replaces MF filter element
S	Unit maintenance adjusts diesel heater air pump output pressure

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

0076 00

SCOPE

This work package lists COEI (Components of End Item) and BII (Basic Issue Items) for the TWPS (Tactical Water Purification System) to help you inventory items for safe and efficient operation of the equipment.

GENERAL

The COEI and BII information is divided into the following lists:

Components of End Item (COEI). This list is for information purposes only and is not authority to requisition replacements. These items are part of the TWPS. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Items of COEI are removed and separately packaged for transportation or shipment only when necessary. Illustrations are furnished to help you find and identify the items.

Basic Issue Items (BII). These essential items are required to place the TWPS in operation, operate it, and to do emergency repairs. Although shipped separately packaged, BII must be with the TWPS during operation and when it is transferred between property accounts. Listing these items is your authority to request/requisition them for replacement based on authorization of the end item by the TOE/MTOE. Illustrations are furnished to help you find and identify the items.

EXPLANATION OF COLUMNS IN THE COEI AND BII LIST

Column (1) - Illus Number. Gives the number of the item illustrated.

Column (2) - National Stock Number (NSN). Identifies the stock number of the item to be used for requisitioning purposes.

Column (3) - Description, CAGEC and Part Number. Identifies the Federal item name (in all capital letters) followed by a minimum description when needed. The stowage location of COEI and BII is also included in this column. The last line below the description is the CAGEC (commercial and Government entity code) (in parentheses) and the part number.

Column (4) – Usable On Code. When applicable, gives you a code if the item you need is not the same for different models of equipment.

Column (5) - Unit of measure (U/M). Indicates the physical measurement or count of the item as issued per the National Stock Number shown in column (2).

Column (6) - Qty Rqr. Indicates the quantity required.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

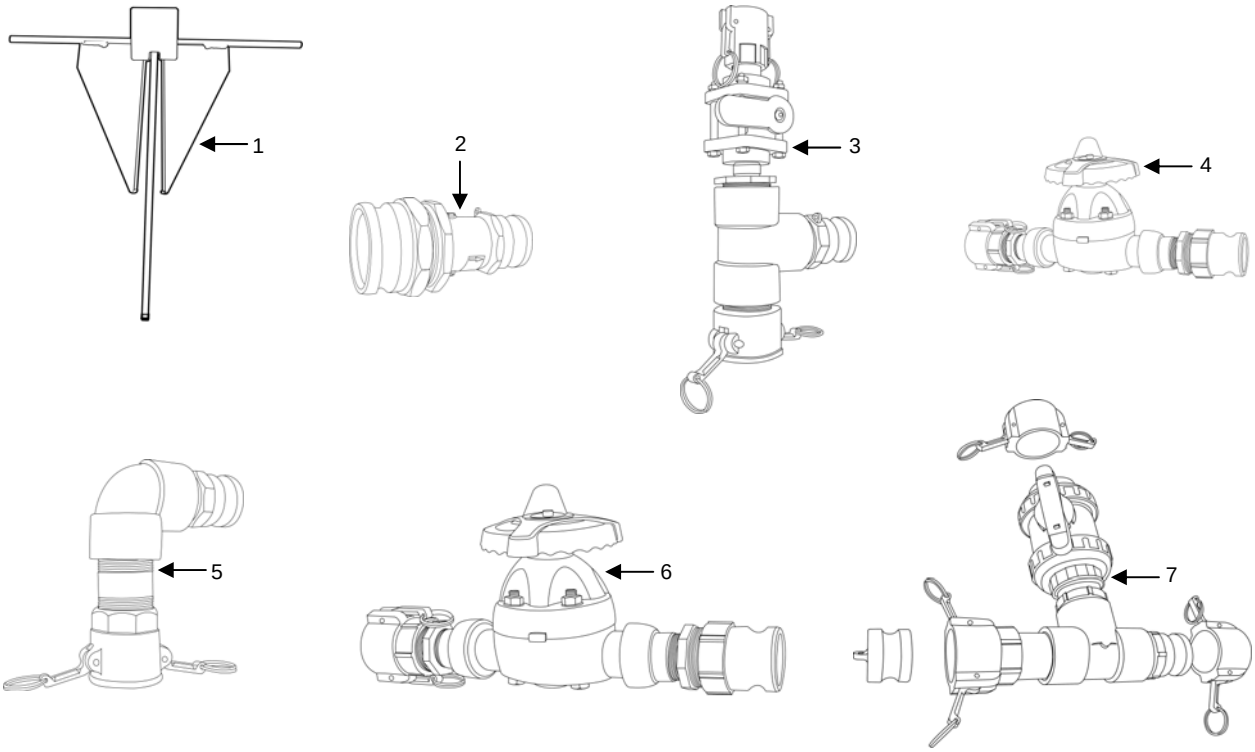

Table 1. Components of End Item List.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1	2040-01-527-5798	ANCHOR (1B1X2) 110091		EA	1
2	4730-01-526-0681	ASSEMBLY, ADAPTOR A01 (0U5N7) 33901085		EA	1
3	4730-01-526-0681	ASSEMBLY, ADAPTOR A02 (0U5N7) 33901086		EA	1
4	4820-01-526-0795	ASSEMBLY, ADAPTOR A03 (0U5N7) 33901089		EA	1
5	4730-01-526-0829	ASSEMBLY, ADAPTOR A04 (0U5N7) 33901087		EA	1
6	4820-01-526-1034	ASSEMBLY, ADAPTOR A05 (0U5N7) 33901088		EA	1
7	4730-01-526-3555	ASSEMBLY, ADAPTOR A07 (0U5N7) 33901093		EA	2

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

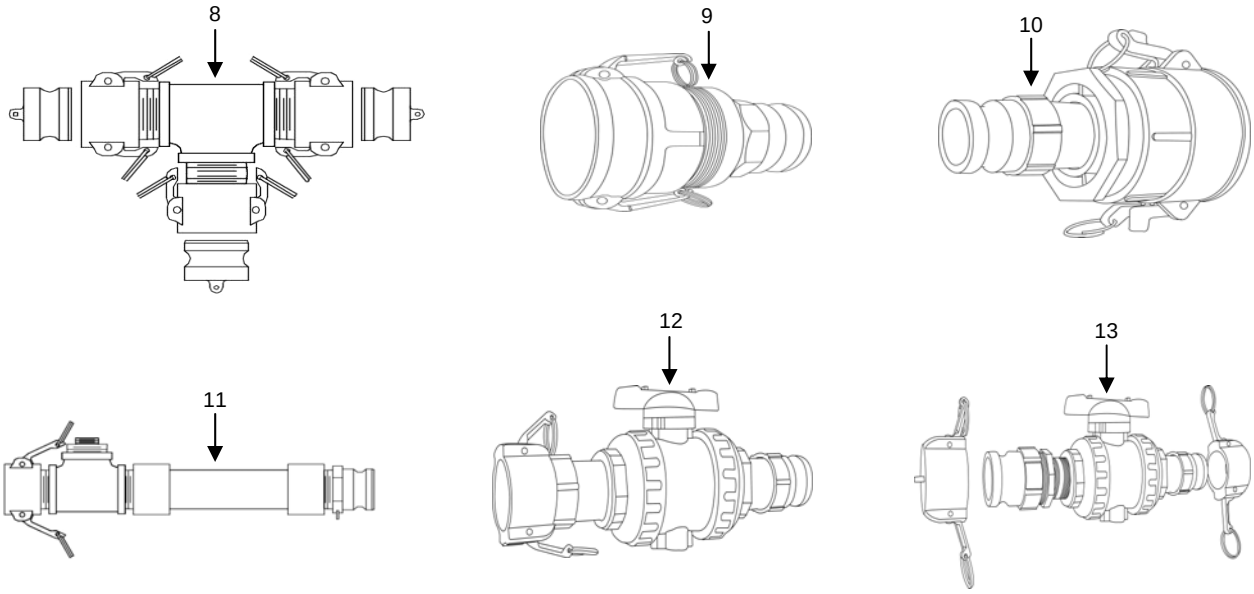

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
8	4820-01-526-3498	ASSEMBLY, ADAPTOR A08 (0U5N7) 33901094		EA	2
9	4730-01-526-2858	ASSEMBLY, ADAPTOR A09 (0U5N7) 33901100		EA	1
10	4730-01-526-2859	ASSEMBLY, ADAPTOR A10 (0U5N7) 33901101		EA	1
11	4820-01-526-3498	ASSEMBLY, ADAPTOR A11 (0U5N7) 33901113		EA	1
12	4820-01-526-2860	ASSEMBLY, ADAPTOR A12 (0U5N7) 33901102		EA	1
13	4730-01-526-3538	ASSEMBLY, ADAPTOR A15 (0U5N7) 33901171		EA	2

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

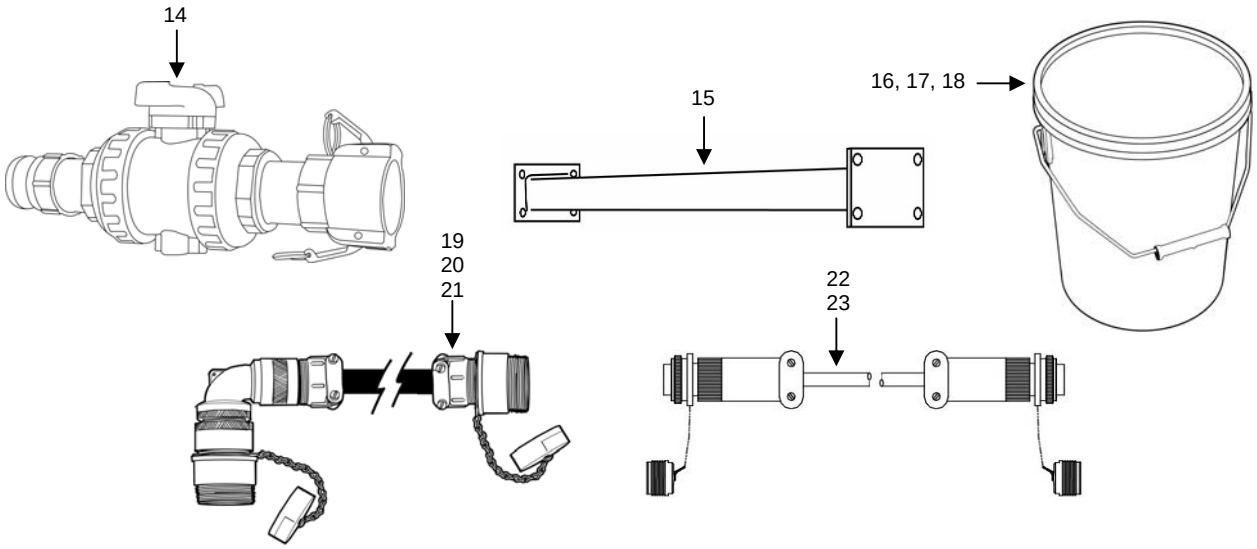

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
14	4820-01-526-0795	ASSEMBLY, ADAPTOR A16 (0U5N7) 33901187		EA	3
15	9520-01-527-6158	BEAM, Operator Station Entry Support (0U5N7) 33901194		EA	1
16	7240-01-094-4305	BUCKET, Chemical , Red (0U5N7) 33901259-3		EA	1
17	7240-01-094-4305	BUCKET, Chemical, Yellow (0U5N7) 33901259-2		EA	1
18	7240-01-094-4305	BUCKET, Chemical, Blue (0U5N7) 33901259-1		EA	1
19	6150-01-526-2420	CABLE, Distribution Pump, Electric, 75 ft. (0U5N7) 33903002		EA	1
20	6150-01-526-2412	CABLE, MF Feed Pump, Electric, 35 ft. (0U5N7) 33903001		EA	1
21	6150-01-526-1813	CABLE, Raw Water Pump, Electric, 135 ft. (0U5N7) 33903000		EA	1
22	6150-01-526-2479	CABLE, Diesel Distribution Pump Heat Blanket (0U5N7) 33903021		EA	1
23	6150-01-526-2419	CABLE, Raw Water Diesel Pump Heat Blanket (0U5N7) 33903003		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

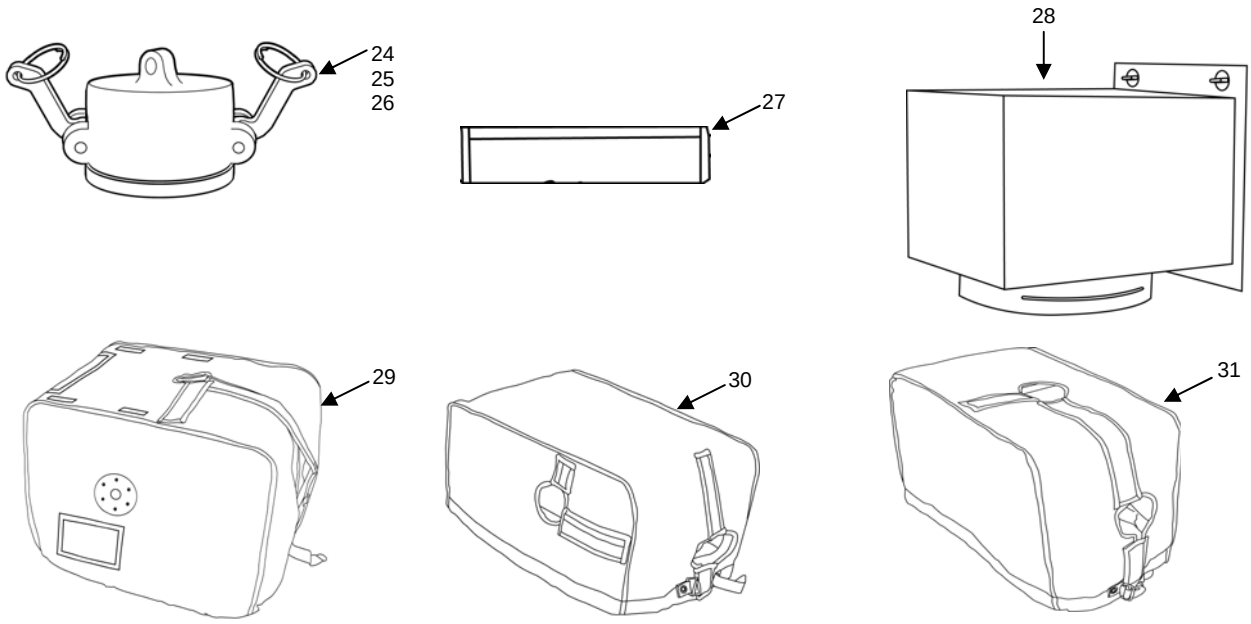

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
24	4730-00-200-0996	CAP, Hose, Protective (OISS) (27554) NX36		EA	1
25	5340-01-526-3531	CAP, Hose, 1.5 in. (33813) 15V-FDAPOLY		EA	6
26	5340-01-526-4624	CAP, Hose 2 in. (33813) 20V-FDAPOLY		EA	21
27		COLLAR, A-02 (0U5N7) 33905065		EA	1
28	2540-01-527-6253	CONNECTOR ASSY, Return Air (0U5N7) 33901600		EA	1
29	2540-01-527-6215	COVER, Diesel Pump (0U5N7) 33901133		EA	2
30	2540-01-527-6248	COVER, Micro Filtration Pump (0U5N7) 33901132		EA	1
31	2540-01-527-6250	COVER, Raw Water Pump P-2 and Distribution Pump -7 (0U5N7) 33901131		EA	2

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

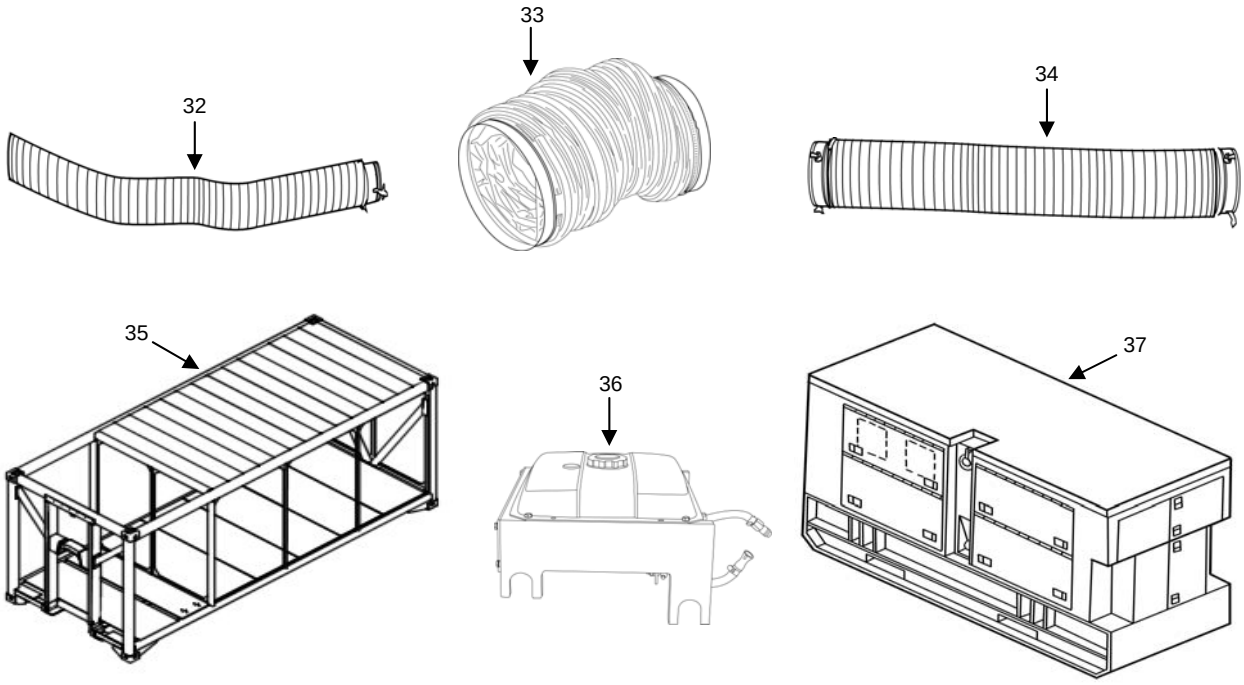

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
32	4720-01-527-6187	DUCT, Air, Flexible, 8 in. x 6 ft. (0U5N7) 33901218		EA	2
33	4720-20-001-8512	DUCT, Air, Flexible, 12 in. x 20 ft. (L1308) 632-88-1220SCJLRMW/07		EA	2
34	4720-01-527-6197	DUCT, Air, Flexible, 4 in. x 5.75 ft. (0U5N7) 33901217		EA	1
35	2510-01-527-6571	FRAME ASSEMBLY, FLATRACK (A-TWPS) (0U5N7) 33901501		EA	1
36	4930-01-527-6151	FUEL TANK ASSY, Diesel Pump (0U5N7) 33901122		EA	2
37	6115-01-462-0291	GENERATOR SET, Diesel Engine Driven (30554) MEP-806B		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

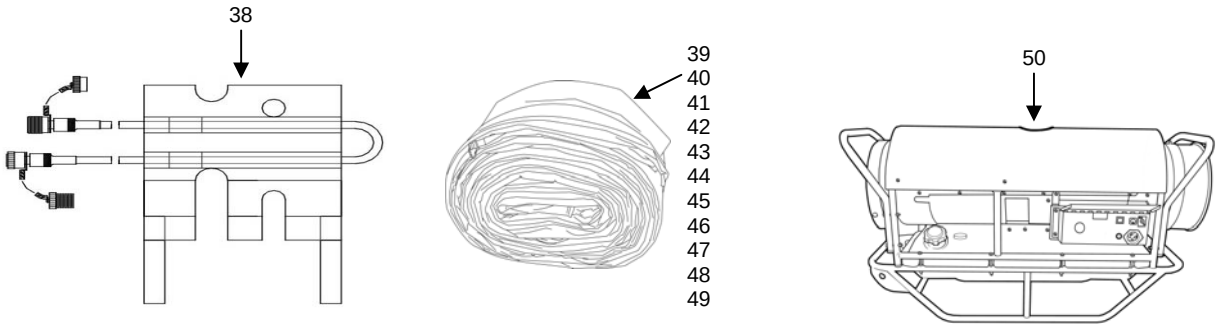

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
38	4540-01-526-3481	HEAT BLANKET ASSY, Adapter A-02 (0U5N7) 33901191		EA	1
39	4540-01-526-3346	HEAT BLANKET ASSY, Hose, 3 in. x 11 ft., F01-1 (0U5N7) 33901126-2		EA	1
40	4540-01-526-3345	HEAT BLANKET ASSY, Hose, 3 in. x 11 ft., F01-2 (0U5N7) 33901324		EA	1
41	4540-01-526-3347	HEAT BLANKET ASSY, Hose, 2 in. x 50.5 ft., F03-1 (0U5N7) 33901126-3		EA	1
42	4540-01-526-3348	HEAT BLANKET ASSY, Hose, 2 in. x 50.5 ft., F03-2 (0U5N7) 33901126-4		EA	3
43	4540-01-526-3355	HEAT BLANKET ASSY, Hose, 3 in. x 21 ft., F07 (0U5N7) 33901126-6		EA	1
44	4540-01-526-3354	HEAT BLANKET ASSY, Hose, 2 in. x 9 ft., F12 (0U5N7) 33901203		EA	1
45	4540-01-526-3472	HEAT BLANKET ASSY, Hose, 1.5 in. x 41.5 ft., P02 (0U5N7) 33901126-7		EA	1
46	4540-01-526-3474	HEAT BLANKET ASSY, Hose, 2 in. x 6 ft., P03-1 (0U5N7) 33901126-8		EA	2
47	4540-01-526-3475	HEAT BLANKET ASSY, Hose, 2 in. x 6 ft., P03-2 (0U5N7) 33901126-9		EA	1
48	4540-01-526-3476	HEAT BLANKET ASSY, Hose, 2 in. x 6 ft., P04 (0U5N7) 33901233		EA	2
49	4540-01-526-3477	HEAT BLANKET ASSY, Hose, 2 in. x 65 ft., P05 (0U5N7) 33901232		EA	4
50	4520-01-527-6260	HEATER, Portable (92878) MV60S-1		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

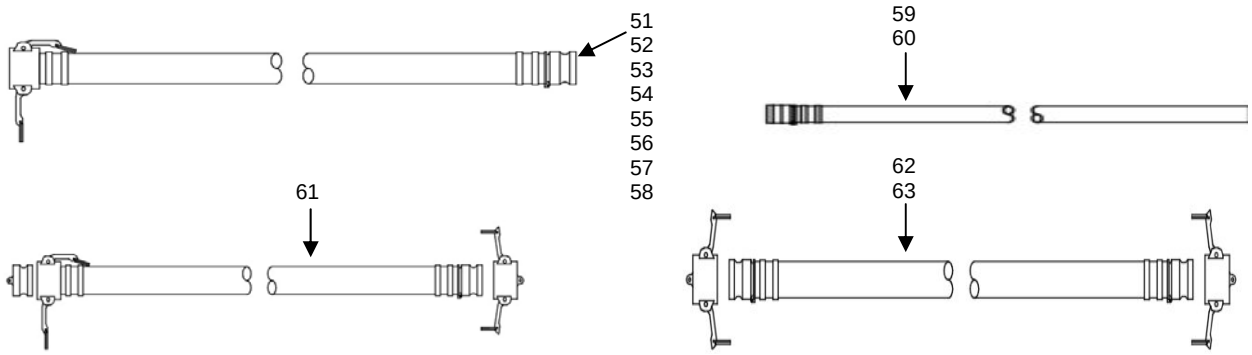

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
51	4720-01-526-0756	HOSE ASSY, F01, 3-in. x 10-ft. (0U5N7) 33901096-1		EA	13
52	4720-01-526-2865	HOSE ASSY, F02, 2-in. x 6-ft. (0U5N7) 33901096-2		EA	1
53	4720-01-526-0800	HOSE ASSY, F03, 2-in. x 50-ft. (0U5N7) 33901096-4		EA	4
54	4720-01-526-1036	HOSE ASSY, F04, 2-in. x 10-ft. (0U5N7) 33901096-3		EA	1
55	4720-01-526-2215	HOSE ASSY, F05, 3-in. x 3-ft. (0U5N7) 33901096-5		EA	1
56	4720-01-526-2218	HOSE ASSY, F07, 3-in x 10-ft. (0U5N7) 33901096-8		EA	2
57	4720-01-526-2837	HOSE ASSY, R04, 4-in. x 5-ft. (0U5N7) 33901096-6		EA	1
58	4720-01-526-2855	HOSE ASSY, R06, 2-in x 10-ft. (0U5N7) 33901096-7		EA	3
59	4720-01-526-1040	HOSE ASSY, F06, 1-in. x 3-ft. (0U5N7) 33901090-1		EA	2
60	4720-01-526-2846	HOSE ASSY, R05, 6-in. x 50-ft. (0U5N7) 33901090-2		EA	1
61	4720-01-526-3524	HOSE ASSY, P02, 1½-in. x 10-ft. (0U5N7) 33901097		EA	4
62	4720-01-526-3485	HOSE ASSY, P03, 2-in. x 5-ft. (0U5N7) 33901098-1		EA	3
63	4720-01-526-3479	HOSE ASSY, P05, 2-in. x 65-ft. (0U5N7) 33901098-2		EA	4

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

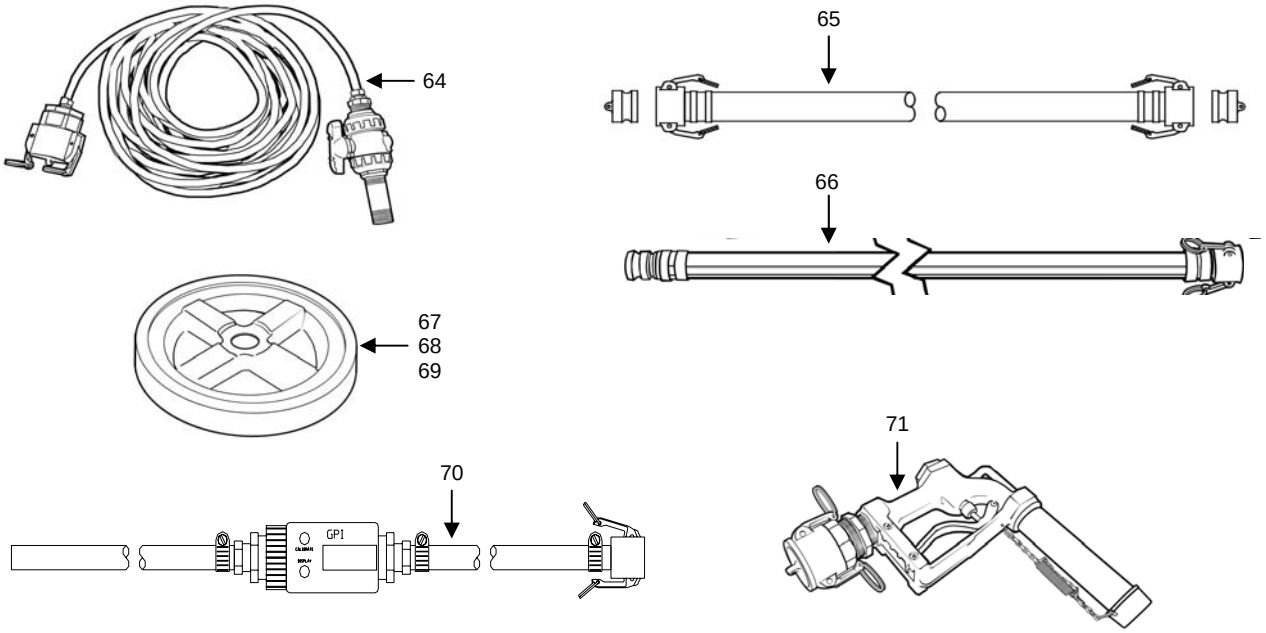

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
64	4720-01-526-3522	HOSE ASSY, P06, 5/8-in. x 50-ft. (0U5N7) 33901095		EA	1
65	4720-01-526-349	HOSE ASSY, P04, 2-in. x 5-ft. (0U5N7) 33901099		EA	2
66	4730-01-526-5657	HOSE ASSY, (OISS), 2-in. x 10-ft. (0EXU3) 861-08399		EA	6
67	7240-01-359-0894	LID, Tank, Chemical, Yellow (0U5N7) 33902558-1		EA	1
68	7240-01-359-0894	LID, Tank, Chemical, Blue (0U5N7) 33902558-2		EA	1
69	7240-01-359-0894	LID, Tank, Chemical, Red (0U5N7) 33902558-3		EA	1
70	6680-01-527-0326	METER ASSY, Flow (0U5N7) 33901082		EA	1
71	4730-01-526-3473	NOZZLE ASSY, Distribution (0U5N7) 33901103		EA	4

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

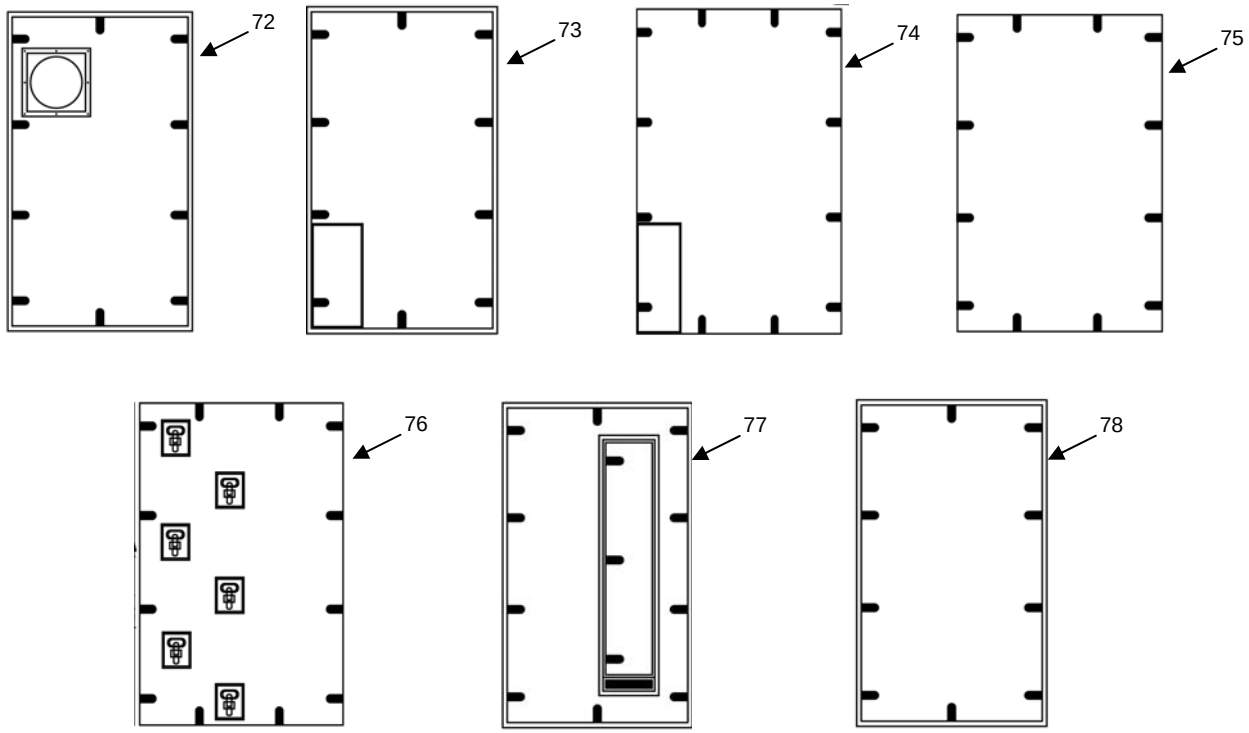

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
72	5340-01-527-6280	PANEL #1 ASSY (0U5N7) 33901586		EA	1
73	5340-01-527-6288	PANEL #2 ASSY (0U5N7) 33901553		EA	1
74	5340-01-527-6289	PANEL #3 ASSY, (0U5N7) 33901551		EA	1
75	5340-01-527-6290	PANEL #4 ASSY (0U5N7) 33901550		EA	1
76	5340-01-527-6292	PANEL #5 ASSY (0U5N7) 33901597		EA	1
77	5340-01-527-6293	PANEL #6 ASSY (0U5N7) 33901590		EA	1
78	5340-01-527-6294	PANEL #7 ASSY (0U5N7) 33901552		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

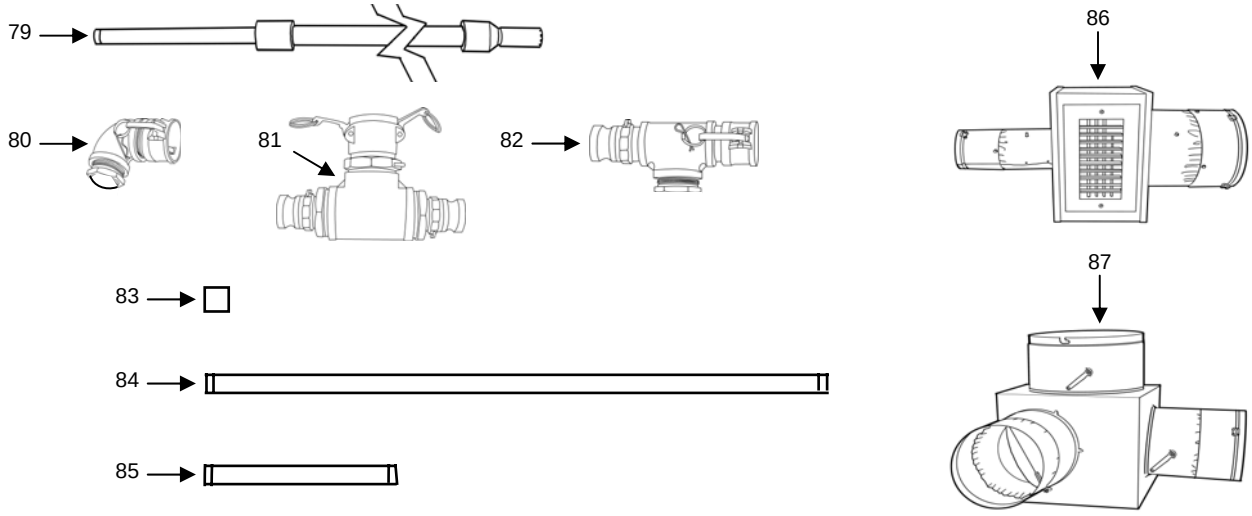

Table 1. Components of End Item List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
70	4710-01-526-3796	PIPE ASSY, CPVC (OISS) (0EXU3) 507-12400		EA	4
80	4730-01-526-3536	PIPE ASSY, ELBOW (OISS) (0EXU3) 507-12433		EA	2
81	4730-01-526-3534	PIPE ASSY, TEE, 3-INCH (OISS) (0EXU3) 507-12430		EA	1
82	4730-01-526-3530	PIPE ASSY, TEE, 2-INCH (OISS) (0EXU3) 507-12431		EA	2
83	4730-01-526-3540	PIPE COUPLING (OISS) (0EXU3) 858-07694-000		EA	4
84	4730-01-526-3571	PIPE NIPPLE, 60-INCH (OISS) (OEXU3) 857-08404-000		EA	8
85	4730-01-526-3568	PIPE NIPPLE, 24-INCH (OISS) (OEXU3) 857-08405-000		EA	4
86	4140-01-527-6186	PLENUM, Right Hot Air (0U5N7) 33901273		EA	1
87	4140-01-527-6184	PLENUM, Main Hot Air (0U5N7) 33901272		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

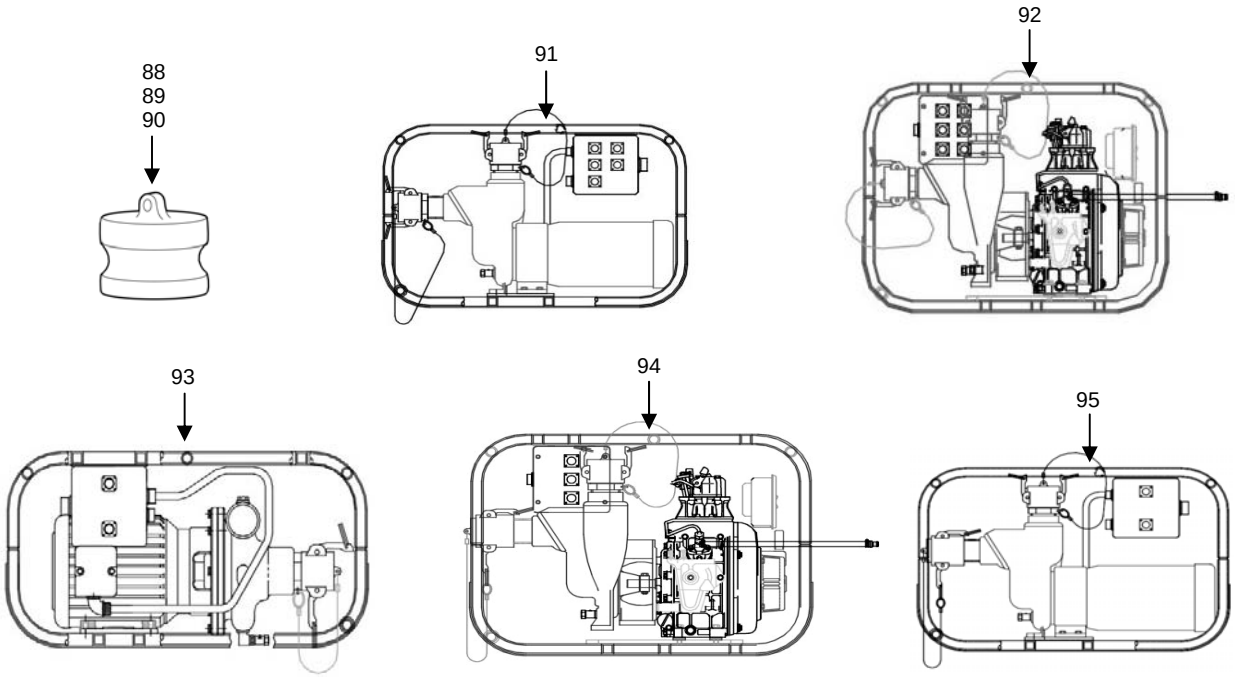

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
88	5340-01-526-0665	PLUG, Hose, 1.5 in. (33813) 15W-FDAPOLY		EA	2
89	5340-01-526-2794	PLUG, Hose, 3 in. (33813) 30W-FDAPOLY		EA	2
90	5340-01-526-3564	PLUG, Hose, 2 in. (33813) 20W-FDAPOLY		EA	16
91	4320-01-527-6155	PUMP ASSY, Distribution, Electric, P7 (0U5N7) 33901110		EA	1
92	4320-01-527-6262	PUMP ASSY, Distribution, Diesel, P8 (0U5N7) 33901153		EA	1
93	4320-01-527-6156	PUMP ASSY, Micro-Filtration, P3 (0U5N7) 33901108		EA	1
94	4320-01-527-5806	PUMP ASSY, Raw Water, Diesel, P1 (0U5N7) 33901104		EA	1
95	4320-01-527-6154	PUMP ASSY, Raw Water, Electric, P2 (0U5N7) 33901106		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

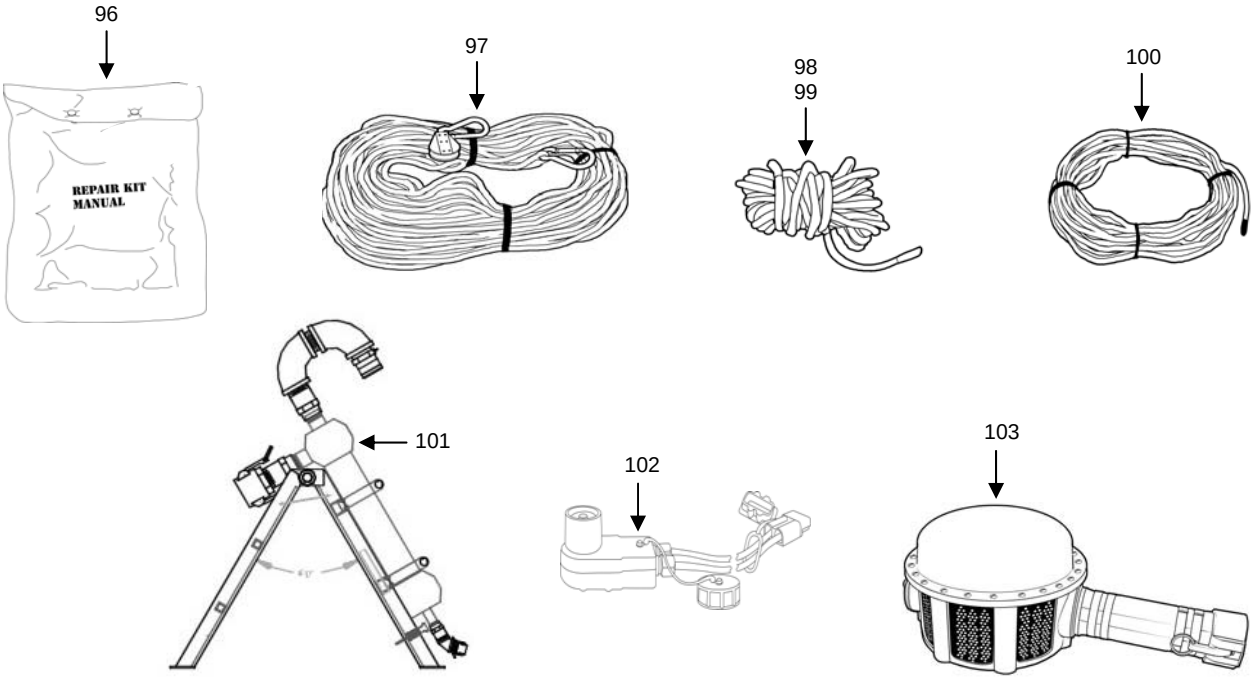

Table 1. Components of End Item List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
96	5430-01-359-1078	REPAIR KIT, COLLAPSIBLE TANK (58536) A-A-52022		EA	1
97	4020-01-526-0755	ROPE ASSY, Anchor (0U5N7) 33901146		EA	1
98	4020-01-526-4646	ROPE, Raw Water Hose (0U5N7) 33902478-4		EA	1
99	4020-01-526-2214	ROPE, MF Strainer (0U5N7) 33902478-1		EA	1
100	4020-01-527-3384	ROPE, Contamination Avoidance Cover, 60 ft. (0U5N7) 33902478-3		EA	3
101	4320-01-527-6152	SEPARATOR ASSY, Cyclone (0U5N7) 33901084		EA	1
102	6150-01-526-421	STARTING CABLE, Diesel Pump P-1, P-8 (0U5N7) 33903004		EA	1
103	4730-01-527-5802	STRAINER ASSY, Raw Water, S01 (0U5N7) 33901160		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

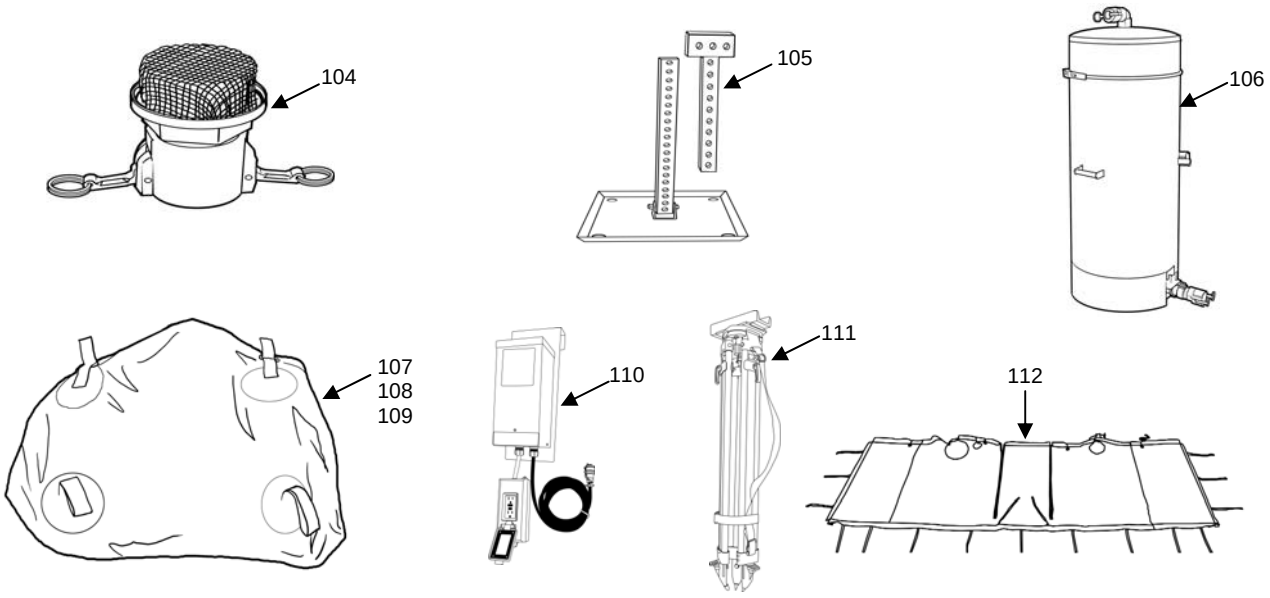

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
104	4730-01-527-6258	STRAINER, ICE (0U5N7) 33901172		EA	1
105	5340-01-527-6317	SUPPORT ASSY, Deck (0U5N7) 33901505		EA	4
106	4230-01-526-1138	TANK ASSY, NBC (0EXU3) 732-D-08057		EA	1
107	5430-01-526-2212	TANK, Fabric, 1000 Gallons, MF Feed (05YK6) RCF-1K-W-OT		EA	1
108	5430-01-470-7380	TANK, Fabric, 3000 Gallons, Distribution (05YK6) RCF-3K-W-OT		EA	5
109	5340-01-527-0341	TANK, Fabric, 1500 Gallons, Cleaning Waste (05YK6) RCF-1.5K-W-OT-Z-WW		EA	1
110	6120-01-526-3099	TRANSFORMER, General Purpose (0U5N7) 33903044		EA	1
111	6625-01-526-9713	TRIPOD ASSEMBLY (0U5N7) 33901322		EA	1
112	2540-01-527-6319	WALL, Fabric (0U5N7) 33905055		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

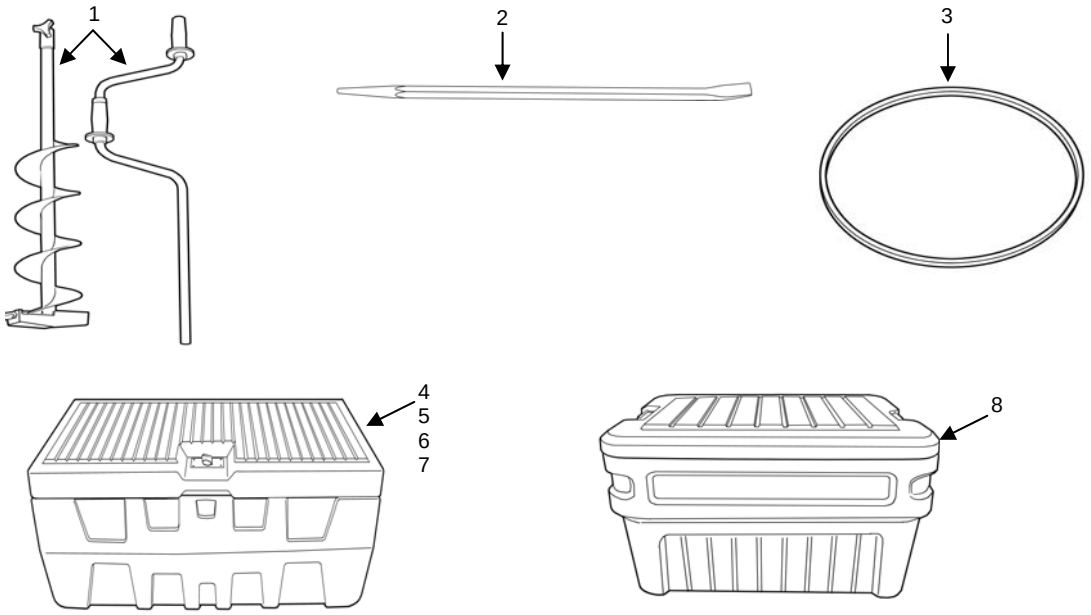

Table 2. Basic Issue Items List.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1	4230-01-526-1138	AUGER, Ice, with handle (61702) HD-06		EA	1
2	5120-01-335-1510	BAR, Pinch (55719) 2430B		EA	1
3	3030-00-445-4514	BELT, V, Air Compressor (04NP0) A76		EA	1
4	2540-01-527-0316	BOX, Storage, BII #1 (0U5N7) 33901230-1		EA	1
5	2540-01-527-0317	BOX, Storage, BII #2 (0U5N7) 33901230-2		EA	1
6	2540-01-527-0318	BOX, Storage, BII #3 (0U5N7) 33901230-3		EA	1
7	2540-01-527-0063	BOX, Storage, BII #8 (0U5N7) 33901230-4		EA	1
8	2540-01-527-0315	BOX, Storage, BII #4 (Chemicals) (0U5N7) 33902549		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

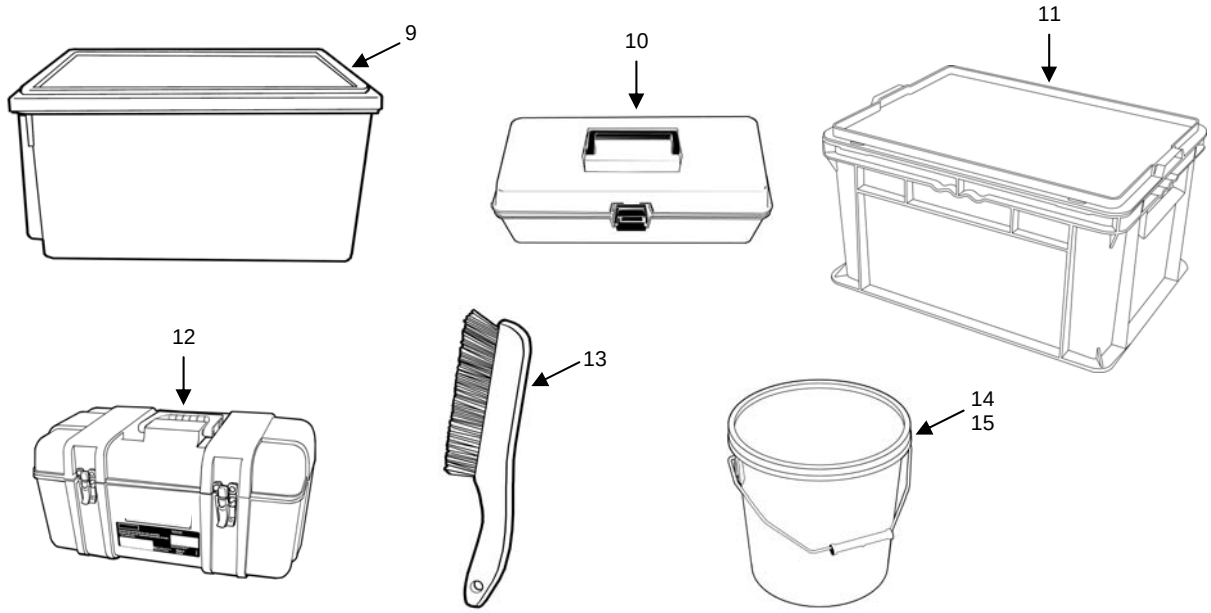

Table 2. Basic Issue Items List. – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
9	2540-01-527-0314	BOX, Storage, BII #5 (Caustic) (0U5N7) 33901238		EA	1
10	2540-01-527-0064	BOX, Storage, BII Spare Parts (1KWN3) 00071589		EA	1
11	3990-01-527-4727	Box, Storage, Manuals (0U5N7) 33901320-1		EA	1
12	2540-01-527-0072	BOX, Tool (53800) 9-65432		EA	1
13	7920-00-244-7431	BRUSH, Plater's (39428) 7187T8		EA	1
14	3990-01-527-4727	BUCKET, Storage, BII #6 (0U5N7) 33902531		EA	1
15	3990-01-517-4727	BUCKET, Storage, BII #7 (Lubricants, Chlorine) (0U5N7) 33902532		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

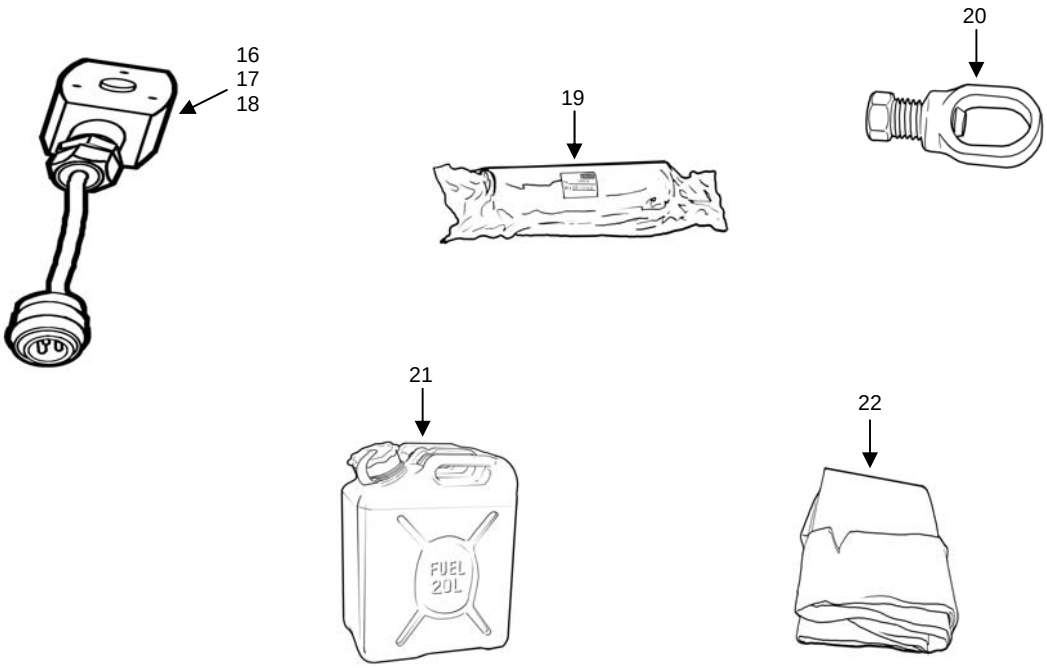

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
16	5945-01-527-0087	CABLE ASSY, Solenoid (XV-901) (0U5N7) 33903015-5		EA	1
17	5945-01-527-0088	CABLE ASSY, Solenoid (XV-902/903/910/911) (0U5N7) 33903015-6		EA	1
18	5945-01-527-0089	CABLE ASSY, Solenoid (XV-912) (0U5N7) 33903015-7		EA	1
19	4310-01-460-7980	CARTRIDGE, Purifier (57328) 058821A		EA	1
20	5940-01-158-4521	CLAMP, Ground Rod (56501) L70		EA	2
21	7240-01-337-5269	CONTAINER, Fuel, Diesel, 5 gallons (56161) 10502788		EA	1
22	4130-01-457-3399	COVER, Contamination Avoidance (90598) 65503-100		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

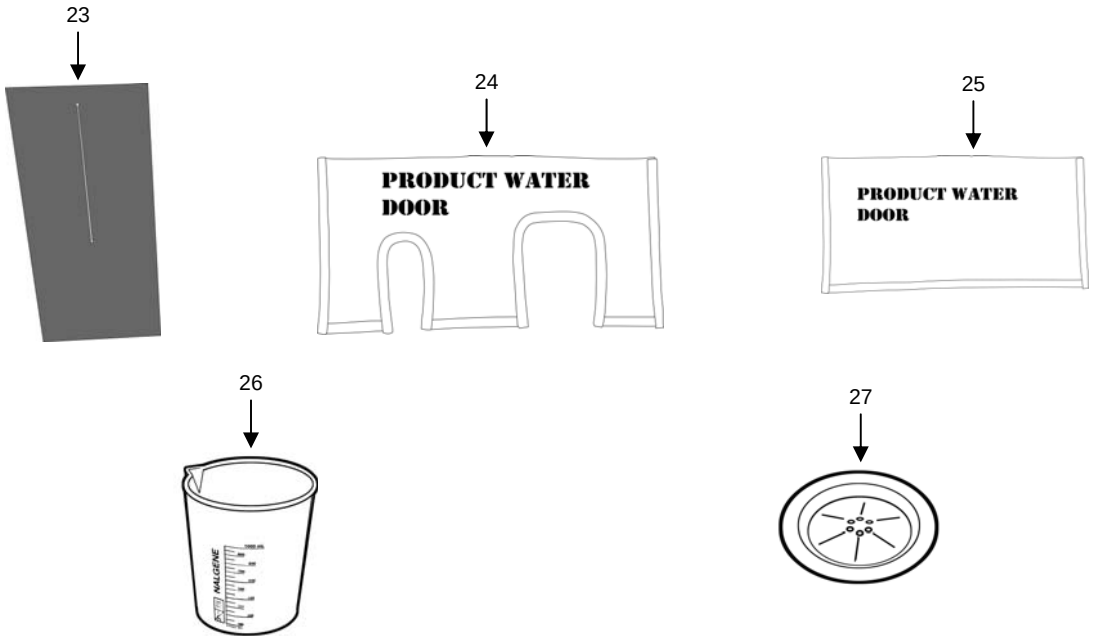

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
23	8465-01-526-9820	COVER, PDP Access (0U5N7) 33901241		EA	1
24	8465-01-526-9822	COVER, Product Water Door (0U5N7) 33905066		EA	1
25	8465-01-526-9824	COVER, Shipping, Product Water Door (0U5N7) 33905072		EA	1
26	6640-01-526-9844	CUP, Measuring 1000 ml (1UD63) 77038		EA	1
27	4820-01-526-2507	DISK, Rupturable (0EXU3) 925-07813		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

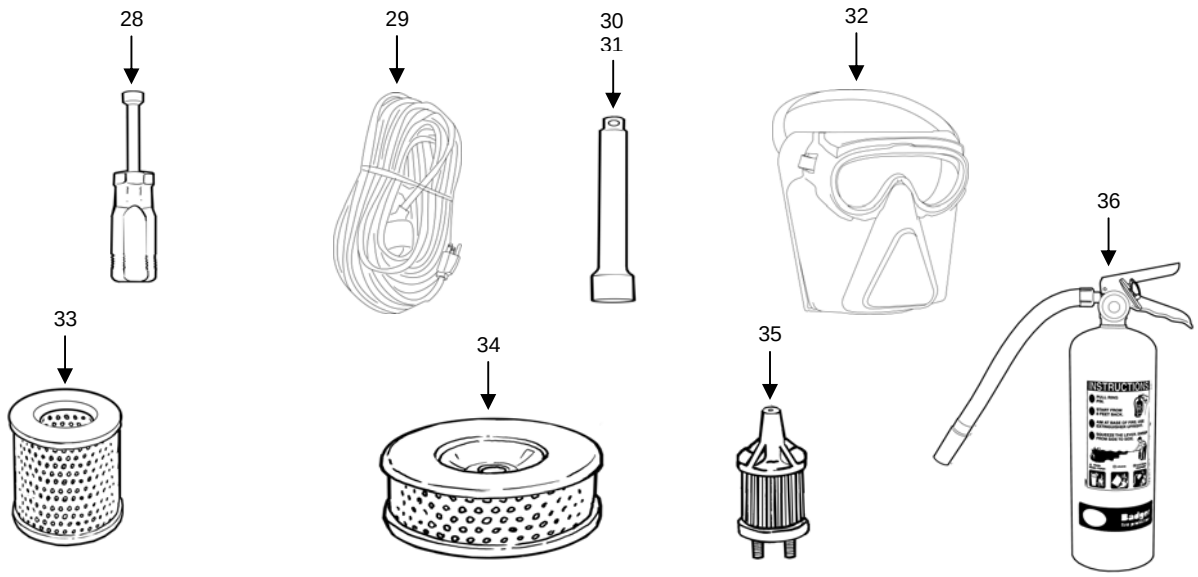

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
28	5120-01-354-2770	DRIVER, Nut, 5/16 in. (1F9N2) 75048140		EA	1
29	6150-01-527-0085	EXTENSION CORD, 100 ft. (39428) 7438K35		EA	1
30	5120-01-398-7666	EXTENSION, Socket Wrench, 3 in. (53800) 9-44264		EA	1
31	5120-01-398-7673	EXTENSION, Socket Wrench, 6 in. (53800) 9-44261		EA	1
32	4240-01-527-0099	FACESHIELD, Industrial (01786) 10179		EA	1
33	4310-01-460-3415	FILTER, Air Compressor Inlet (57328) N00070		EA	1
34	2940-01-310-4495	FILTER, Air, Diesel Pump (0AK42) 114250-12581		EA	1
35	2910-01-310-6566	FILTER, Fuel, Diesel Pump (0AK42) 114250-55121		EA	1
36	4210-01-527-0100	FIRE EXTINGUISHER, Dry Chemical, 3A-40B (6U173) 21032		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

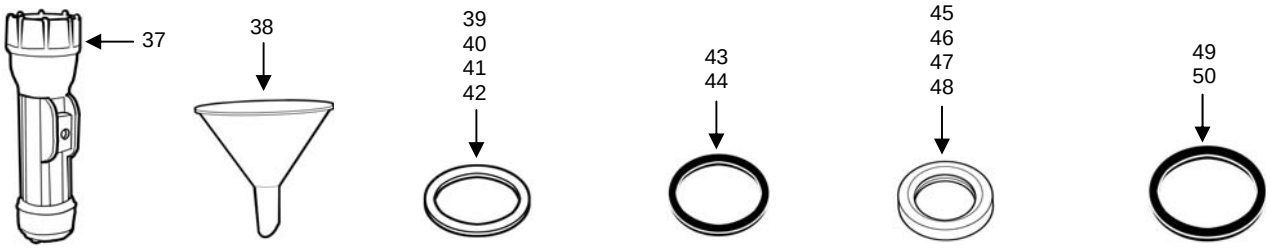

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
37	6230-01-527-0102	FLASHLIGHT, D-Size (1F9N2) 01042134		EA	4
38	7240-00-404-9797	FUNNEL, 3 in. (39428) 1479T3		EA	1
39	5330-01-526-5279	GASKET, C&G, 1 in. (33813) NW2		EA	1
40	5330-01-526-0670	GASKET, C&G, 1-1/2 in. (33813) NW4		EA	2
41	5330-01-349-8921	GASKET, C&G, 2 in. (33813) NW5		EA	12
42	5330-01-349-6190	GASKET, C&G, 3 in. (33813) NW7		EA	10
43	5330-01-526-4417	GASKET, C&G, 4 in. (33813) B08		EA	1
44	5330-01-526-4418	GASKET, C&G, 6 in. (33813) B010		EA	1
45	5330-01-526-4840	GASKET, Grooved Coupling, 1 in. (79154) 75-E-1.0IN		EA	2
46	5330-01-247-8525	GASKET, Grooved Coupling, 1.5 in. (79154) 75-E-1.5IN		EA	4
47	5330-01-271-5788	GASKET, Grooved Coupling, 2 in. (79154) STYLE 77/75/78-2.0IN GR E		EA	2
48	5330-01-271-5159	GASKET, Grooved Coupling, 3 in. (79154) STYLE 77/75/78-3.0IN GR E		EA	1
49	5330-01-509-7366	GASKET, Sanitary, 4 in. (0EXU3) 853-09903		EA	1
50	5330-01-515-3904	GASKET, Sanitary 6 in. (0EXU3) 853-09909		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

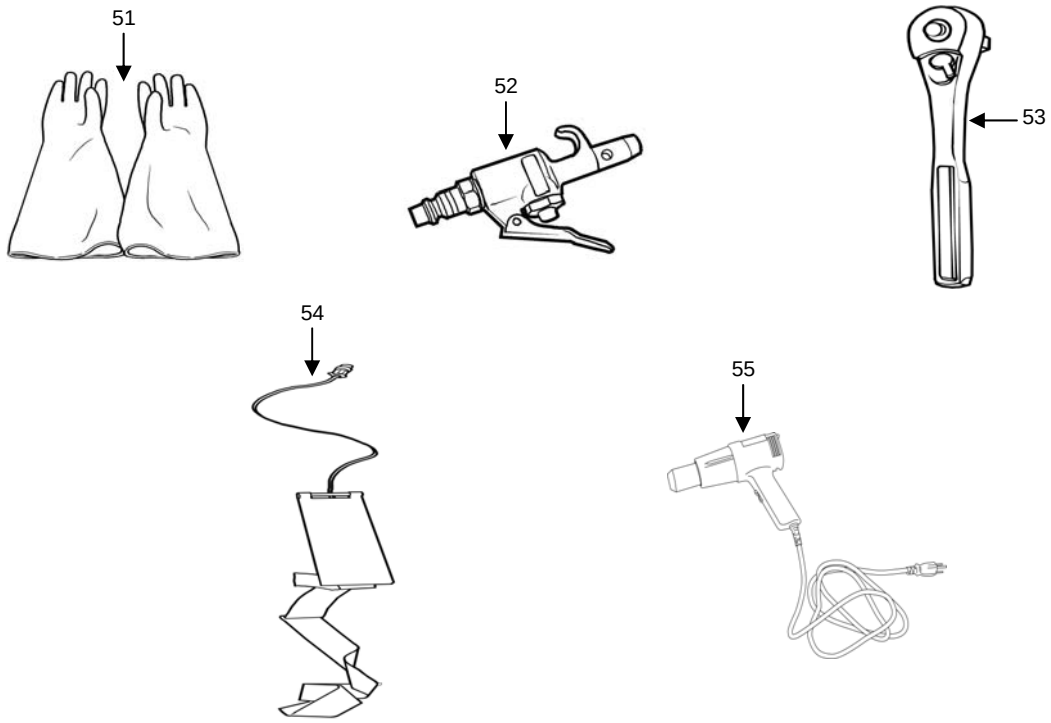

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
51	8415-01-526-9826	GLOVES, Rubber, Chemical, Pair (6M644) 6B-6681-9		EA	2
52	4940-00-873-3651	GUN, Air Blow (55719) JT10AS		EA	1
53	5120-01-398-7647	HANDLE, Socket Wrench, 3/8 in. (53800) 9-44811		EA	1
54	4540-01-526-5918	HEATER, Pump, Strap-On (Winter) (0PKE1) 040150A7		EA	3
55	4940-01-526-2893	HEAT GUN (39428) 32605K44		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

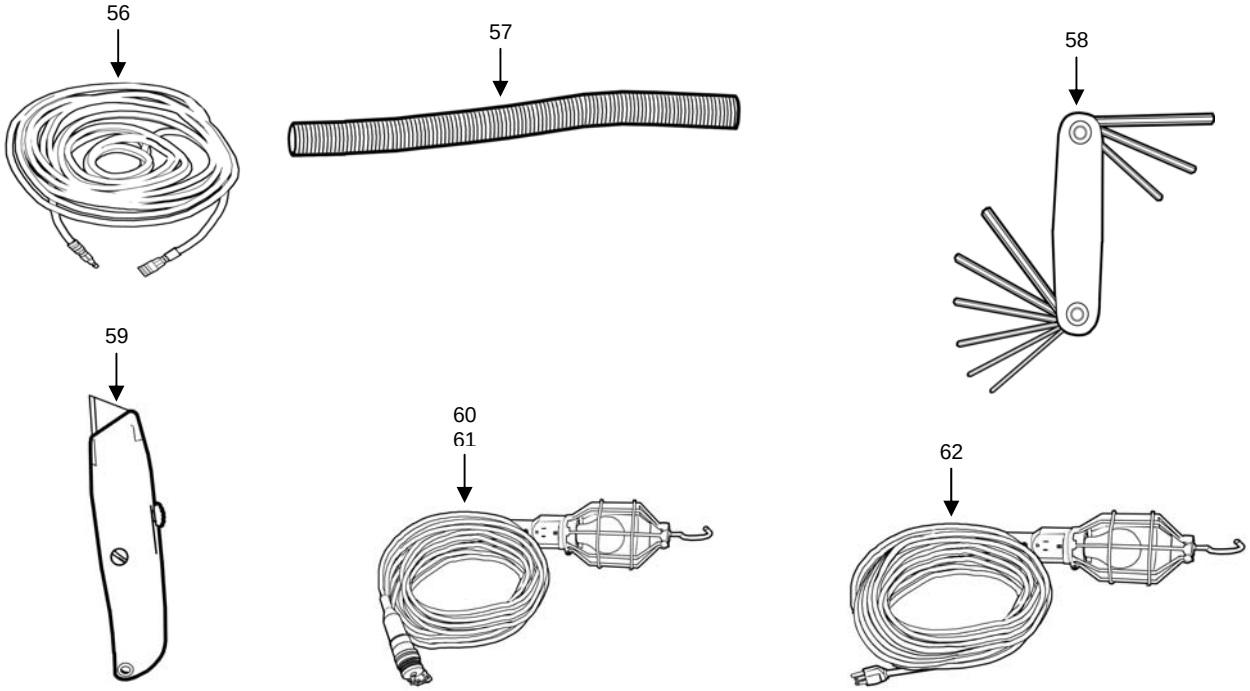

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
56	4720-01-527-0107	HOSE, Air, w/Quick Disconnect (0U5N7) 33901165		EA	1
57	4720-01-527-6200	HOSE, Engine Exhaust, Diesel Pumps P-1, P-8 (0U5N7) 33901224		EA	2
58	5110-01-459-2663	KEY SET, Hex, Foldup Set (98198) 90-BH12589		EA	1
59	5110-01-428-5225	KNIFE, Utility (1CV05) 10-179		EA	1
60	6230-01-527-0111	LIGHT ASSY, Blackout (0U5N7) 33903017		EA	1
61	6230-01-527-0115	LIGHT ASSY, Trouble (39428) 8407K12		EA	1
62	6230-01-527-0117	LIGHT ASSY, Work (0U5N7) 33903016		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

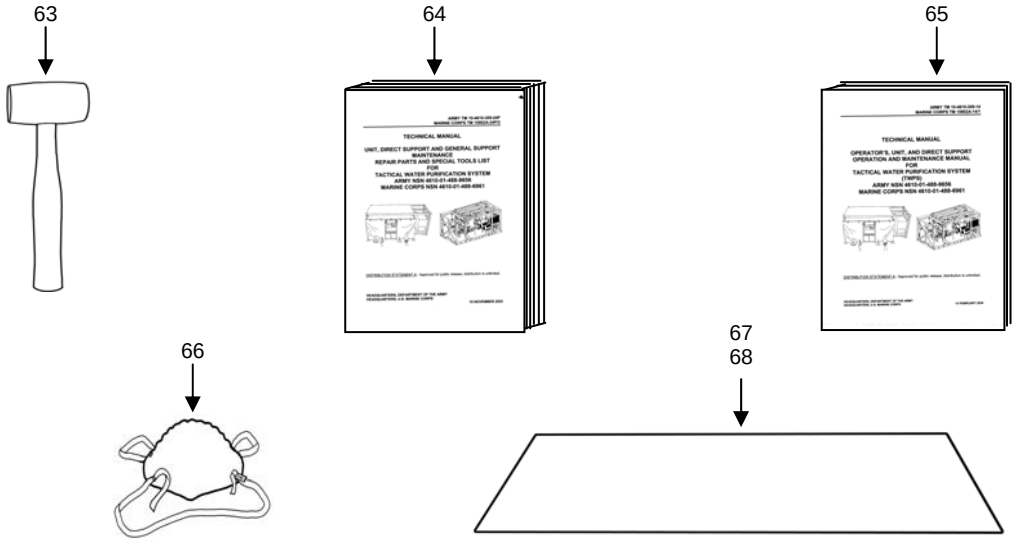

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
63	5120-01-116-6996	MALLET, Rubber, Wood Handle (53800) 9-45787		EA	1
64		MANUAL, Operation and Maintenance TM 10-4610-309-14		EA	1
65		MANUAL, RPSTL TM 10-4610-309-24P		EA	1
66	4240-01-527-0105	MASK, Air Filtering (Package of 5) (6M644) 67644		PG	1
67	2540-01-527-0125	MAT, Equipment Area Floor (0U5N7) 33902486		EA	1
68	2540-01-527-0126	MAT, Operator Station Area Floor (0U5N7) 33902488		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY **0076 00**

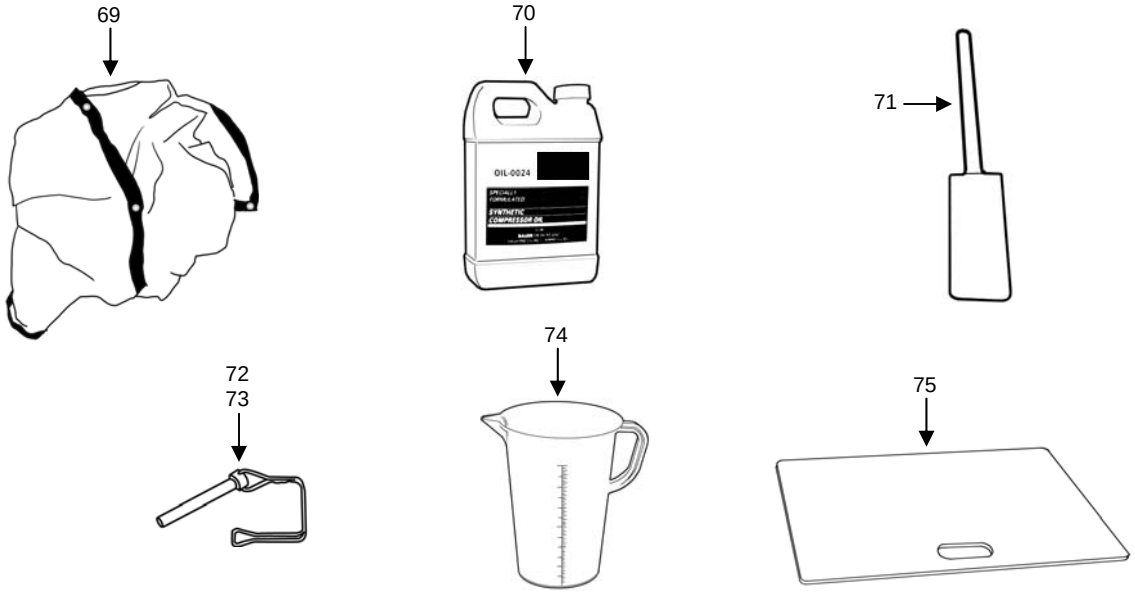

Table 2. Basic Issue Items List - Continued.

1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
69	3940-01-527-0139	NET, Cargo (098P0) B9154-120144-2R		EA	1
70	6850-00-294-0860	OIL, Lubricating, Air Compressor (0EXU3) 887-07607-000		QT	1
71	2040-01-413-1455	PADDLE, Boat (Stirring Paddle) (27901) 23092		EA	1
72	5315-01-527-0166	PIN, Quick Release (39428) 98480A135		EA	6
73	5315-01-526-3545	PIN, Quick Release (39428) 98416A125		EA	2
74	7240-00-138-7985	PITCHER, Priming (27901) 80120		EA	1
75	2540-01-527-0436	PLATFORM, Pump (0U5N7) 33902269		EA	5

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

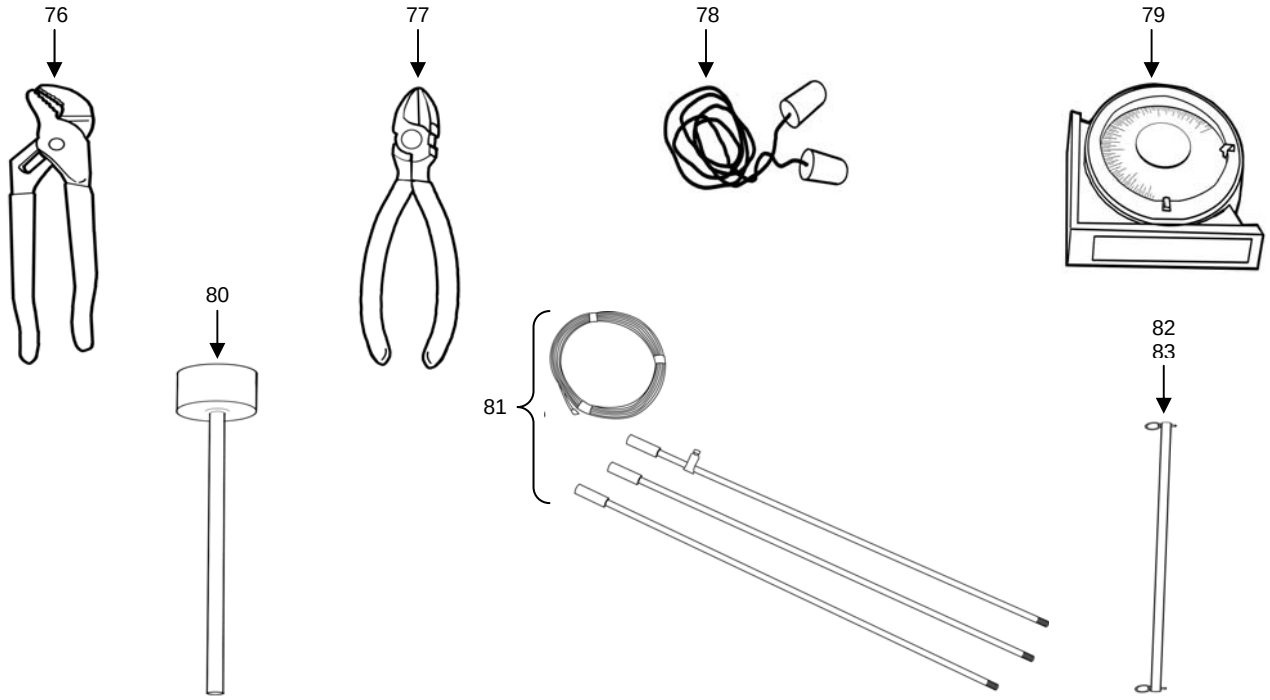

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
76	5120-00-069-5230	PLIERS, Slip Joint (71379) 10310-006-8		EA	1
77	5110-01-131-7095	PLIERS, Diagonal (43786) CS9336C		EA	1
78	6515-01-413-7414	PLUG, Ear (3W556) 0485		PR	10
79	5210-01-462-6741	PROTRACTOR (Level) (08125) 939840		EA	1
80	4610-01-527-0101	PUSHER, RO Element (0U5N7) 33901222		EA	1
81	3820-00-930-6086	ROD ASSEMBLY, Ground (18990) 30162		EA	1
82	9510-01-527-6320	ROD, Pump Skid Retaining, Long, 32.5 in. (0U5N7) 33901229		EA	2
83	9510-01-527-6321	ROD, Pump Skid Retaining, Short 20.25 in. (0U5N7) 33901228		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

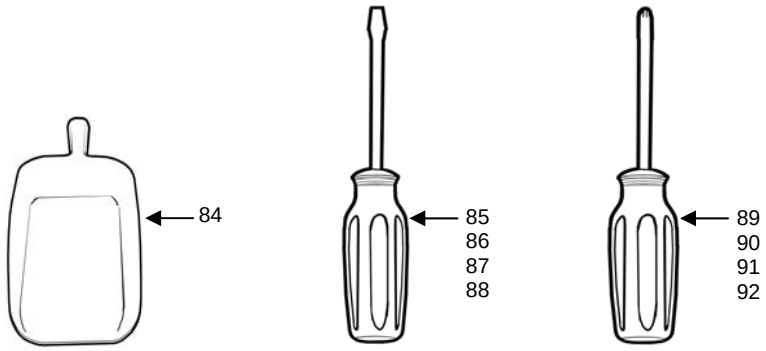

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
84	6640-01-035-7935	SCOOP, Large (1UD63) 80012		EA	1
85	5120-01-398-9399	SCREWDRIVER, Flat Tip, 1/8 in. x 3 in. (53800) 9-47440		EA	1
86	5120-01-398-9400	SCREWDRIVER, Flat Tip, 3/16 x 4 in. (53800) 9-47441		EA	1
87	5120-01-398-9403	SCREWDRIVER, Flat Tip, 1/4 in. x 6 in. (53800) 9-47445		EA	1
88	5120-01-398-9404	SCREWDRIVER, Flat Tip, 5/16 in. x 8 in. (53800) 9-47447		EA	1
89	5120-01-398-9402	SCREWDRIVER, Cross Tip, #0 x 3 in. (53800) 9-47434		EA	1
90	5120-01-398-9405	SCREWDRIVER, Cross Tip, #1 x 4 in. (53800) 9-47435		EA	1
91	5120-01-398-9244	SCREWDRIVER, Cross Tip, #2 x 4 in. (53800) 9-47436		EA	1
92	5120-01-398-9245	SCREWDRIVER, Cross Tip, #3 x 6 in. (53800) 9-47437		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0076 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY

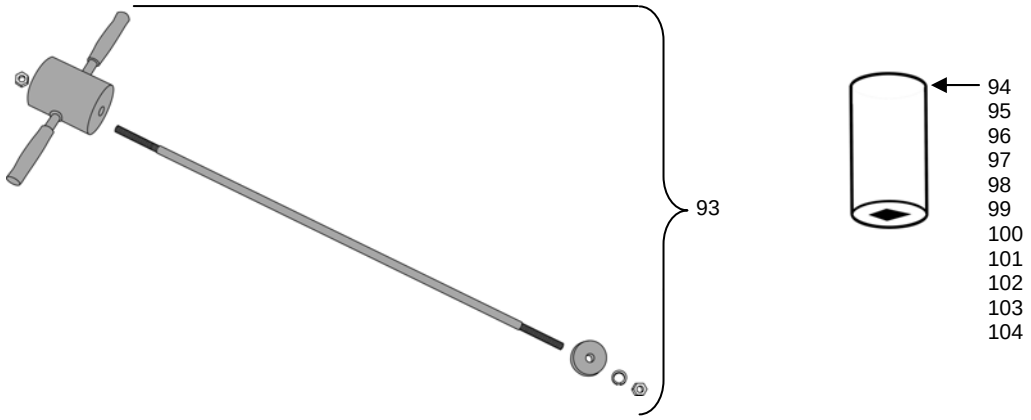

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
93	5120-01-013-1676	SLIDE HAMMER, Ground Rod (45225) P74-144		EA	1
94	5120-01-431-2720	SOCKET, 1/2 in. (2K880) 45116		EA	1
95	5120-01-431-2589	SOCKET, 11/16 in. (2K880) 45022		EA	1
96	5120-01-431-2591	SOCKET, 13/16 in. (2K880) 45026		EA	1
97	5120-01-431-2614	SOCKET, 15/16 in. (2K880) 45030		EA	1
98	5120-01-431-2600	SOCKET, 3/4 in. (2K880) 45024		EA	1
99	5120-01-431-2717	SOCKET, 3/8 in. (2K880) 45112		EA	1
100	5120-01-431-2596	SOCKET, 5/8 in. (2K880) 45020		EA	1
101	5120-01-431-2778	SOCKET, 7/16 in. (2K880) 45114		EA	1
102	5120-01-431-2595	SOCKET, 7/8 in. (2K880) 45028		EA	1
103	5120-01-431-2588	SOCKET, 9/16 in. (2K880) 45118		EA	1
104	5120-01-431-2718	SOCKET, Spark Plug, 5/8 in. (2K880) 4420		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY **0076 00**

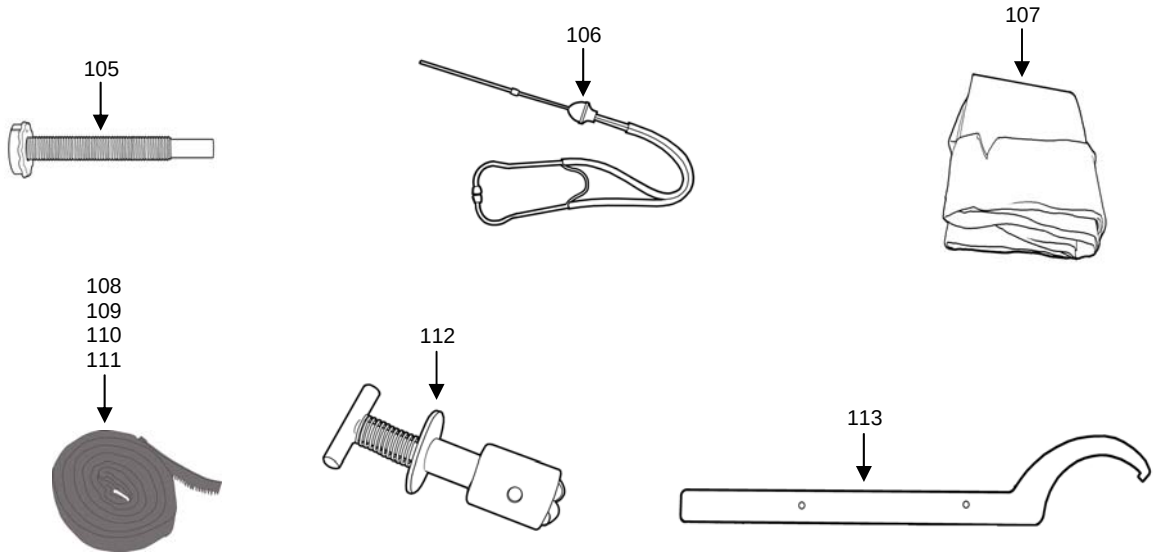

Table 2. Basic Issue Items List – Continued.

1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
105	7240-00-177-6154	SPOUT, Fuel Can (2C071) 04353		EA	1
106	4940-00-494-1533	STETHOSCOPE, Engineer's (78495) 2001		EA	1
107	4730-01-526-2213	STRAINER, MF Feed Tank (0EXU3) 923-08139		EA	3
108	5975-01-476-8290	STRAP, Tiedown, Hook and Loop, 12 in (39428) 3955T71		EA	6
109	3990-01-527-0068	STRAP, Tiedown, Hook and Loop, 18 in (39428) 3955T72		EA	8
110	3990-01-527-0070	STRAP, Tiedown, Hook and Loop, 36 in (39428) 3955T74		EA	14
111	3990-01-527-0073	STRAP, Tiedown, Hook and Loop, 48 in (39428) 3955T75		EA	22
112		TOOL, MF Filter Bypass (0EXU3) 843-08049		EA	1
113		TOOL, MF Filter C-Spanner (0U5N7) 33902284		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY **0076 00**

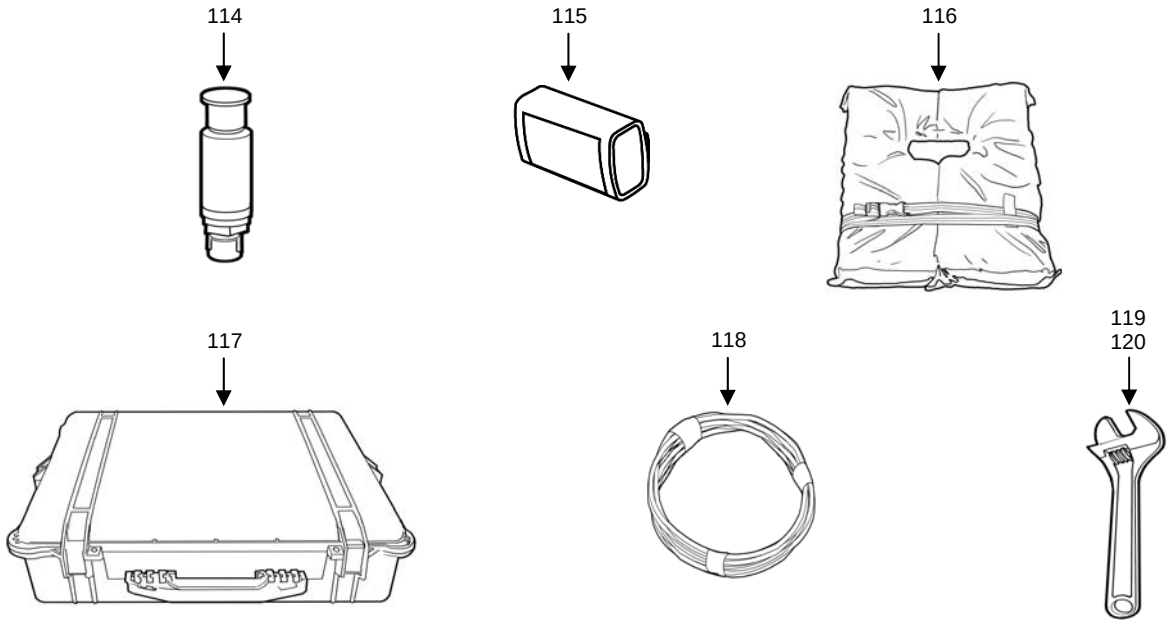

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
114	6685-01-526-3457	TRANSMITTER, Pressure, 0-100 PSIG, PT-201 (1CE49) PTX 317-8938		EA	1
115	4440-01-475-9949	VAPOR CAPSULE (08TA7) VC2-1		EA	4
116	4220-01-527-0078	VEST, Floatation (1B1X2) 250181		EA	1
117	6630-01-477-2395	WATER QUALITY ANALYSIS SET, Purification (04NB0) IITC-WQAS/P-401		EA	1
118	6145-01-527-0081	WIRE, Grounding (39428) 7512K611		EA	1
119	5120-00-449-8083	WRENCH, Adjustable, 10 in. (96508) D710		EA	1
120	5120-00-240-5328	WRENCH, Adjustable, 8 in. (80063) TL476U		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - ARMY **0076 00**

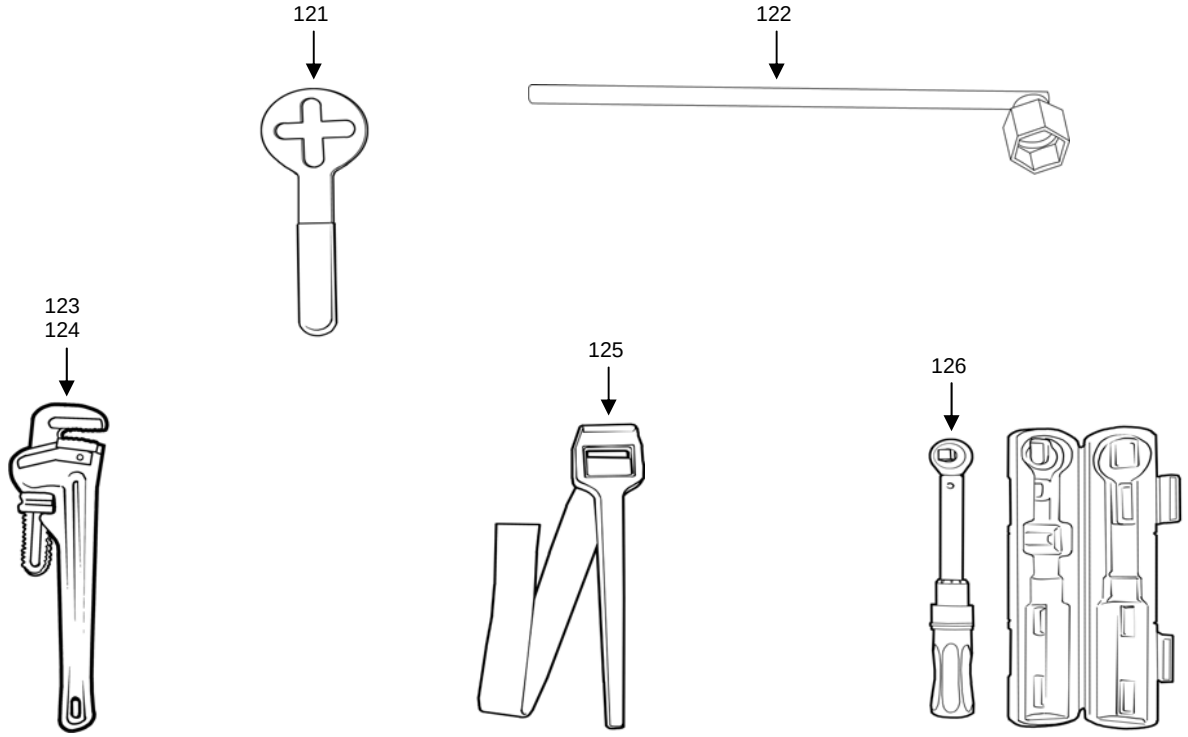

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
121	5120-01-486-5722	WRENCH, Air Compressor Purification Chamber (57328) WRH-0005		EA	1
122		WRENCH, Flat Rack Bail Bar (0U5N7) 33901601		EA	1
123	5120-01-335-1031	WRENCH, Pipe, 12 in. (55719) PW12C		EA	1
124	5120-01-335-1033	WRENCH, Pipe, 18 in. (55719) PW18C		EA	1
125	5120-01-334-9858	WRENCH, Strap, 1-in. to 5-in. pipe (55719) YA826A		EA	1
126	5120-00-430-8889	WRENCH, Torque, with case (0-250 in.-lb.) (02JD2) 4YR01		EA	1

END OF WORK PACKAGE

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS

SCOPE

This work package lists COEI (Components of End Item) and BII (Basic Issue Items) for the TWPS (Tactical Water Purification System) to help you inventory items for safe and efficient operation of the equipment.

GENERAL

The COEI and BII information is divided into the following lists:

Components of End Item (COEI). This list is for information purposes only and is not authority to requisition replacements. These items are part of the TWPS. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Items of COEI are removed and separately packaged for transportation or shipment only when necessary. Illustrations are furnished to help you find and identify the items.

Basic Issue Items (BII). These essential items are required to place the TWPS in operation, operate it, and to do emergency repairs. Although shipped separately packaged, BII must be with the TWPS during operation and when it is transferred between property accounts. Listing these items is your authority to request/requisition them for replacement based on authorization of the end item by the TOE/MTOE. Illustrations are furnished to help you find and identify the items.

EXPLANATION OF COLUMNS IN THE COEI AND BII LIST

Column (1) - Illus Number. Gives the number of the item illustrated.

Column (2) - National Stock Number (NSN). Identifies the stock number of the item to be used for requisitioning purposes.

Column (3) - Description, CAGEC and Part Number. Identifies the Federal item name (in all capital letters) followed by a minimum description when needed. The stowage location of COEI and BII is also included in this column. The last line below the description is the CAGEC (commercial and Government entity code) (in parentheses) and the part number.

Column (4) – Usable On Code. When applicable, gives you a code if the item you need is not the same for different models of equipment.

Column (5) - Unit of measure (U/M). Indicates the physical measurement or count of the item as issued per the National Stock Number shown in column (2).

Column (6) - Qty Rqr. Indicates the quantity required.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

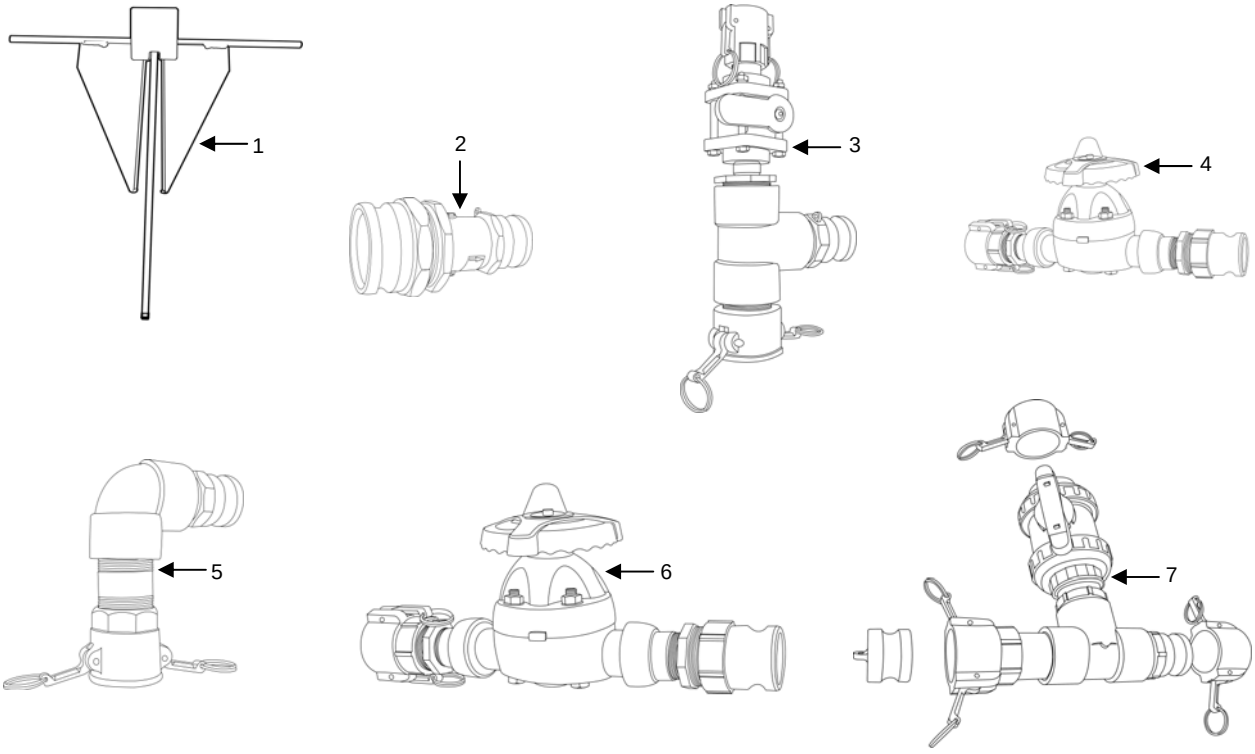

Table 1. Components of End Item List.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1	2040-01-527-5798	ANCHOR (1B1X2) 110091		EA	1
2	4730-01-526-0681	ASSEMBLY, ADAPTOR A01 (0U5N7) 33901085		EA	1
3	4730-01-526-0681	ASSEMBLY, ADAPTOR A02 (0U5N7) 33901086		EA	1
4	4820-01-526-0795	ASSEMBLY, ADAPTOR A03 (0U5N7) 33901089		EA	1
5	4730-01-526-0829	ASSEMBLY, ADAPTOR A04 (0U5N7) 33901087		EA	1
6	4820-01-526-1034	ASSEMBLY, ADAPTOR A05 (0U5N7) 33901088		EA	1
7	4730-01-526-3555	ASSEMBLY, ADAPTOR A07 (0U5N7) 33901093		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

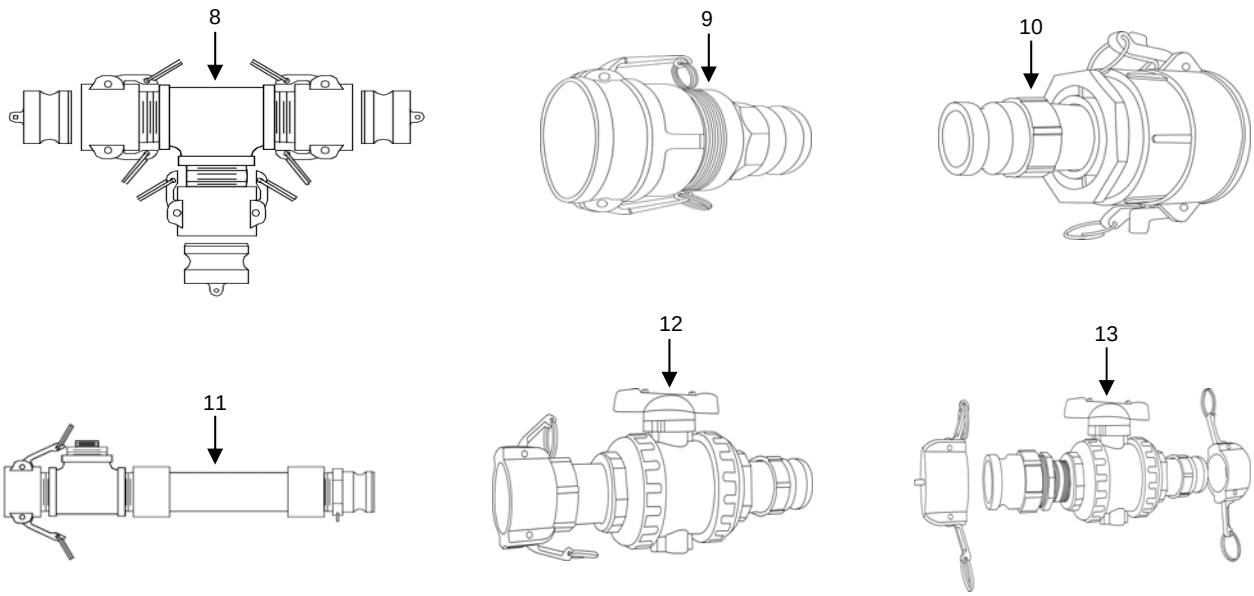

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
8	4820-01-526-3498	ASSEMBLY, ADAPTOR A08 (0U5N7) 33901094		EA	1
9	4730-01-526-2858	ASSEMBLY, ADAPTOR A09 (0U5N7) 33901100		EA	1
10	4730-01-526-2859	ASSEMBLY, ADAPTOR A10 (0U5N7) 33901101		EA	1
11	4820-01-526-3498	ASSEMBLY, ADAPTOR A11 (0U5N7) 33901113		EA	1
12	4820-01-526-2860	ASSEMBLY, ADAPTOR A12 (0U5N7) 33901102		EA	1
13	4730-01-526-3538	ASSEMBLY, ADAPTOR A15 (0U5N7) 33901171		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

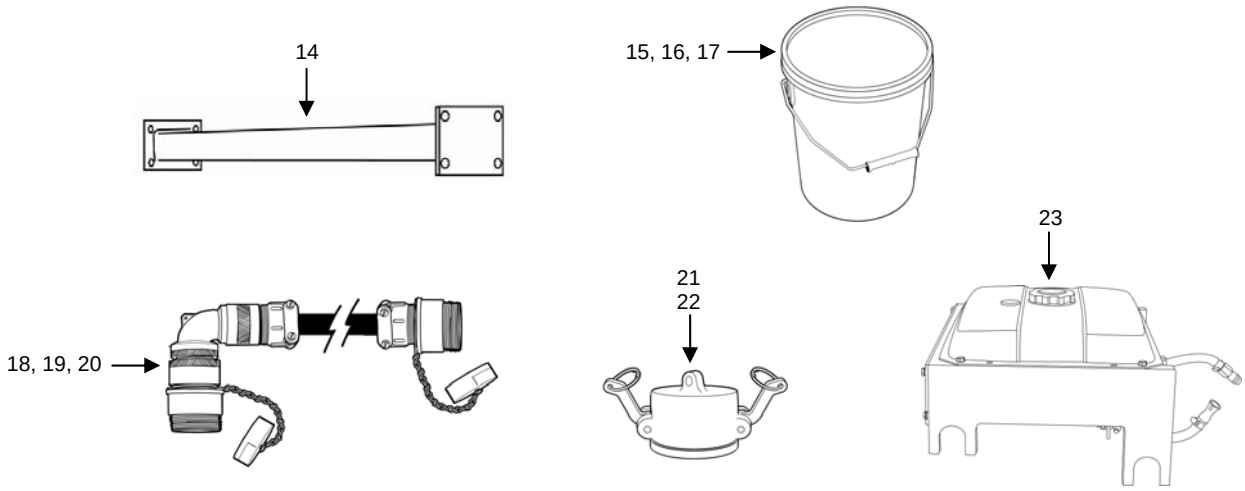

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
14	9520-01-527-6158	BEAM, Operator Station Entry Support (0U5N7) 33901194		EA	1
15	9520-01-527-6158	BUCKET, Chemical , Red (0U5N7) 33901259-3		EA	1
16	7240-01-094-4305	BUCKET, Chemical, Yellow (0U5N7) 33901259-2		EA	1
17	7240-01-094-4305	BUCKET, Chemical, Blue (0U5N7) 33901259-1		EA	1
18	6150-01-526-2420	CABLE, Distribution Pump, Electric, 75 ft. (0U5N7) 33903002		EA	1
19	6150-01-526-2412	CABLE, MF Feed Pump, Electric, 35ft. (0U5N7) 33903001		EA	1
20	6150-01-526-1813	CABLE, Raw Water Pump, Electric, 135 ft. (0U5N7) 33903000		EA	1
21	5340-01-526-3531	CAP, Hose, 1.5 in. (33813) 15V-FDAPOLY		EA	6
22	5340-01-526-4624	CAP, Hose 2 in. (33813) 20V-FDAPOLY		EA	10
23	4930-01-527-6151	FUEL TANK ASSY, Diesel Pump (0U5N7) 33901122		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

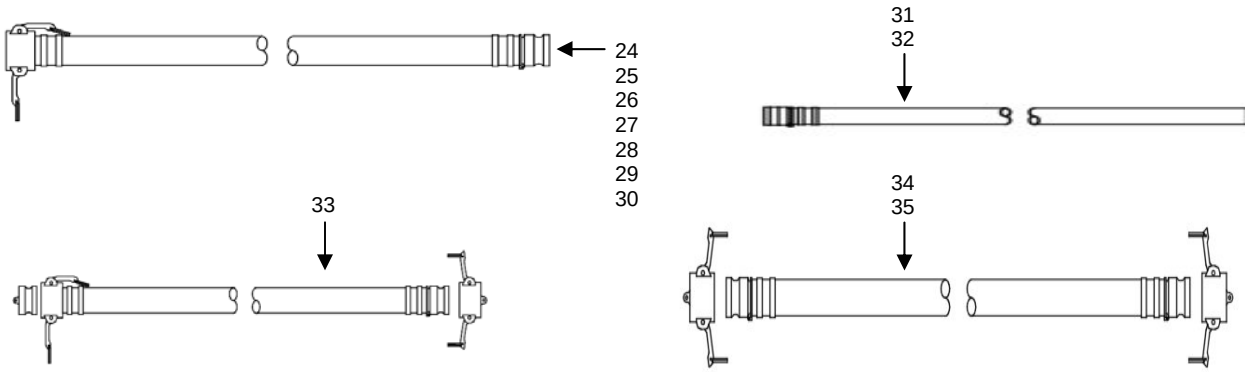

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
24	4720-01-526-0756	HOSE ASSY, F01, 3-in. x 10-ft. (0U5N7) 33901096-1		EA	13
25	4720-01-526-2865	HOSE ASSY, F02, 2-in. x 6-ft. (0U5N7) 33901096-2		EA	1
26	4720-01-526-0800	HOSE ASSY, F03, 2-in. x 50-ft. (0U5N7) 33901096-4		EA	4
27	4720-01-526-1036	HOSE ASSY, F04, 2-in. x 10-ft. (0U5N7) 33901096-3		EA	1
28	4720-01-526-2215	HOSE ASSY, F05, 3-in. x 3-ft. (0U5N7) 33901096-5		EA	1
29	4720-01-526-2218	HOSE ASSY, F07, 3-in x 10-ft. (0U5N7) 33901096-8		EA	2
30	4720-01-526-2837	HOSE ASSY, R04, 4-in. x 5-ft. (0U5N7) 33901096-6		EA	1
31	4720-01-526-1040	HOSE ASSY, F06, 1-in. x 3-ft. (0U5N7) 33901090-1		EA	2
32	4720-01-526-2846	HOSE ASSY, R05, 6-in. x 50-ft. (0U5N7) 33901090-2		EA	1
33	4720-01-526-3524	HOSE ASSY, P02, 1½-in. x x10-ft. (0U5N7) 33901097		EA	4
34	4720-01-526-3485	HOSE ASSY, P03, 2-in. x 5-ft. (0U5N7) 33901098-1		EA	1
35	4720-01-526-3479	HOSE ASSY, P05, 2-in. x 65-ft. (0U5N7) 33901098-2		EA	2

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

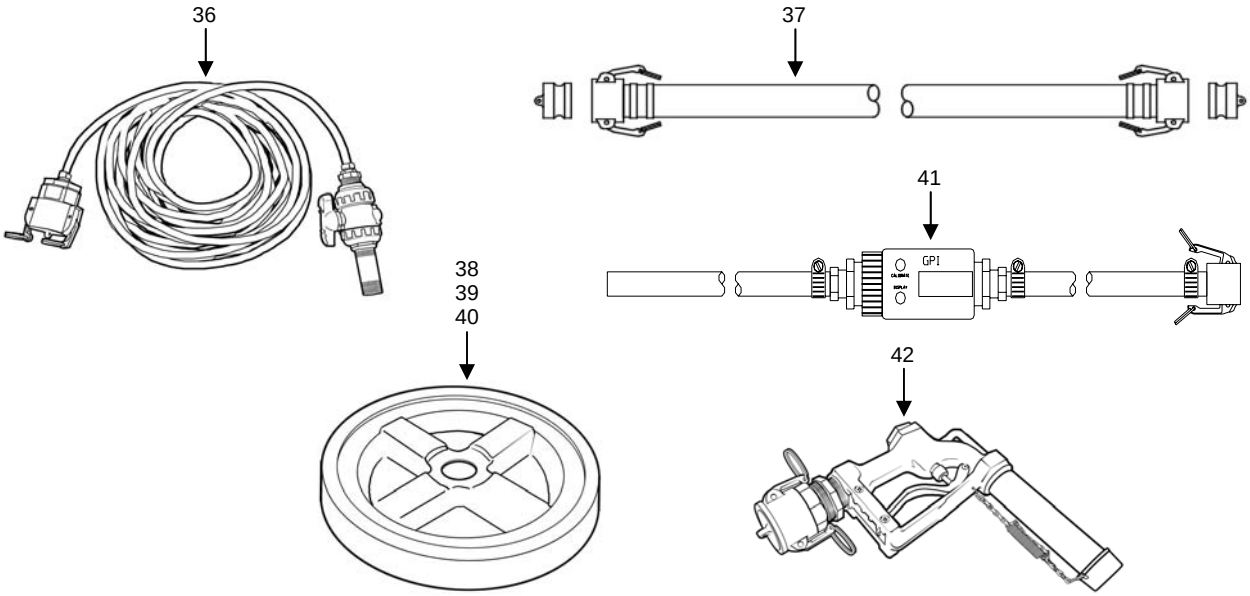

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
36	4720-01-526-3522	HOSE ASSY, P06, 5/8-in. x 50-ft. (0U5N7) 33901095		EA	1
37	4720-01-526-349	HOSE ASSY, P04, 2-in. x 5-ft. (0U5N7) 33901099		EA	1
38	7240-01-359-0894	LID, Tank, Chemical, Yellow (0U5N7) 33902558-1		EA	1
39	7240-01-359-0894	LID, Tank, Chemical, Blue (0U5N7) 33902558-2		EA	1
40	7240-01-359-0894	LID, Tank, Chemical, Red (0U5N7) 33902558-3		EA	1
41	6680-01-527-0326	METER ASSY, Flow (0U5N7) 33901082		EA	1
42	4730-01-526-3473	NOZZLE ASSY, Distribution (0U5N7) 33901103		EA	2

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

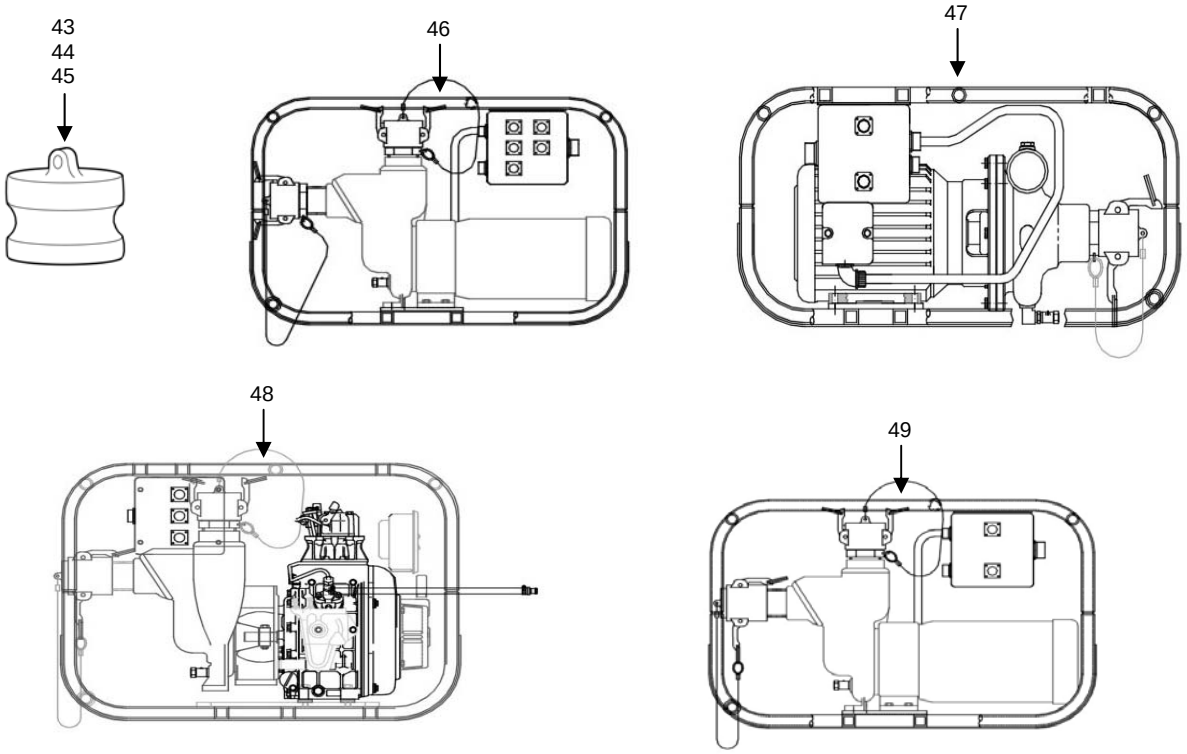

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
43	5340-01-526-0665	PLUG, Hose, 1.5 in. (33813) 15W-FDAPOLY		EA	5
44	5340-01-526-2794	PLUG, Hose, 3 in. (33813) 30W-FDAPOLY		EA	1
45	5340-01-526-3564	PLUG, Hose, 2 in. (33813) 20W-FDAPOLY		EA	8
46	4320-01-527-6155	PUMP ASSY, Distribution, Electric, P-7 (0U5N7) 33901110		EA	1
47	4320-01-527-6156	PUMP ASSY, Micro-Filtration, P-3 (0U5N7) 33901108		EA	1
48	4320-01-527-5806	PUMP ASSY, Raw Water, Diesel, P-1 (0U5N7) 33901104		EA	1
49	4320-01-527-6154	PUMP ASSY, Raw Water, Electric, P-2 (0U5N7) 33901106		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

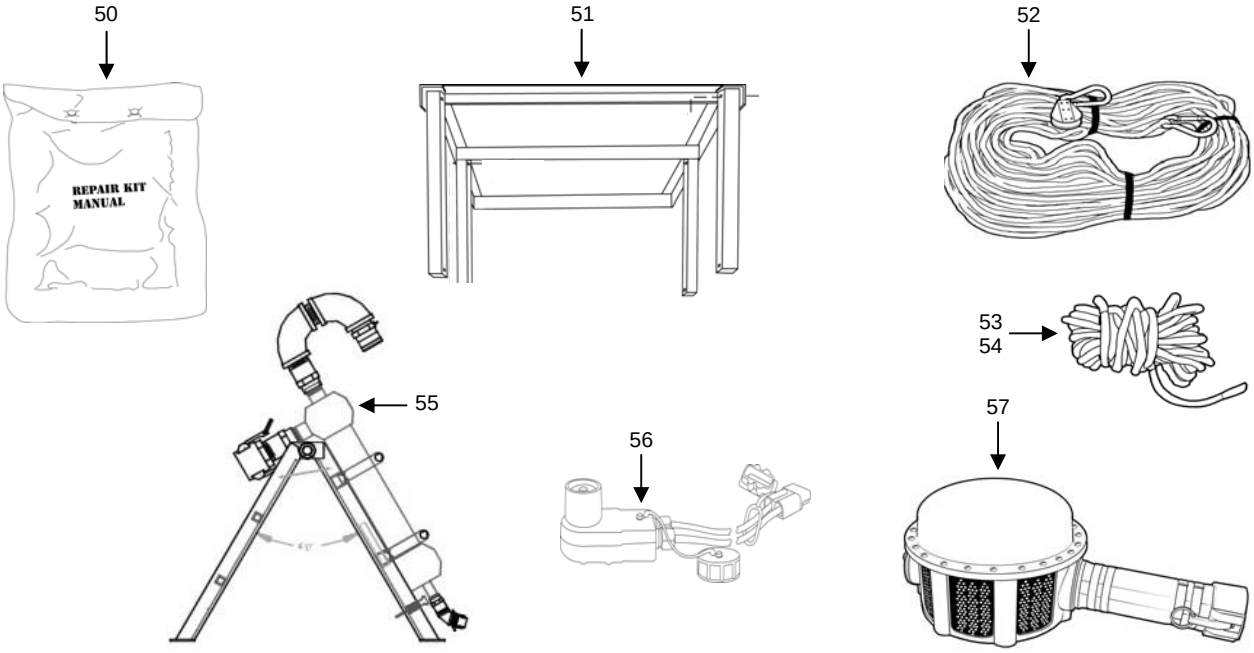

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
50	5430-01-359-1078	REPAIR KIT, COLLAPSIBLE TANK (58536) A-A-52022		EA	1
51		ROOF, Operation Station (0U5N7)		EA	1
52	4020-01-526-0755	ROPE ASSY, Anchor (0U5N7) 33901146		EA	1
53	4020-01-526-4646	ROPE, Raw Water Hose (0U5N7) 33902478-4		EA	1
54	4020-01-526-2214	ROPE, MF Strainer (0U5N7) 33902478-1		EA	1
55	4320-01-527-6152	SEPARATOR ASSY, Cyclone (0U5N7) 33901084		EA	1
56	6150-01-526-421	STARTING CABLE, Diesel Pump (P-1) (0U5N7) 33903004		EA	1
57	4730-01-527-5802	STRAINER ASSY, Raw Water, S-1 (0U5N7) 33901160		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

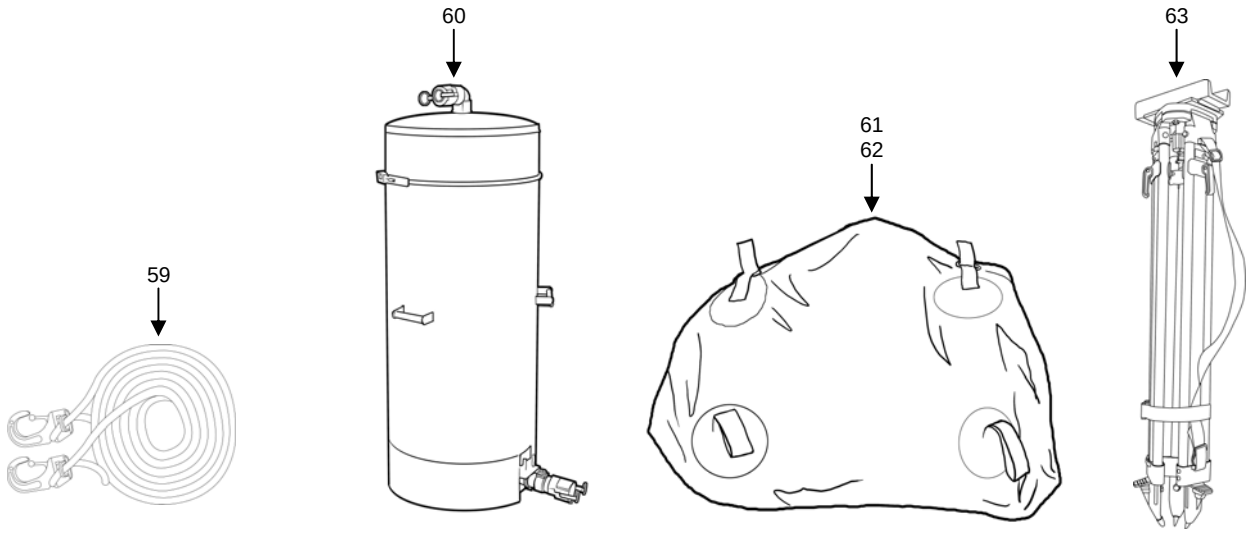

Table 1. Components of End Item List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
59		STRAP, Roof Sheet (0Z3R2) 89903009		EA	3
60	4230-01-526-1138	TANK ASSEMBLY, NBC (0EXU3) 732-D-08057		EA	1
61	5430-01-526-2212	TANK, Fabric, 1000 Gallons, MF Feed (05YK6) RCF-1K-W-OT		EA	1
62	5430-01-470-7380	TANK, Fabric, 3000 Gallons (05YK6) RCF-3K-W-OT		EA	2
63	6625-01-526-9713	TRIPOD ASSEMBLY (0U5N7) 33901322		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS

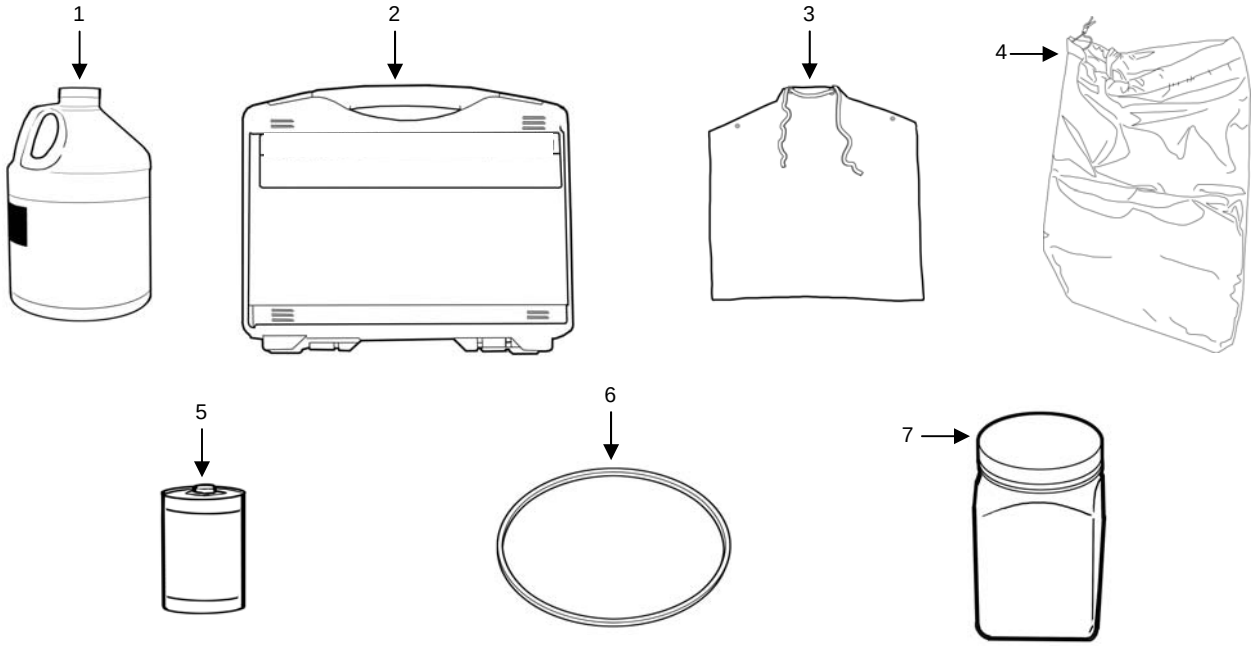

Table 2. Basic Issue Items List.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1		ANTISCALANT (0EXU3) 803-07886		GA	2
2		ANALYZER, Chlorine (05668) U-99581-000		EA	1
3	8415-00-234-9253	APRON, Laboratory (80063) MC111		EA	2
4		BAG, Storage, Cargo Net (0U5N7) 33905081		EA	1
5	6135-00-835-7211	BATTERY, D-Size, Package of 6 (77542) HD-D		EA	6
6	3030-00-445-4514	BELT, V, Air Compressor (04NP0) A76		EA	1
7		BOTTLE, Measuring, Clear PVC (27901) 77075		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

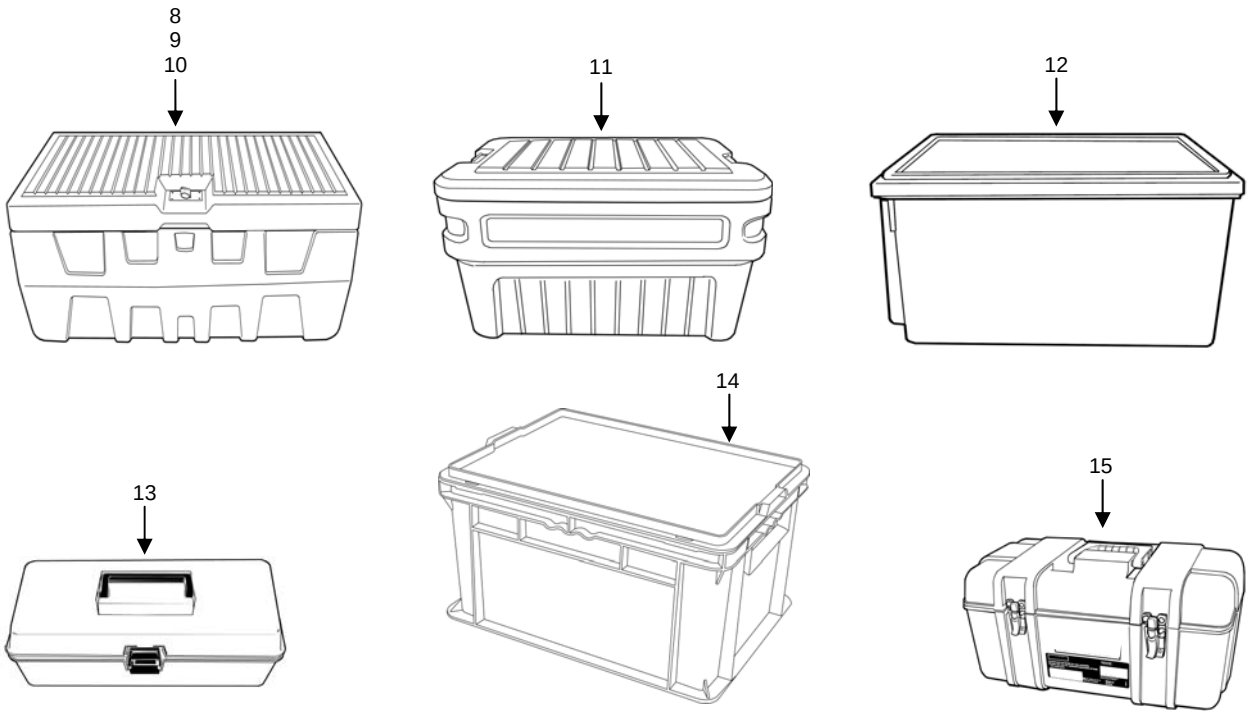

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
8	2540-01-527-0316	BOX, Storage, BII #1 (0U5N7) 33901230-1		EA	1
9	2540-01-527-0318	BOX, Storage, BII #3 (0U5N7) 33901230-3		EA	1
10	2540-01-527-0063	BOX, Storage, BII #8 (0U5N7) 33901230-4		EA	1
11	2540-01-527-0315	BOX, Storage, BII #4 (Chemicals) (0U5N7) 33902549		EA	1
12	2540-01-527-0314	BOX, Storage, BII #5 (Caustic) (0U5N7) 33901238		EA	1
13	2540-01-527-0064	BOX, Storage, BII Spare Parts 00071589		EA	1
14	3990-01-527-4727	BOX, Storage, Technical Manuals (0U5N7) 33901320-1		EA	1
15	2540-01-527-0072	BOX, Tool (53800) 9-65432		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

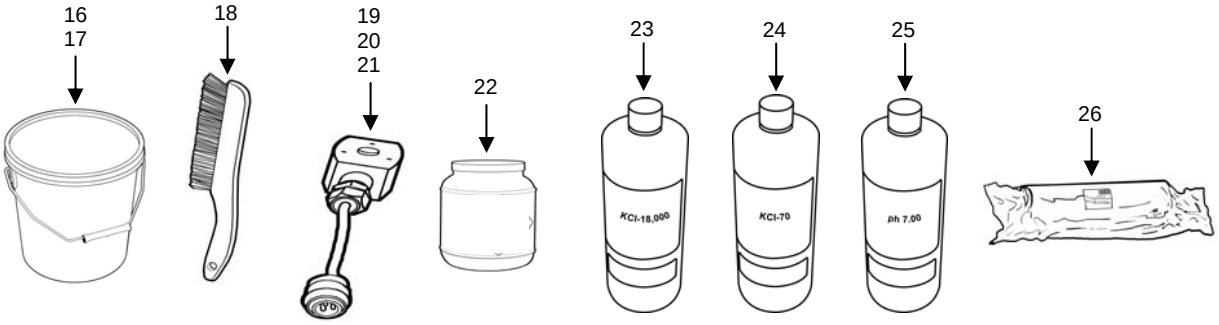

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
16	3990-01-527-4727	BUCKET, Storage, BII #6 (0U5N7) 33902531		EA	1
17	3990-01-517-4727	BUCKET, Storage, BII #7 (Lubricants, Chlorine) (0U5N7) 33902532		EA	1
18	7920-00-244-7431	BRUSH, Plater's (39428) 7187T8		EA	1
19	5945-01-527-0087	CABLE ASSY, Solenoid (XV-901) (0U5N7) 33903015-5		EA	1
20	5945-01-527-0088	CABLE ASSY, Solenoid (XV-902/903/910/911) (0U5N7) 33903015-6		EA	1
21	5945-01-527-0089	CABLE ASSY, Solenoid (XV-912) (0U5N7) 33903015-7		EA	1
22		CALCIUM HYPOCHLORITE, Package of ten 4-oz pks (0EXU3) 803-07882		EA	1
23		CALIBRATION SOLUTION, KCI-18000, 32-oz. (30053) KCL-18000 (32 OZ)		EA	1
24		CALIBRATION SOLUTION, KCI-70, 32-oz. (30053) KCL-70 (32 OZ)		EA	1
25		CALIBRATION SOLUTION, pH-7.00, 32-oz. (30053) BUFFER (32 OZ)		EA	1
26	4310-01-460-7980	CARTRIDGE, Purifier (57328) 058821A		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

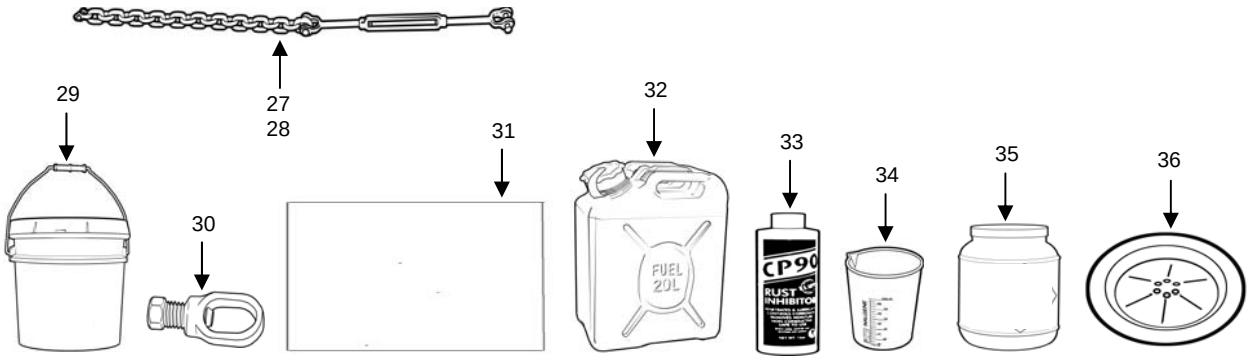

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
27		CHAIN, Transport Reinforcement Assy (0U5N7) 33901190-1		EA	1
28		CHAIN, Transport Reinforcement Assy (0U5N7) 33901190-2		EA	1
29		CITRIC ACID, 20-lb bucket (0EXU3) 803-07891		EA	1
30	5940-01-158-4521	CLAMP, Ground Rod (56501) L70		EA	2
31		CLOTH, Drop, Fuel Absorbent (39428) 7516T48		EA	1
32	7240-01-337-5269	CONTAINER, Fuel, Diesel, 5 gallons (56161) 10502788		EA	1
33		CORROSION PREVENTIVE COMPOUND (03GK3) T32CP90		EA	1
34	6640-01-526-9844	CUP, Measuring 1000 ml (1UD63) 77038		EA	1
35		DETERGENT, High PH (0EXU3) 803-07884		EA	4
36	4820-01-526-2507	DISK, RUPTURABLE (0EXU3) 925-07813		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

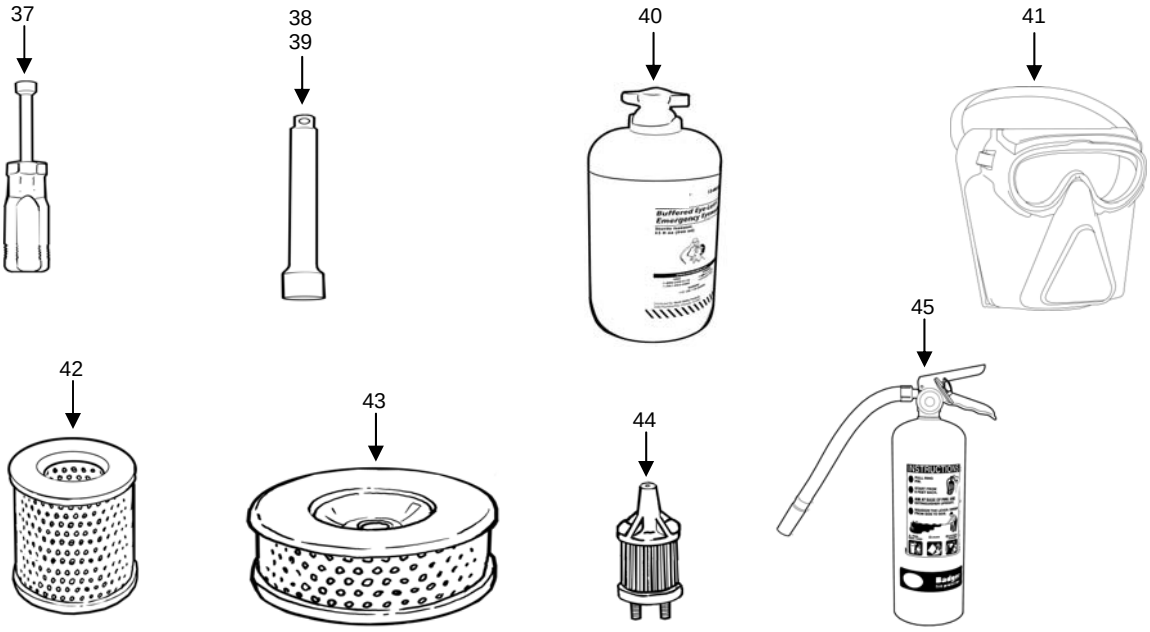

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
37	5120-01-354-2770	DRIVER, Nut, 5/16 in. (1F9N2) 75048140		EA	1
38	5120-01-398-7666	EXENSION, SOCKET WRENCH, 3 in. (53800) 9-44264		EA	1
39	5120-01-398-7673	EXTENSION, SOCKET WRENCH, 6 in. (53800) 9-44261		EA	1
40	4510-01-496-6954	EYEWASH, Eyewash Station, Refill (25795) 5T064		EA	2
41	4240-01-527-0099	FACESHIELD, Industrial (01786) 10179		EA	1
42	4310-01-460-3415	FILTER, Air Compressor Inlet (57328) N00070		EA	1
43	2940-01-310-4495	FILTER, Air, Diesel Pump (0AK42) 114250-12581		EA	1
44	2910-01-310-6566	FILTER, Fuel, Diesel Pump (0AK42) 114250-55121		EA	1
45	4210-01-527-0100	FIRE EXTINGUISHER, Dry Chemical, 3A-40B (6U173) 21032		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

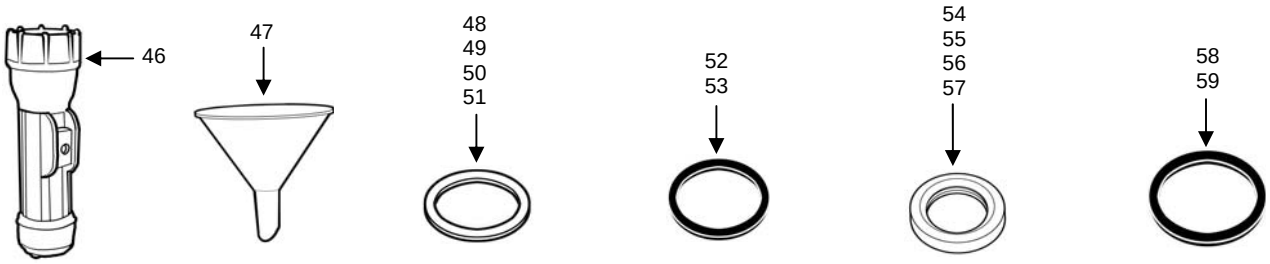

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
46	6230-01-527-0102	FLASHLIGHT, D-Size (1F9N2) 01042134		EA	4
47	7240-00-404-9797	FUNNEL, 3 in. (39428) 1479T3		EA	1
48	5330-01-526-5279	GASKET, C&G, 1 in. (33813) NW2		EA	1
49	5330-01-526-0670	GASKET, C&G, 1-1/2 in. (33813) NW4		EA	2
50	5330-01-349-8921	GASKET, C&G, 2 in. (33813) NW5		EA	12
51	5330-01-349-6190	GASKET, C&G, 3 in. (33813) NW7		EA	10
52	5330-01-526-4417	GASKET, C&G, 4 in. (33813) B08		EA	1
53	5330-01-526-4418	GASKET, C&G, 6 in. (33813) B010		EA	1
54	5330-01-526-4840	GASKET, Grooved Coupling, 1 in. (79154) 75-E-1.0IN		EA	2
55	5330-01-247-8525	GASKET, Grooved Coupling, 1.5 in. (79154) 75-E-1.5IN		EA	4
56	5330-01-271-5788	GASKET, Grooved Coupling, 2 in. (79154) STYLE 77/75/78-2.0IN GR E		EA	2
57	5330-01-271-5159	GASKET, Grooved Coupling, 3 in. (79154) STYLE 77/75/78-3.0IN GR E		EA	1
58	5330-01-509-7366	GASKET, Sanitary, 4 in. (0EXU3) 853-9586		EA	1
59	5330-01-515-3904	GASKET, Sanitary 6 in. (0EXU3) 853-9826		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

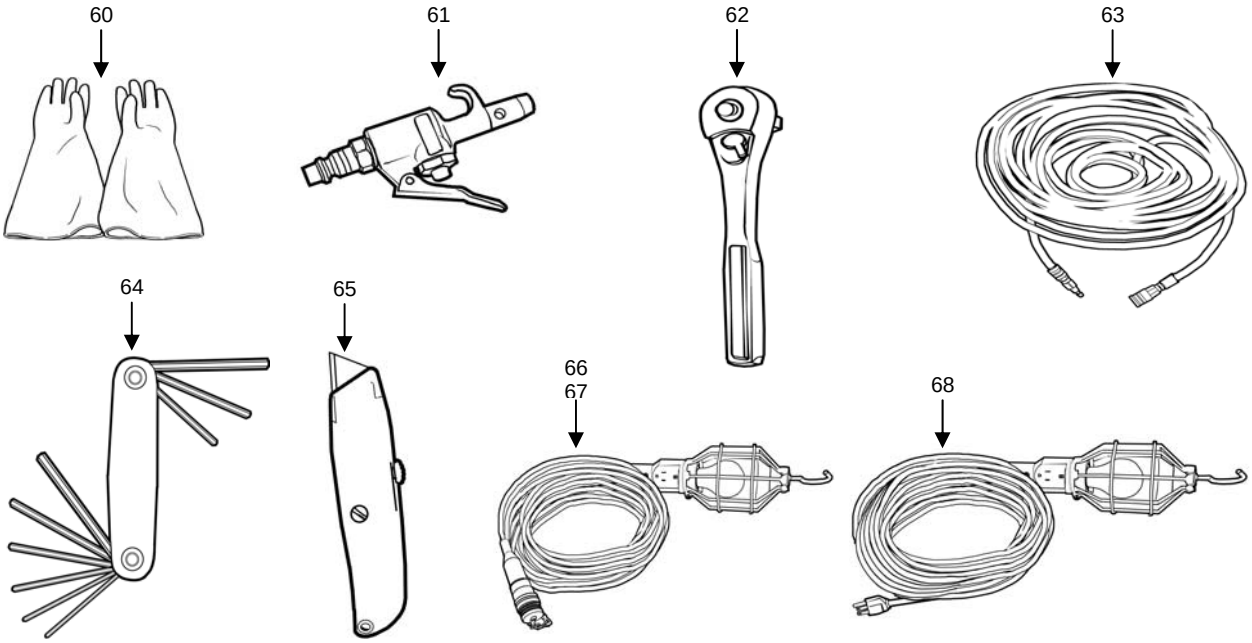

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
60	8415-01-526-9826	GLOVES, Rubber, Chemical, Pair (6M644) 6B-6681-9		EA	2
61	4940-00-873-3651	GUN, Air Blow (55719) JT10AS		EA	1
62	5120-01-398-7647	HANDLE, Socket Wrench, 3/8 in. (53800) 9-44811		EA	1
63	4720-01-527-0107	HOSE, Air, w/Quick Disconnect (0U5N7) 33901165		EA	1
64	5110-01-459-2663	KEY SET, Hex, Foldup Set (53800) 90-BH12589		EA	1
65	5110-01-428-5225	KNIFE, Utility (1CV05) 10-179		EA	1
66	6230-01-527-0111	LIGHT ASSY, Blackout (0U5N7) 33903017		EA	1
67	6230-01-527-0115	LIGHT ASSY, Trouble (39428) 8407K12		EA	1
68	6230-01-527-0117	LIGHT ASSY, Work (0U5N7) 33903016		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

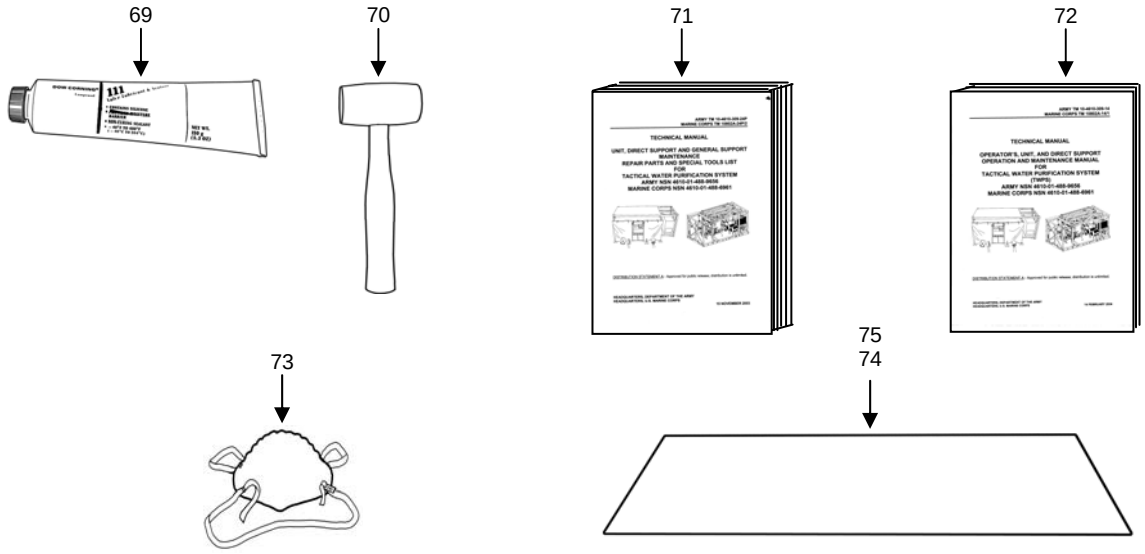

Table 2. Basic Issue Items List – Continued.

1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
69		LUBRICANT, Silicone (0EXU3) 887-07510-000		OZ	1
70	5120-01-116-6996	MALLET, Rubber, Wood Handle (53800) 9-45787		EA	1
71		MANUAL, Operation and Maintenance TM 10-4610-309-14 (2 volumes)		EA	1
72		MANUAL, RPSTL TM 10-4610-309-24P		EA	1
73	4240-01-527-0105	MASK, Air Filtering (Package of 5) (6M644) 67644		PG	1
74	2540-01-527-0125	MAT, Equipment Area Floor (0U5N7) 33902486		EA	1
75	2540-01-527-0126	MAT, Operator Station Area Floor (0U5N7) 33902488		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

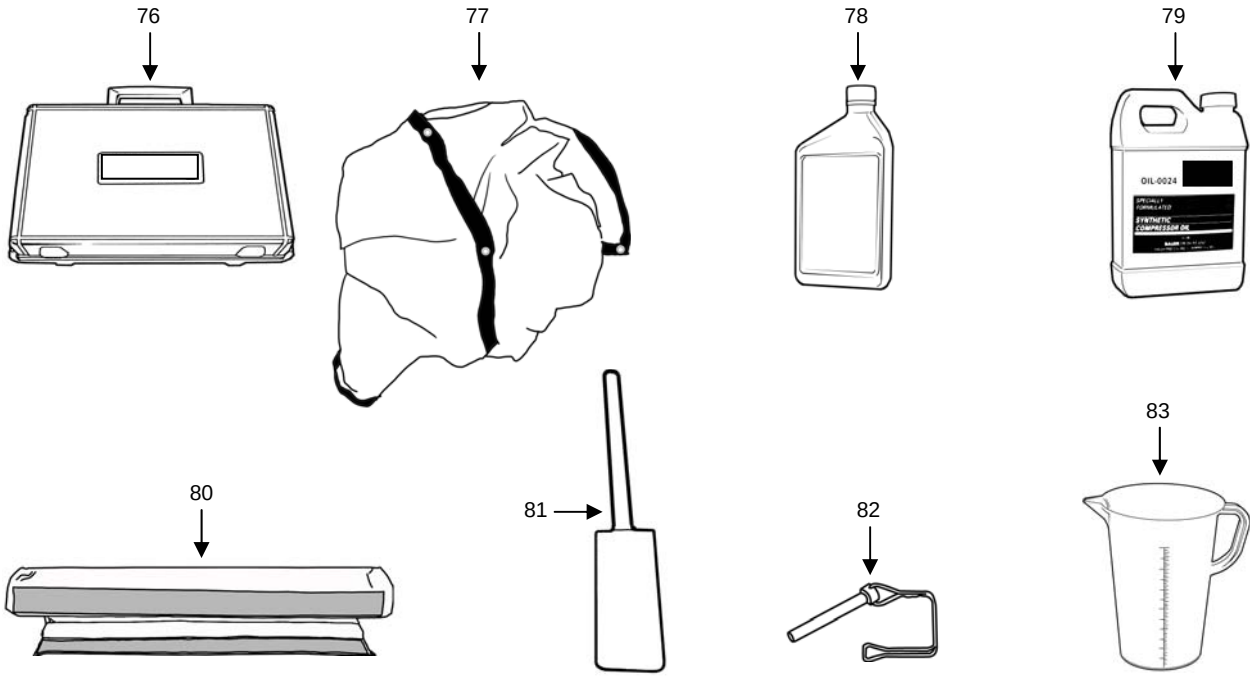

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
76	6630-01-491-2184	METER, TDS (30053) 6P		EA	1
77	3940-01-527-0139	NET, Cargo (0U5N7) 33904205		EA	2
78	9150-01-178-4725	OIL, Diesel Engine, Quart Bottle (81349) 15W-40/QT/BT/2104		QT	1
79	6850-00-294-0860	OIL, Lubricating, Air Compressor (0EXU3) 887-07607		QT	1
80		PAD, Support Beam (0U5N7) 33905061		EA	1
81	2040-01-413-1455	PADDLE, Boat (Stirring Paddle) (27901) 23092		EA	1
82	5315-01-527-0166	PIN, Quick Release (39428) 98480A135		EA	4
83	7240-00-138-7985	PITCHER, Priming (27901) 80120		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

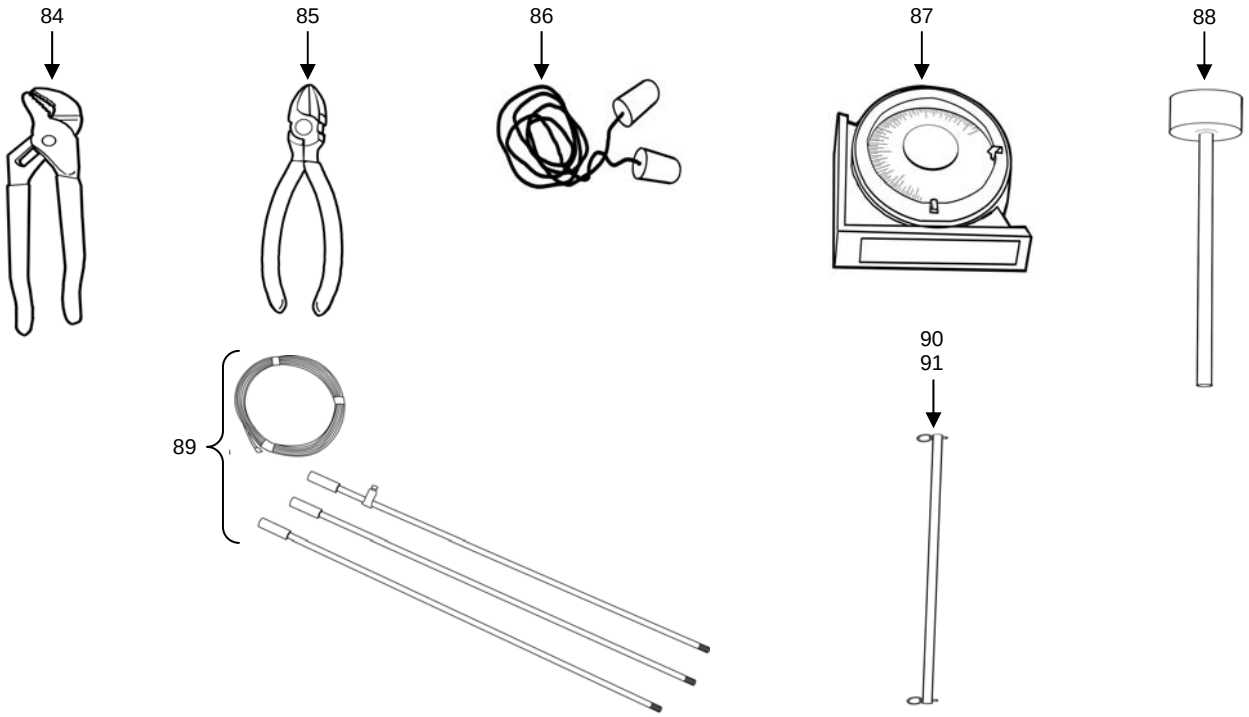

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
84	5120-00-069-5230	PLIERS, Slip Joint (71379) 10310-006-8		EA	1
85	5110-01-131-7095	PLIERS, Diagonal (43786) CS9336C		EA	1
86	6515-01-413-7414	PLUG, Ear (3W556) 0485		PR	10
87	5210-01-462-6741	PROTRACTOR (Level) (6X622) 939840		EA	1
88	4610-01-527-0101	PUSHER, RO Element (0U5N7) 33901222		EA	1
89	3820-00-930-6086	ROD ASSEMBLY, Ground (18990) 30162		EA	1
90	9510-01-527-6320	ROD, Pump Skid Retaining, Long, 32.5 in. (0U5N7) 33901219		EA	2
91	9510-01-527-6321	ROD, Pump Skid Retaining, Short 20.25 in. (0U5N7) 33901228		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

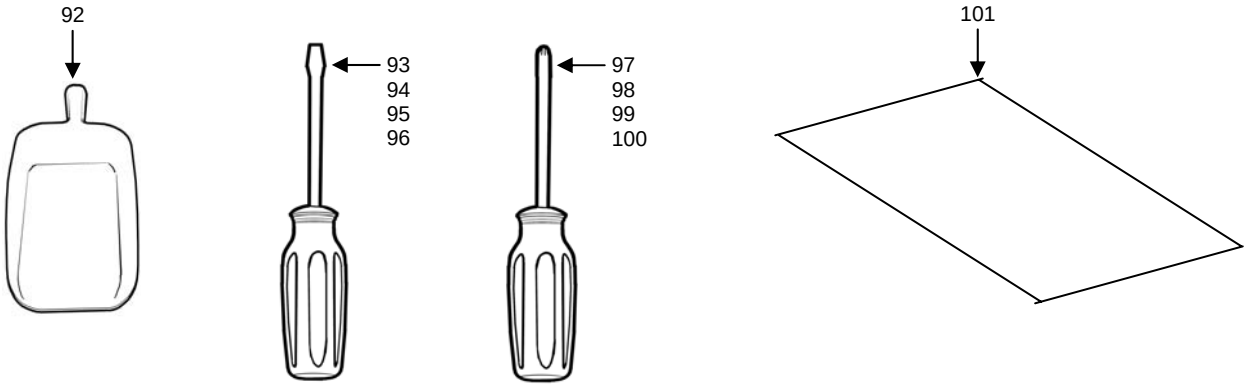

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
92	6640-01-035-7935	SCOOP, Large (1UD63) 80012		EA	1
93	5120-01-398-9399	SCREWDRIVER, Flat Tip, 1/8 in. x 3 in. (53800) 9-47440		EA	1
94	5120-01-398-9400	SCREWDRIVER, Flat Tip, 3/16 x 4 in. (53800) 9-47441		EA	1
95	5120-01-398-9403	SCREWDRIVER, Flat Tip, 1/4 in. x 6 in. (53800) 9-47445		EA	1
96	5120-01-398-9404	SCREWDRIVER, Flat Tip, 5/16 in. x 8 in. (53800) 9-47447		EA	1
97	5120-01-398-9402	SCREWDRIVER, Cross Tip, #0 x 3 in. (53800) 9-47434		EA	1
98	5120-01-398-9405	SCREWDRIVER, Cross Tip, #1 x 4 in. (53800) 9-47435		EA	1
99	5120-01-398-9244	SCREWDRIVER, Cross Tip, #2 x 4 in. (53800) 9-47436		EA	1
100	5120-01-398-9245	SCREWDRIVER, Cross Tip, #3 x 6 in. (53800) 9-47437		EA	1
101		SHEETS, Roof Support (0U5N7) 33902557		EA	3

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

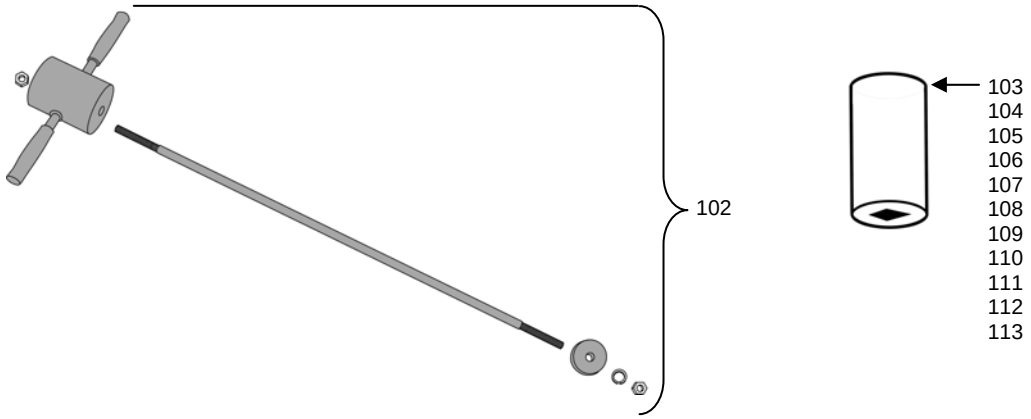

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
102	5120-01-013-1676	SLIDE HAMMER, Ground Rod (45225) P74-144		EA	1
103	5120-01-431-2720	SOCKET, 1/2 in. (2K880) 45116		EA	1
104	5120-01-431-2589	SOCKET, 11/16 in. (2K880) 45022		EA	1
105	5120-01-431-2591	SOCKET, 13/16 in. (2K880) 45026		EA	1
106	5120-01-431-2614	SOCKET, 15/16 in. (2K880) 45030		EA	1
107	5120-01-431-2600	SOCKET, 3/4 in. (2K880) 45024		EA	1
108	5120-01-431-2717	SOCKET, 3/8 in. (2K880) 45112		EA	1
109	5120-01-431-2596	SOCKET, 5/8 in. (2K880) 45020		EA	1
110	5120-01-431-2778	SOCKET, 7/16 in. (2K880) 45114		EA	1
111	5120-01-431-2595	SOCKET, 7/8 in. (2K880) 45028		EA	1
112	5120-01-431-2588	SOCKET, 9/16 in. (2K880) 45118		EA	1
113	5120-01-431-2718	SOCKET, Spark Plug, 5/8 in. (2K880) 4420		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

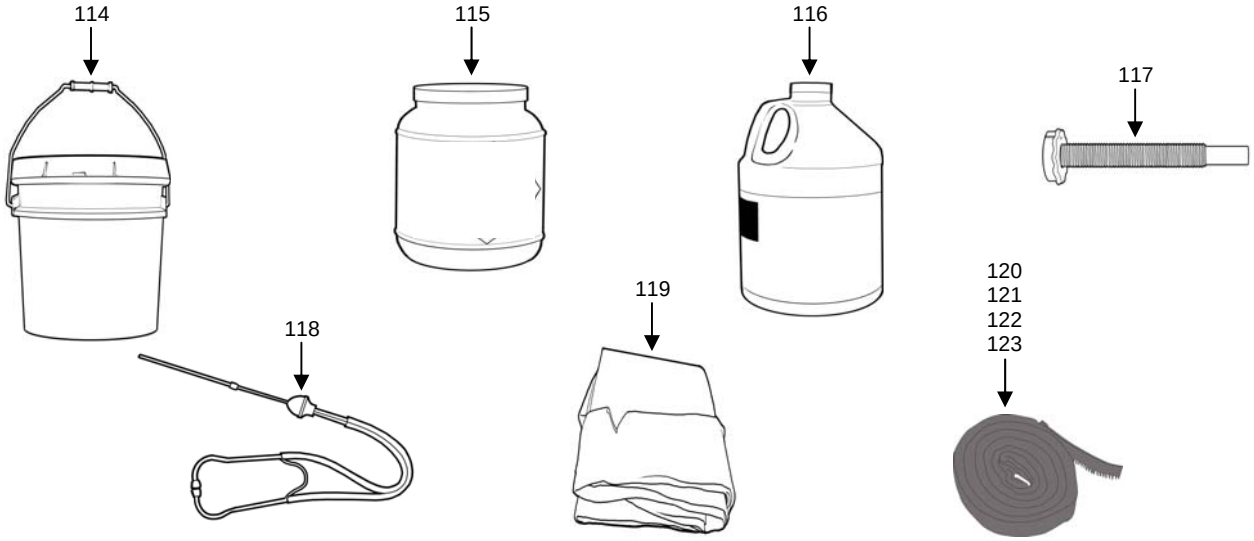

Table 2. Basic Issue Items List – Continued.

1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
114		SODIUM BISULFITE, 10-lb Bucket. (09647) 803-07892		EA	1
115		SODIUM BISULFITE, 12-oz. Bags, Container of 10 (09647) 803-07880		EA	1
116		SODIUM HYDROXIDE (Caustic), 1 gal. bottle 803-07888		GL	4
117	7240-00-177-6154	SPOUT, Fuel Can (2C071) 04353		EA	1
118	4940-00-494-1533	STETHOSCOPE, Engineer's (78495) 2001		EA	1
119	4730-01-526-2213	STRAINER, MF Feed Tank (0EXU3) 923-08139		EA	3
120	5975-01-476-8290	STRAP, Tiedown, Hook and Loop, 12 in (39428) 3955T71		EA	6
121	3990-01-527-0068	STRAP, Tiedown, Hook and Loop, 18 in (39428) 3955T72		EA	10
122	3990-01-527-0070	STRAP, Tiedown, Hook and Loop, 36 in (39428) 3955T74		EA	2
123	3990-01-527-0073	STRAP, Tiedown, Hook and Loop, 48 in (39428) 3955T75		EA	4

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

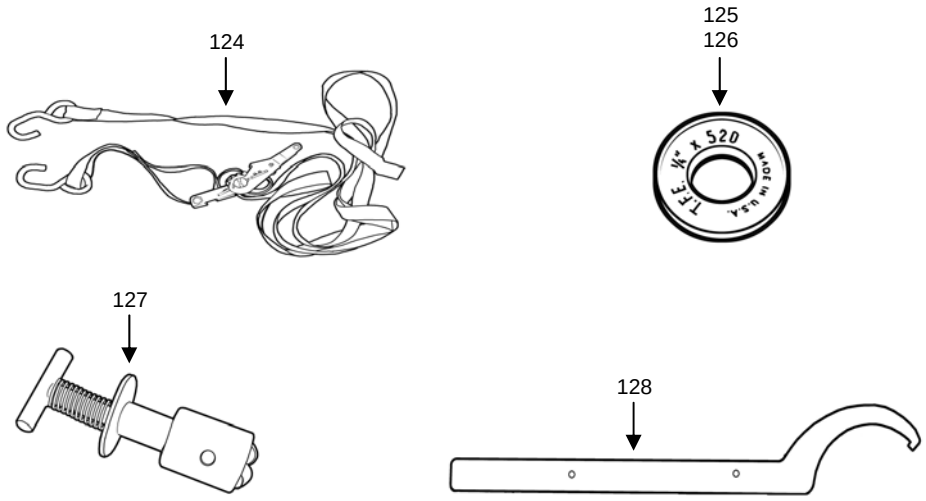

Table 2. Basic Issue Items List – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
124		STRAP, Ratchet, 1 in x 10 ft (3C2D2) R2710SH		EA	10
125	8030-00-889-3535	TAPE, Antiseizing, 1/2 in. Wide (81755) P5025-2R		EA	1
126	8030-00-889-3534	TAPE, Antiseizing, 1/4 in. Wide (81755) P5025-1R		EA	1
127		TOOL, MF Filter Bypass (0EXU3) 843-08049		EA	1
128		TOOL, MF Filter C-Spanner (0U5N7) 33902284		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS **0077 00**

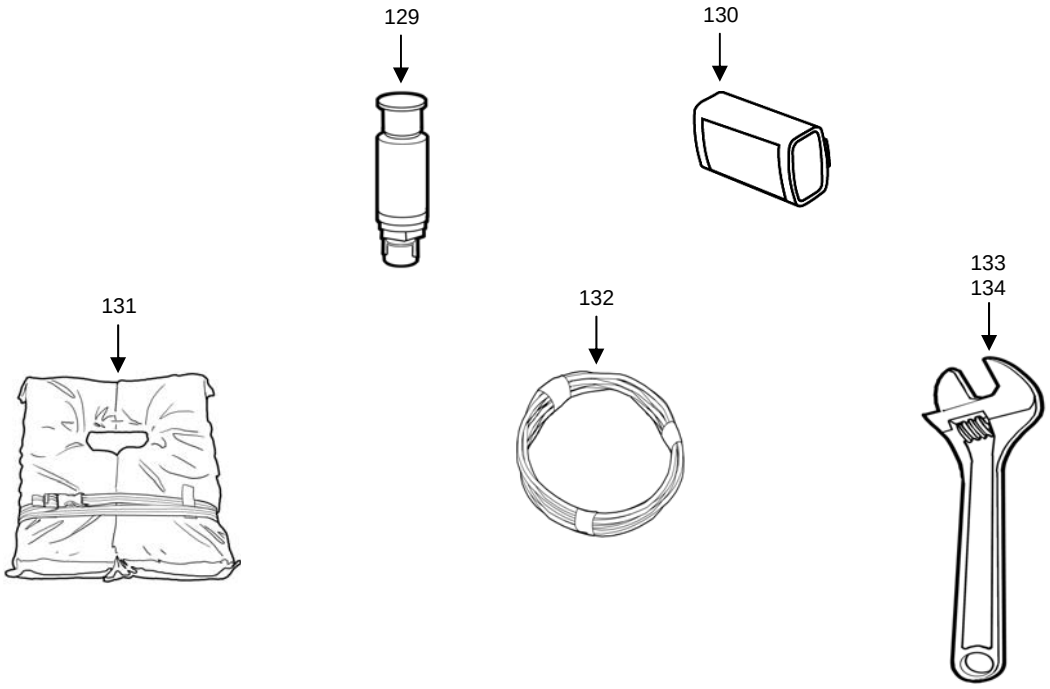

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
129	6685-01-526-3457	TRANSMITTER, Pressure, 0-100 PSIG, PT-201 (1CE49) PTX 317-8938		EA	1
130	4440-01-475-9949	VAPOR CAPSULE (08TA7) VC2-1		EA	4
131	4220-01-527-0078	VEST, Floatation (1B1X2) 250181		EA	1
132	6145-01-527-0081	WIRE, Grounding (39428) 7512K611		EA	1
133	5120-00-449-8083	WRENCH, Adjustable, 10 in. (96508) D710		EA	1
134	5120-00-240-5328	WRENCH, Adjustable, 8 in. (80063) TL476U		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0077 00**
SUPPORTING INFORMATION
COMPONENT OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS

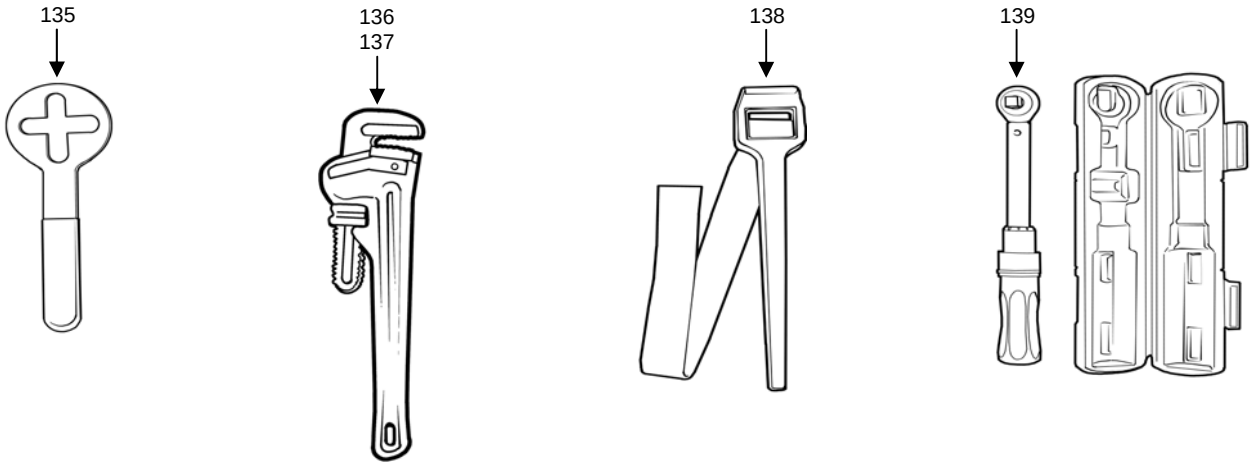

Table 2. Basic Issue Items List - Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
135	5120-01-486-5722	WRENCH, Air Compressor Purification Chamber (57328) WRH-0005		EA	1
136	5120-01-335-1031	WRENCH, Pipe, 12 in. (55719) PW12C		EA	1
137	5120-01-335-1033	WRENCH, Pipe, 18 in. (55719) PW18C		EA	1
138	5120-01-334-9858	WRENCH, Strap, 1 in. to 5 in. pipe (55719) YA826A		EA	1
139		WRENCH, Torque, with case (0-250 in.-lb.) (02JD2) 4YRO1		EA	1

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS EXTENDED CAPABILITY KITS

0078 00

SCOPE

This work package lists COEI and BII for the TWPS (Tactical Water Purification System) to help you inventory items for safe and efficient operation of the equipment.

GENERAL

The COEI and BII information is divided into the following lists:

Table 1. - Cold Weather Kit
Table 2. - Cleaning Waste Storage Kit
Table 3. - Ocean Intake Structure System Kit
Table 4. - NBC Water Treatment Kit
Table 5. - NBC Survivability Kit

Components of End Item (COEI). This list is for information purposes only and is not authority to requisition replacements. These items are part of the TWPS. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Items of COEI are removed and separately packaged for transportation or shipment only when necessary. Illustrations are furnished to help you find and identify the items.

Basic Issue Items (BII). These essential items are required to place the TWPS in operation, operate it, and to do emergency repairs. Although shipped separately packaged, BII must be with the TWPS during operation and when it is transferred between property accounts. Listing these items is your authority to request/requisition them for replacement based on authorization of the end item by the TOE/MTOE. Illustrations are furnished to help you find and identify the items.

EXPLANATION OF COLUMNS IN THE COEI AND BII LIST

Column (1) - Illus Number. Gives the number of the item illustrated.

Column (2) - National Stock Number (NSN). Identifies the stock number of the item to be used for requisitioning purposes.

Column (3) - Description, CAGEC and Part Number. Identifies the Federal item name (in all capital letters) followed by a minimum description when needed. The stowage location of COEI and BII is also included in this column. The last line below the description is the CAGEC (commercial and Government entity code) (in parentheses) and the part number.

Column (4) – Usable On Code. When applicable, gives you a code if the item you need is not the same for different models of equipment.

Column (5) - Unit of measure (U/M). Indicates the physical measurement or count of the item as issued per the National Stock Number shown in column (2).

Column (6) - Qty Rqr. Indicates the quantity required.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

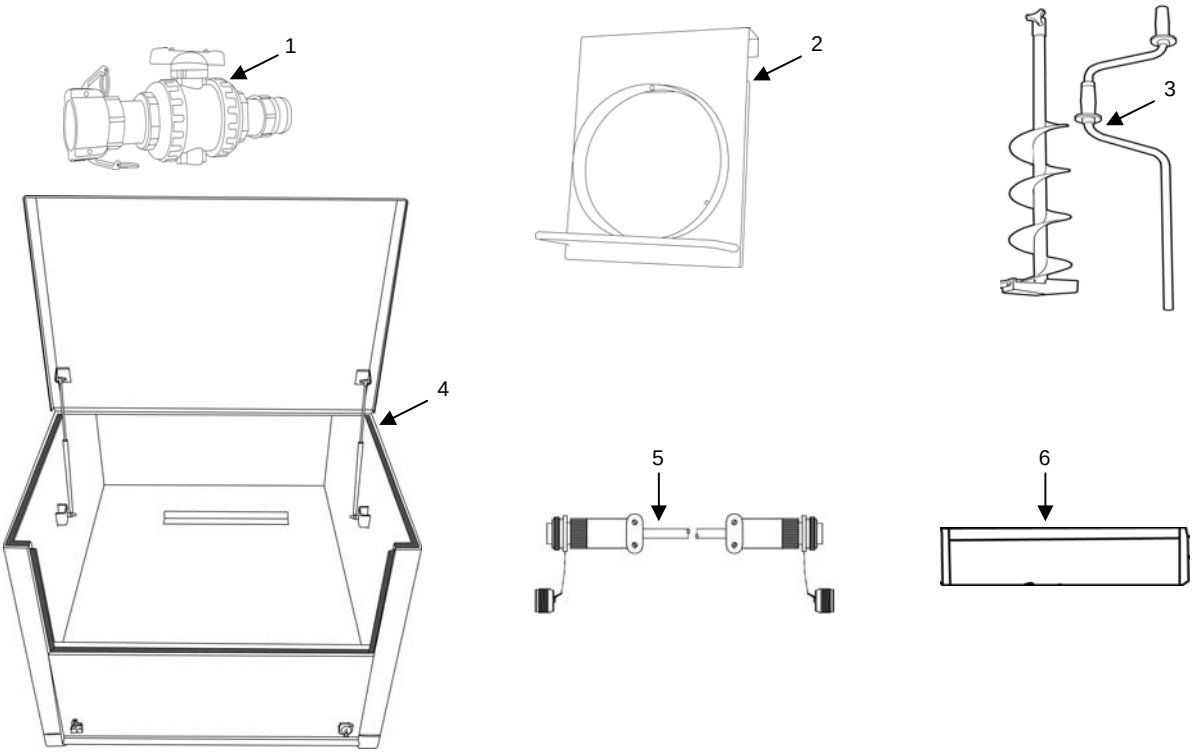

Table 1. Cold Weather Kit.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1	4820-01-526-2860	ADAPTER ASSEMBLY, A12 (0U5N7) 33901102		EA	1
2		ADAPTER, Return Air (0U5N7) 33901596		EA	1
3	4230-01-526-1138	AUGER, Ice, with handle (0U5N7) 33905017		EA	1
4		BOX, Cold Weather Kit Packout (0U5N7) 33905086		EA	1
5	6150-01-526-2419	CABLE, Raw Water Diesel Pump Heat Blanket (0U5N7) 33903003		EA	1
6		COLLAR, A-02 (0U5N&) 33905065		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

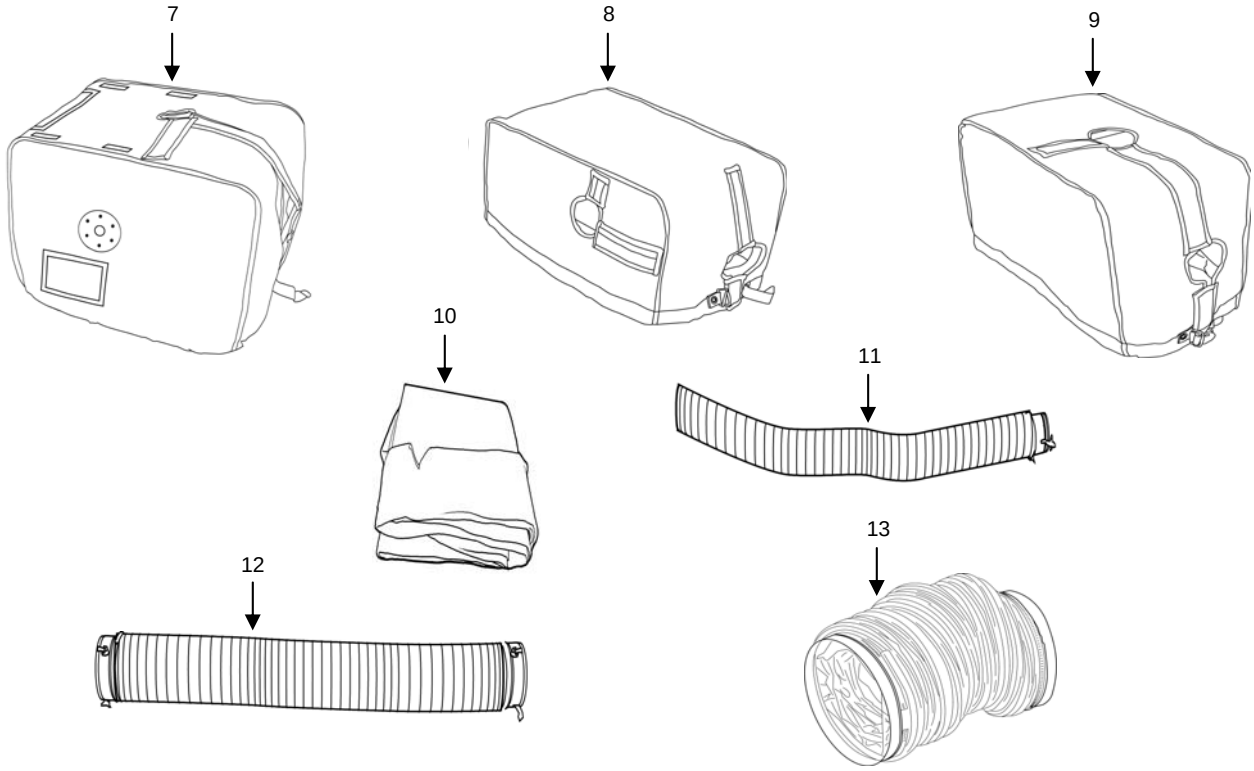

Table 1. Cold Weather Kit – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
7	2540-01-527-6215	COVER, Diesel Pump (0U5N7) 33901133		EA	2
8	2540-01-527-6248	COVER, Micro Filtration Pump (0U5N7) 33901132		EA	1
9	2540-01-527-6250	COVER, Raw Water Pump P-2 and Distribution Pump P-7 (0U5N7) 33901131		EA	2
10		COVER, Winter (0U5N7) 33905074		EA	1
11	4720-01-527-6197	DUCT, Air, Flexible, 4 in x 5.75 ft (0U5N7) 33901217		EA	1
12	4720-01-527-6187	DUCT, Air, Flexible, 8 in x 6 ft (0U5N7) 33901218		EA	2
13	4720-20-001-8512	DUCT, Air, Flexible, 12 in x 20 ft (L1308) 632-88-1220SCJLRMN/07		EA	2

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

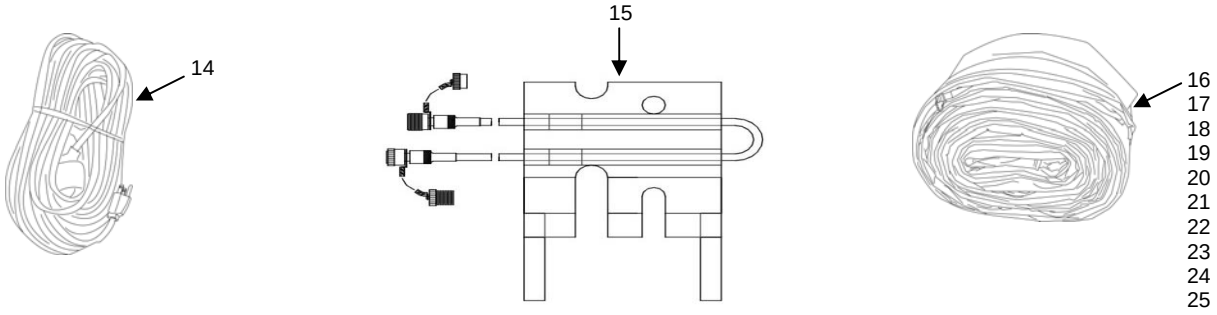

Table 1. Cold Weather Kit – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
14	6150-01-527-0085	EXTENSION CORD, 100 ft. (39428) 7438K35		EA	1
15	4540-01-526-3481	HEAT BLANKET ASSY, Adapter A-02 (0U5N7) 33901191		EA	1
16	4540-01-526-3346	HEAT BLANKET ASSY, Hose, 3 in. x 11 ft., F01-1 (0U5N7) 33901126-2		EA	1
17	4540-01-526-3345	HEAT BLANKET ASSY, Hose, 3 in. x 11 ft., F01-2 (0U5N7) 33901324		EA	1
18	4540-01-526-3347	HEAT BLANKET ASSY, Hose, 2 in. x 50.5 ft., F03-1 (0U5N7) 33901126-3		EA	1
19	4540-01-526-3348	HEAT BLANKET ASSY, Hose, 2 in. x 50.5 ft., F03-2 (0U5N7) 33901126-4		EA	3
20	4540-01-526-3355	HEAT BLANKET ASSY, Hose, 3 in. x 21 ft., F07 (0U5N7) 33901126-6		EA	1
21	4540-01-526-3354	HEAT BLANKET ASSY, Hose, 2 in. x 9, F12 (0U5N7) 33901203		EA	1
22	4540-01-526-3472	HEAT BLANKET ASSY, Hose, 1.5 in. x 41.5 ft., P02 (0U5N7) 33901126-7		EA	1
23	4540-01-526-3474	HEAT BLANKET ASSY, Hose, 2 in. x 6 ft., P03-1 (0U5N7) 33901126-8		EA	1
24	4540-01-526-3476	HEAT BLANKET ASSY, Hose, 2 in. x 6 ft., P04 (0U5N7) 33901233		EA	1
25	4540-01-526-3477	HEAT BLANKET ASSY, Hose, 2 in. x 65 ft., P05 (0U5N7) 33901232		EA	2

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

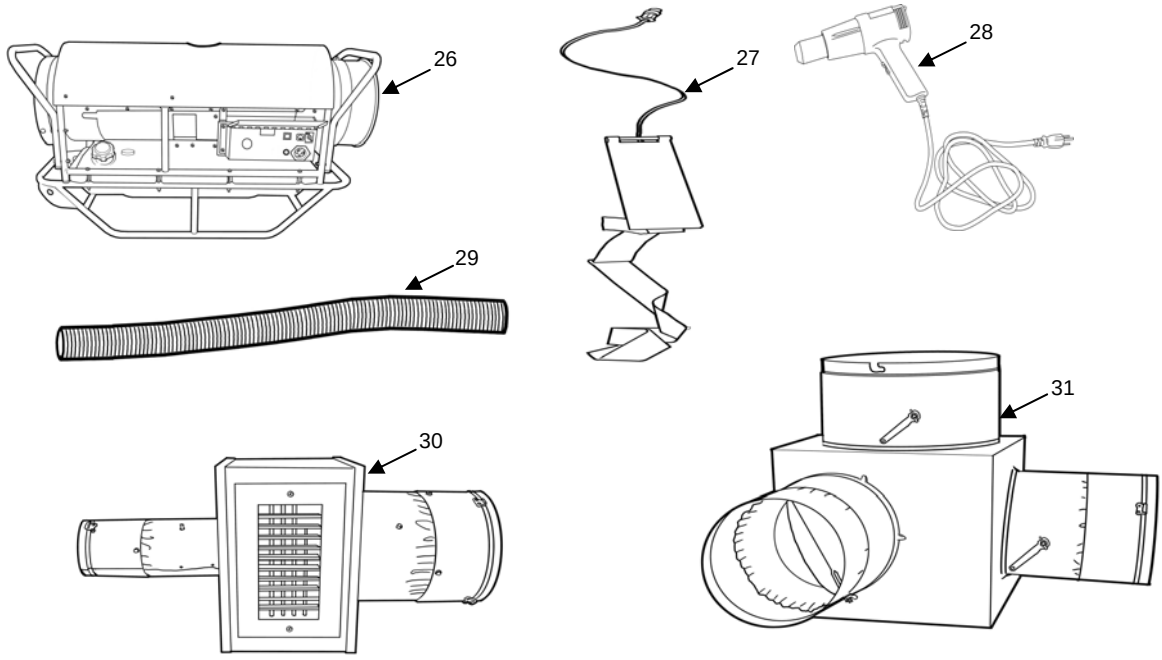

Table 1. Cold Weather Kit – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
26	4520-01-527-6260	HEATER, Portable (92878) MV60S-1		EA	1
27	4540-01-526-5918	HEATER, Pump, Strap-On (Winter) (0PKE1) 040150A7		EA	3
28	4940-01-526-2893	HEAT GUN (39428) 32605K44		EA	1
29	4720-01-527-6200	HOSE, Corrugated Metal 1-1/8 in. ID, 24 in. Long (0U5N7) 33901224		EA	2
30	4140-01-527-6186	PLENUM, Right Hot Air (0U5N7) 33901273		EA	1
31	4140-01-527-6184	PLENUM, Main Hot Air (0U5N7) 33901272		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

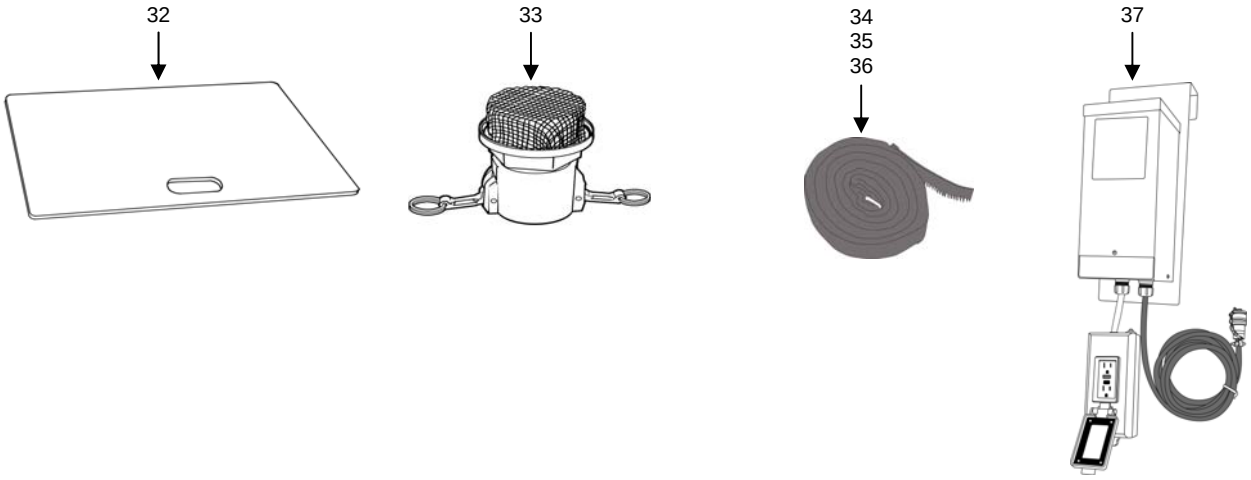

Table 1. Cold Weather Kit – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
32	2540-01-527-0436	PLATE, Pump (0U5N7) 33902269		EA	4
33	4730-01-527-6258	STRAINER, Ice Intake (0U5N7) 33901172		EA	1
34	3990-01-527-0068	STRAP, Hook and Loop, 18 in. (39428) 3955T72		EA	2
35	3990-01-527-0070	STRAP, Hook and Loop, 36 in. (39428) 3955T74		EA	7
36	3990-01-527-0073	STRAP, Hook and Loop, 48 in. (39428) 3955T75		EA	7
37	6120-01-526-3099	TRANSFORMER, General Purpose (0U5N7) 33903044		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

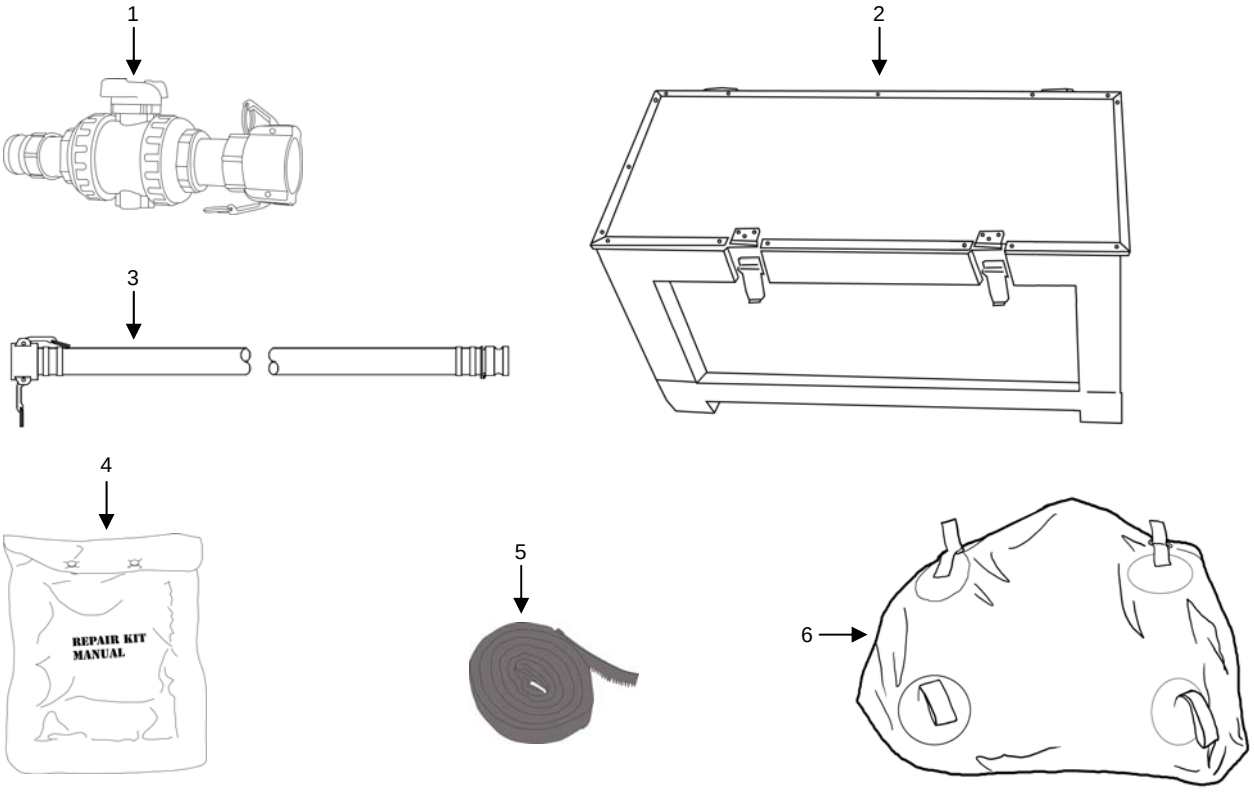

Table 2. Cleaning Waste Storage Kit.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1	4820-01-526-0795	ADAPTER ASSY, A16 (0U5N7) 33901187		EA	3
2		BOX, Cleaning Waste Storage Kit Packout (0U5N7) 33905089		EA	1
3	4720-01-526-2855	HOSE ASSY, R06, 2-in x 10-ft. (0U5N7) 33901096-7		EA	3
4	5430-01-359-1078	REPAIR KIT, Collapsible Tank (58536) A-A-52022		EA	1
5	3990-01-527-0070	STRAP, Hook and Loop, 36 in. (39428) 3955T74		EA	2
6	5340-01-527-0341	TANK, Fabric, 1500 Gallons, Cleaning Waste (05YK6) RCF-1.5K-W-OT-Z-WW		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

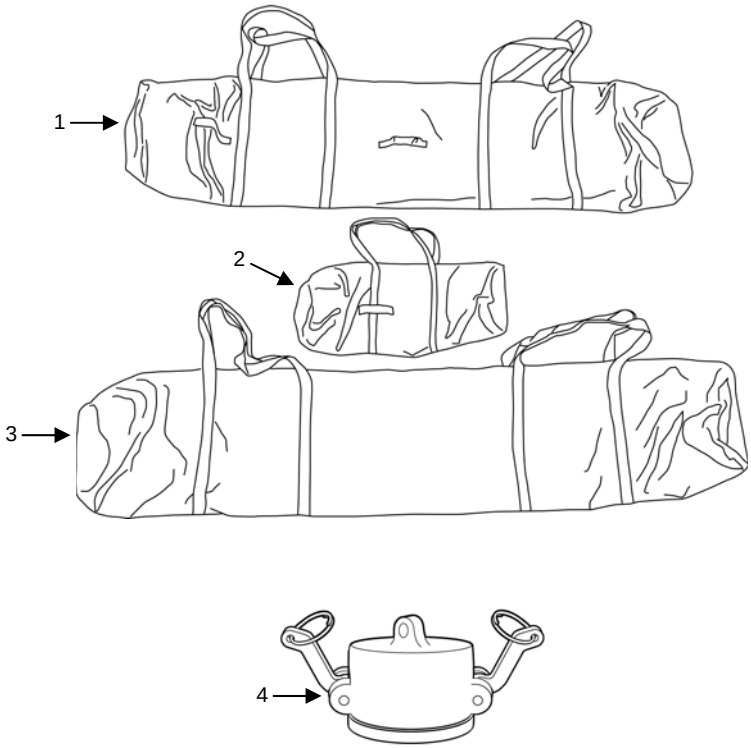

Table 3. Ocean Intake Structure System.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1		Bag, Storage, OISS Long Riser Pipes (0U5N7) 33905077		EA	2
2		Bag, Storage, OISS Short Riser Pipes (0U5N7) 33905079		EA	1
3		Bag, Storage, OISS Wellpoint (0U5N7) 33905078		EA	1
4		CAP, Hose, Protective (OISS) (39428) 5535K44		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

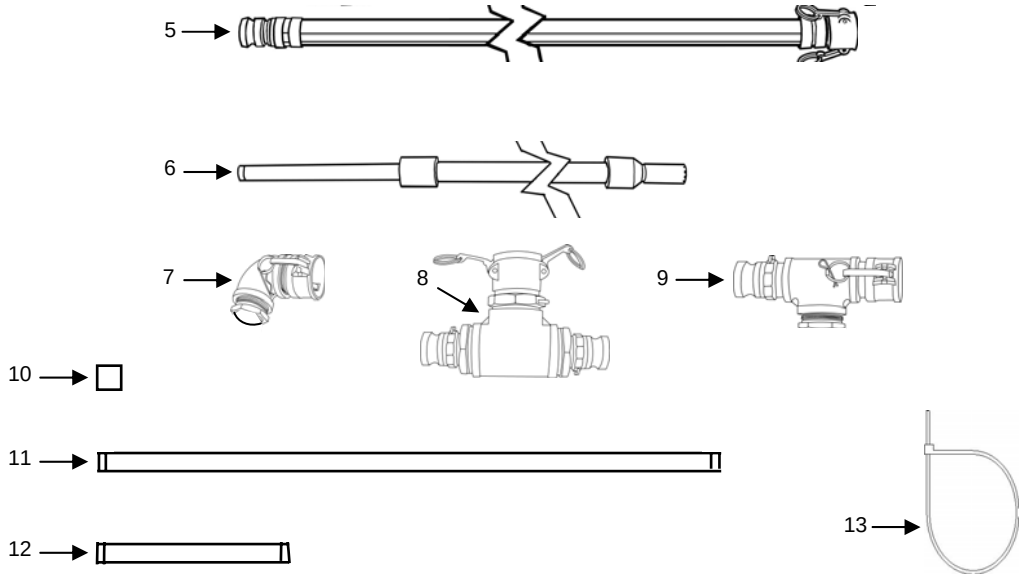

Table 3. Ocean Intake Structure System – Continued.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
5	4730-01-526-5657	HOSE ASSY, (OISS), 2-in. x 10-ft. (0EXU3) 861-08399		EA	6
6	4710-01-526-3796	PIPE ASSY, CPVC (OISS) (0EXU3) 507-12400		EA	4
7	4730-01-526-3536	PIPE ASSY, ELBOW (OISS) (0EXU3) 507-12433		EA	2
8	4730-01-526-3534	PIPE ASSY, TEE, 3-INCH (OISS) (0EXU3) 507-12430		EA	1
9	4730-01-526-3530	PIPE ASSY, TEE, 2-INCH (OISS) (0EXU3) 507-12431		EA	2
10	4730-01-526-3540	PIPE COUPLING (OISS) (0EXU3) 858-07694-000		EA	4
11	4730-01-526-3571	PIPE NIPPLE, 60-INCH (OISS) (OEXU3) 857-08404-000		EA	8
12	4730-01-526-3568	PIPE NIPPLE, 24-INCH (OISS) (OEXU3) 857-08405-000		EA	4
13	5975-01-481-4977	TIES, Wire, package of 100 (39428) 7130K56		EA	1

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0078 00**
SUPPORTING INFORMATION
COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) -
MARINE CORPS EXTENDED CAPABILITY KITS

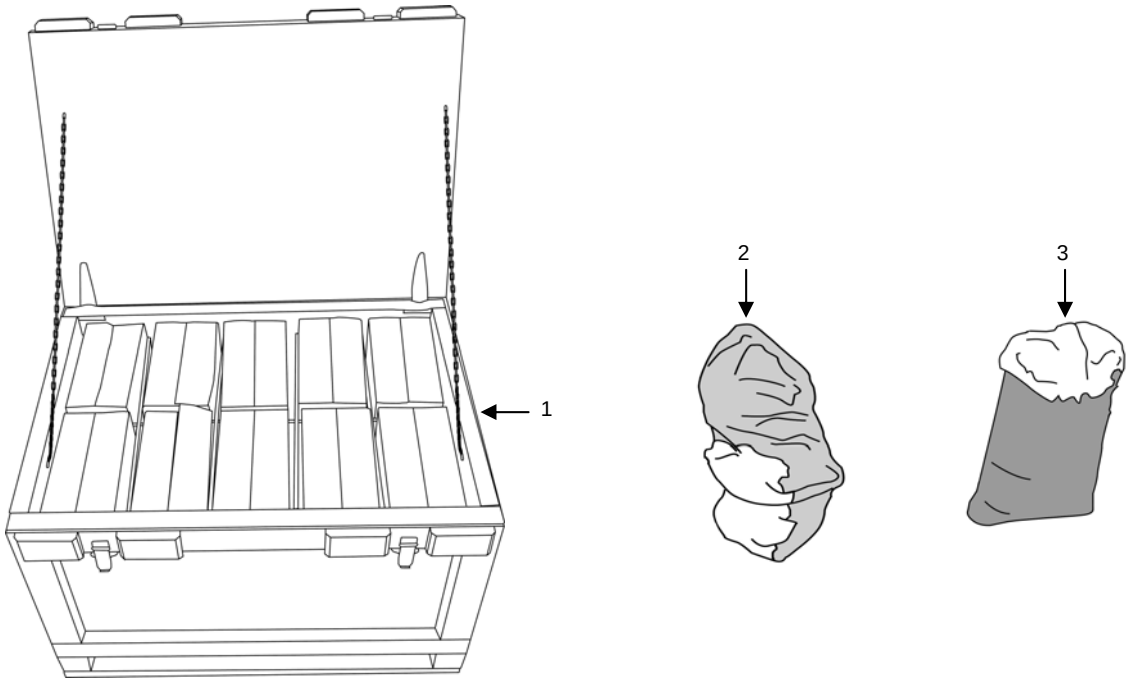

Table 4. NBC Water Treatment Kit.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1		BOX, NBC Media Shipping (0EXU3) 626-08800		EA	1
2		MEDIA, Resin (NBC Kit) (0EXU3) 803-07831		EA	6
3		MEDIA, Carbon (NBC Kit) (0EXU3) 803-07832		EA	4

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS (BII) - MARINE CORPS EXTENDED CAPABILITY KITS **0078 00**

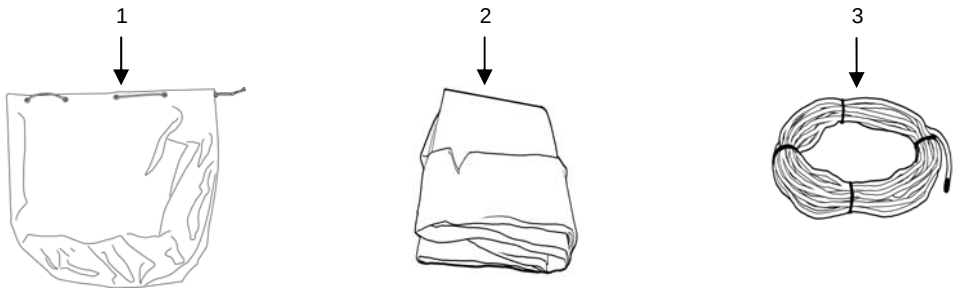

Table 5. NBC Survivability Kit.

(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION (CAGE) and PART NUMBER	(4) USABLE ON CODE	(5) U/M	(6) QTY RQR
1		BAG, Storage, Contamination Avoidance Cover (0U5N7) 33905080		EA	1
2		COVER, Contamination Avoidance (0U5N7) 33905063-2		EA	1
3		ROPE, Contamination Cover, 60 ft. (0U5N7) 3390-2478-3		EA	3

END OF WORK PACKAGE

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION EXPENDABLE AND DURABLE ITEMS LIST

0079 00

INTRODUCTION

Scope

This work package lists expendable and durable items you will need to operate and maintain the Tactical Water Purification System (TWPS). This list is for information only and is not authority to requisition the listed items. These items are authorized to you by CTA 50-970, Expendable/Durable Items (Except Medical, Class V Repair Parts, and Heraldic Items), or CTA 8-100, Army Medical Department Expendable/Durable Items.

Refer to TM 9-6115-672-14 for expendable and durable items for the Generator, Skid-Mounted, Tactical Quiet, 60 KW, 50/60 Hz.

Refer to TM 10-6630-222-12&P for expendable and durable items for the Water Quality Analysis Set: Purification (WQAS-P).

Explanation of Columns in the Expendable/Durable Items List

Column (1) – Item Number. This number is assigned to the entry in the list and is referenced in the narrative instructions to identify the item (e.g., Use brake fluid (item 5, WP 0098 00).).

Column (2) – Level. This column identifies the lowest level of maintenance that requires the listed item (C=Operator/Crew, O=Unit Maintenance, F=Direct Support).

Column (3) – National Stock Number (NSN). This is the NSN assigned to the item; use it to request or requisition the item.

Column (4) – Item Name, Description, Commercial and Government Entity Code (CAGEC), and Part Number (P/N). This column provides the other information you need to identify the item.

Column (5) – Unit of Measure (U/M). This code shows the physical measurement or count of an item, such as gallon, dozen, gross, etc.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION EXPENDABLE AND DURABLE ITEMS LIST

0079 00

Table 1. Expendable and Durable Items List.

(1) ITEM NO.	(2) LEVEL	(3) NSN	(4) ITEM NAME, DESCRIPTION, (CAGEC), PART NUMBER	(5) U/M
1	O	8040-01-501-5557	Adhesive, Silicone, 3 oz tube (71984) RTV 732	TU
2	C		Antiseize Compound, Marine Grade, 8 oz can (1Y2R4) NMBT-8	CN
3	C		ANTISCALANT (0EXU3) 803-07886	GL
4	C	8415-00-234-9253	Apron, Laboratory (80063) MC111	EA
5	C	6135-01-447-0949	Battery, Chlorine Analyzer and TDSMeter, 9v-DC, package of 2 (80204) 1604A	EA
6	C	6135-00-835-7211	Battery, Flashlight, Size D, package of 6 (77542) HD-D	PG
7	C	5110-01-428-5269	Blade, Knife, package of 5 (1CV05) 11-921	PG
8	C		Bottle, Measuring, Clear PVC (27901) 77075	EA
9	C		Calcium Hypochlorite, Package of ten 4-oz packs (0EXU3) 803-07882	PG
10	C		Calibration Solution – KCI-18000, 32-oz. (30053) KCL-18000 (32 OZ)	OZ
11	C		Calibration Solution – KCI-70, 32-oz. (30053) KCL-70 (32 OZ)	OZ
12	C		Calibration Solution – pH-7.00, 32-oz. (30053) BUFFER (32 OZ)	OZ
13	C		Case, Carrying, Marine Corps TDS Meter (30053) PKU	EA
14	C		Citric Acid, 20-lb bucket (0EXU3) 803-07891	EA
15	O	5350-00-161-9066	Cloth, Abrasive, package of 50 sheets (76318) 05144-02459	PG
16	C		Cloth, Drop, Fuel Absorbent (39428) 7516T48	EA
17	C	8030-00-414-7423	Corrosion Preventive Compound, 16 oz spray bottle, box of 12 (03GK3) T32CP90S6	BX
18	C		Detergent, High pH (0EXU3) 803-07884	EA
19	O	6850-00-664-5685	Dry Cleaning Solvent, 1 qt can (58536) AA59601-1D	QT

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0079 00**
SUPPORTING INFORMATION
EXPENDABLE AND DURABLE ITEMS LIST

Table 1. Expendable and Durable Items List. – Continued.

(1) ITEM NO.	(2) LEVEL	(3) NSN	(4) ITEM NAME, DESCRIPTION, (CAGEC), PART NUMBER	(5) U/M
20	C	4510-01-496-6954	Eyewash, Eyewash Station, Refill (25795) 5T064	EA
21	C	6810-01-359-4919	Glycerin, 16 oz bottle (97403) 13229E0172	BT
22	O	9150-01-197-7690	Grease, Automotive and Artillery (81349) M-10924C	CN
23	O	9150-00-053-0101	Grease, Molybdenum Disulfide, 3 lb can (94999) MOLYKOTE Z	CN
24	C	6850-00-569-7690	Leak Test Compound, 1 gal bottle (03530) 372E	GL
25	C		Lubricant, Silicone (0EXU3) 887-07510-000	OZ
26	C		Lubricant, Valve Seal (12474) 6020-041	TU
27	C	9150-01-178-4725	Lubricating Oil, Engine, 1 qt bottle, SAE 15W-40 (81349) 15W-40/QT/BT/2104	QT
28	C		Media, Resin, Package of 6 Bags (0EXU3) 803-07831	PG
29	C		Media, Carbon, Package of 4 bags (0EXU3) 803-07832	PG
30	C		Oil, Air Compressor, 1 qt bottle (0EXU3) 887-07607-000	QT
31	C	7920-00-151-6120	Pad, Scouring, package of 10 (83421) 7920-00-151-6120	PG
32	C	9150-00-250-0926	Petrolatum, Technical, 1.75 lb can (82146) 14P1	CN
33	C	7920-00-205-1711	Rag, Wiping (80244) 7920-00-205-1711	BE
34	C		Reagent Kit, Chlorine Analyzer (free chlorine and total chlorine tablets) (05668) 99581-54)	EA
35	O	8030-01-025-1692	Sealing Compound, Loctite 242, 250 cc bottle (05972) 24241	BT
36	O		Sealing Compound, 1 pt can (05972) 30557	CN

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0079 00**
SUPPORTING INFORMATION
EXPENDABLE AND DURABLE ITEMS LIST

Table 1. Expendable and Durable Items List. – Continued.

(1) ITEM NO.	(2) LEVEL	(3) NSN	(4) ITEM NAME, DESCRIPTION, (CAGEC), PART NUMBER	(5) U/M
37	O	8030-01-505-0628	Sealing Compound, 6 oz tube with separate catalyst (83574) PR-1440 B-2	CA
38	C		SODIUM BISULFITE, 10-lb Bucket. (09647) 803-07892	EA
39	C		SODIUM BISULFITE, 12-oz. Bags, Container of 10 (09647) 803-07880	EA
40	C	6810-01-386-9964	Sodium Carbonate, 50 lb container (3D914) 90111	EA
41	C		Sodium Hydroxide (Caustic), 1 gal. bottle 803-07888	GL
42	C	9905-00-537-8955	Tag, Marker, package of 50 (64067) 9905-00-537-8955	PG
43	C	8030-00-889-3535	Tape, Antiseizing, roll, 1/2" wide (81755) P5025-2R	EA
44	C	8030-00-889-3534	Tape, Antiseizing, roll, 1/4" wide (81755) P5025-1R	EA
45	C	5975-01-481-4977	Ties, Wire, Package of 100 (39428) 7130K56	EA
46	C	4440-01-475-9949	Vapor Capsule, Corrosion Inhibiting (08TA7) VC2-1	EA

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0080 00**
SUPPORTING INFORMATION
OPERATING DATA LOG

OPERATING DATA LOG

An Operating Data Log is included in this work package. Entries on the data sheet are derived from instrument readings on the Operator Control Panel (OCP) and are recorded hourly. Submit the daily report according to specific operational instructions.

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0080 00**
SUPPORTING INFORMATION
OPERATING DATA LOG

UNIT SERIAL #_____. LOCATION _____. WATER SOURCE _____.

DATE	TIME	OP TIME HRS	FEED TDS MG/L	MF FLOW GPM	MF TMP PSI	RO FEED FLOW GPM	RO FEED PRESS PSIG	REJ FLOW GPM	% SALT REJECT	PROD FLOW GPM	PROD TDS MG/L	TOTAL PROD GAL	FEED TEMP ^{0}F	COMMENTS

Note: Feed TDS is as measured with hand held TDS meter. Adjust Feed TDS Set switch to measured value before completing data.

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

OPERATOR MAINTENANCE LOG

An Operator Maintenance Log is included in this work package. As a preventive maintenance action is performed in accordance with the PMCS, recording the action in this log will ensure that the action was completed and will not be duplicated.

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

TWPS OPERATOR MAINTENANCE LOG
Page 1

Unit Serial #: _____

Preventive Maintenance Action Monthly	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
Monthly fire extinguisher check												
Diesel engine monthly fuel drain												

Preventive Maintenance Action - Time	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter
P-1 raw water diesel engine oil replacement, 100 hours engine operation												
P-8 extended distribution diesel engine oil replacement, 100 hours engine operation												
Air compressor belt check every 100 hours												
P-1 raw water diesel engine fuel filter cleaning, 200 hours engine operation												

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

TWPS OPERATOR MAINTENANCE LOG
Page 2

Unit Serial #: _____

Preventive Maintenance Action - Time	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter
P-8 extended distribution diesel engine fuel filter cleaning, 200 hours engine operation												
P-1 raw water diesel engine air filter check, 200 hours engine operation												
P-8 extended distribution diesel engine air filter check, 200 hours engine operation												
Air system filter (AF-1) cleaning & rotation, every 300 hours												
Air system filter (AF-1) replacement after third rotation, every 900 hours												

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

TWPS OPERATOR MAINTENANCE LOG
Page 3

Unit Serial #: _____

Preventive Maintenance Action - Time	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter
Air system filter (AF-2) replacement every 300 hours												
MF Integrity test, beginning and end of deployment or 300 hours												
P-1 raw water diesel engine fuel filter replacement every 400 hours engine operation												
P-8 extended distribution diesel engine fuel filter replacement every 400 hours engine operation												
P-1 raw water diesel engine oil filter replacement every 400 hours engine operation												
P-8 extended distribution diesel engine oil filter replacement every 400 hours engine operation												

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

TWPS OPERATOR MAINTENANCE LOG
Page 4

Unit Serial #: _____

Preventive Maintenance Action - Time	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter
P-1 raw water diesel engine air filter replacement every 400 hours engine operation												
P-8 extended distribution diesel engine air filter replacement every 400 hours engine operation												
P-1 raw water diesel engine valve adjustment every 500 hours												
P-8 extended distribution diesel engine valve adjustment every 500 hours												
RO Conductivity Test, beginning and end of deployment or 500 hours												

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

TWPS OPERATOR MAINTENANCE LOG
Page 5

Unit Serial #: _____

Preventive Maintenance Action - Time	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter
Air Compressor Oil Change, 1000 hours												
Diesel engine cylinder head maintenance and piston ring replacement, 1000 hours												
P-5 High Pressure Pump (front pump) replace valves and pistons, 1000 hours												
P-6 High Pressure Pump (back pump) replace valves and pistons, 1000 hours												
Air system intermediate separator and CO-1 coalescer filter element clean and inspect, 1500 hours												

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

TWPS OPERATOR MAINTENANCE LOG
Page 6

Unit Serial #: _____

Preventive Maintenance Action - Time	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter
P-5 High Pressure Pump (front pump) replace valves, pistons, cluster plate and shaft seal, 2000 hours												
P-6 High Pressure Pump (back pump) replace valves, pistons, cluster plate and shaft seal, 2000 hours												
Air compressor head/valve assembly replacement, 3000 hours												
P-3 MF Feed Pump motor apply grease through the zirk fitting, annually												
P-4 RO Feed Pump motor apply grease through the zirk fitting, annually												

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0081 00**
SUPPORTING INFORMATION
OPERATOR MAINTENANCE LOG

TWPS OPERATOR MAINTENANCE LOG
Page 7

Unit Serial #: _____

Preventive Maintenance Action - Time	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter	Date Time Hr Meter
Air Compressor motor apply grease through the zirk fitting, annually												
P-5 High Pressure Pump motor (front pump) apply grease through the zirk fitting, annually												
P-6 High Pressure Pump motor (back pump) apply grease through the zirk fitting, annually												

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0082 00**
SUPPORTING INFORMATION
REVERSE OSMOSIS ELEMENT PERFORMANCE LOG

REVERSE OSMOSIS ELEMENT PERFORMANCE LOG

A Reverse Osmosis (RO) Element Performance Log is included in this work package. Maintaining the log will help determine the need for RO element replacement. The RO Element Performance Log Form should be kept in this manual and locally reproduced when forms are needed.

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0082 00**
SUPPORTING INFORMATION
RO ELEMENT PERFORMANCE LOG

RO ELEMENT PERFORMANCE LOG

Unit Serial #: _____

Test date: _____ Operating Hour Meter Reading: _____

Product flow: _____ Product TDS: _____ Source water TDS: _____

Source water Temp: _____ Source water location: _____

Element #	Product TDS	Product Flow	Element #	Product TDS	Product Flow
1					
			2		
			3		
4					
5					
			6		
			7		
8					
9					
			10		

Unit Serial #: _____

Test date: _____ Operating Hour Meter Reading: _____

Product flow: _____ Product TDS: _____ Source water TDS: _____

Source water Temp: _____ Source water location: _____

Element #	Product TDS	Product Flow	Element #	Product TDS	Product Flow
1					
			2		
			3		
4					
5					
			6		
			7		
8					
9					
			10		

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TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0083 00**
SUPPORTING INFORMATION
REVERSE OSMOSIS % CLEAN CALCULATION

REVERSE OSMOSIS % CLEAN CALCULATION

This work package provides the procedure for calculating the Reverse Osmosis (RO) % Clean Factor. This factor indicates the water production performance of the TWPS RO membranes relative to the performance of new, clean membranes. The calculation compares the permeability, or ease of water flow, through the RO membranes with the permeability of new clean membranes. The result is expressed as a percentage. For example, a % Clean Factor of 85% means that the RO membranes are performing at 85% of the new, clean membrane performance. As the % Clean Factor becomes lower, the required operating pressure increases. Refer to WP 0016 for how to use the % Clean Factor data to determine the need for RO cleaning and to determine the performance limitations resulting from low % Clean values.

The data required to perform the calculation is obtained from the Operating Data Log, WP 0080.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) SUPPORTING INFORMATION REVERSE OSMOSIS % CLEAN CALCULATION

0083 00

RO % CLEAN CALCULATION

The following data from the Operational Data Log is required:

- Feed TDS (mg/l)
- RO Feed Pressure (psig)
- Product Flow (gpm)
- Feed Temperature (^{0}F)

Step 1

With the Feed TDS and the Feed Temperature, use Table 1 to determine Factor A. Use the table values closest to the actual Feed TDS and Feed Temperature to determine Factor A.

Table 1. Factor A.

Feed TDS	Feed Temperature (^{0}F)																
	32	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
500	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1000	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6
2000	10	10	10	10	10	11	11	11	11	11	11	11	11	11	11	12	12
3000	15	15	15	15	16	16	16	16	16	16	17	17	17	17	17	17	17
4000	20	21	21	21	21	21	22	22	22	22	22	23	23	23	23	23	24
5000	25	25	26	26	26	26	27	27	27	27	28	28	28	28	29	29	29
6000	31	31	31	32	32	32	33	33	33	34	34	34	34	35	35	35	35
7000	36	36	37	37	37	38	38	38	39	39	39	40	40	41	41	41	42
8000	41	42	42	42	43	43	44	44	45	45	45	46	46	47	47	48	48
9000	47	47	47	48	48	49	49	50	50	51	51	52	52	53	53	53	54
10000	51	51	52	52	53	53	54	54	55	55	56	56	57	58	58	59	59
11000	57	57	58	58	59	60	60	61	61	62	62	63	64	64	65	65	66
12000	62	62	63	64	64	65	66	66	67	68	68	69	69	70	71	71	72
13000	67	68	68	69	70	70	71	72	72	73	74	75	75	76	77	77	78
14000	72	73	74	74	75	76	77	77	78	79	80	80	81	82	82	83	84
15000	77	78	78	79	80	81	81	82	83	84	85	85	86	87	88	89	89
16000	83	83	84	85	86	87	88	88	89	90	91	92	93	93	94	95	96
17000	88	89	89	90	91	92	93	94	95	96	97	97	98	99	100	101	102
18000	93	94	95	96	97	98	98	99	100	101	102	103	104	105	106	107	108
19000	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
20000	104	104	105	106	107	108	109	110	112	113	114	115	116	117	118	119	120
21000	109	109	110	112	112	114	115	116	117	118	119	120	122	123	124	125	126
22000	114	115	116	117	118	119	120	122	123	124	125	126	127	129	130	131	132
23000	119	120	121	122	123	125	126	127	128	130	131	132	133	134	136	137	138
24000	124	125	126	128	129	130	131	133	134	135	136	138	139	140	141	143	144
25000	129	130	132	133	134	136	137	138	139	141	142	143	145	146	147	149	150
26000	135	135	137	138	140	141	142	144	145	146	148	149	151	152	153	155	156
27000	140	141	142	144	145	146	148	149	151	152	153	155	156	158	159	161	162
28000	145	146	147	149	150	152	153	155	156	158	159	161	162	164	165	167	168
29000	150	151	153	154	156	157	159	160	162	162	165	166	168	169	171	172	174
30000	155	156	158	159	161	163	164	166	167	169	171	172	174	175	177	178	180
31000	161	162	163	165	166	168	170	171	173	175	176	178	180	181	183	184	186
32000	166	167	168	170	172	173	175	177	179	180	182	184	185	187	189	190	192
33000	171	172	174	175	177	179	181	182	184	186	188	189	191	193	195	196	198
34000	176	77	179	181	183	184	186	188	190	192	193	195	197	199	200	202	204

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0083 00**
SUPPORTING INFORMATION
REVERSE OSMOSIS % CLEAN CALCULATION

Table 1. Factor A – Continued.

Feed	Feed Temperature (^{0}F)																
TDS	32	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
35000	181	182	184	186	188	190	192	193	195	197	199	201	203	205	206	208	210
36000	186	188	190	191	193	195	197	199	201	203	205	207	208	210	212	214	216
37000	192	193	195	197	199	201	203	205	206	208	210	212	214	216	218	220	222
38000	197	198	200	202	204	206	208	210	212	214	216	218	220	222	224	226	228
39000	202	203	205	207	209	212	214	216	218	220	222	224	226	228	230	232	234
40000	207	208	211	213	215	217	219	221	223	225	227	230	232	234	236	238	240
41000	212	214	216	218	220	222	225	227	229	231	233	235	237	240	242	244	246
42000	218	219	221	223	226	228	230	232	234	237	239	241	243	246	248	250	252
43000	223	224	226	229	231	233	235	238	240	242	245	247	249	251	254	256	258
44000	228	229	232	234	236	239	241	243	246	248	250	253	255	257	260	262	264
45000	233	235	237	239	242	244	246	249	251	254	256	258	261	263	265	268	270
46000	238	240	242	245	247	250	252	254	257	259	262	264	267	269	271	274	276
47000	244	245	248	250	252	255	257	260	262	265	267	270	272	275	277	280	282
48000	249	250	253	255	258	260	263	265	268	271	273	276	278	281	283	286	288
49000	254	255	258	261	263	266	268	271	274	276	279	281	284	286	289	292	294
50000	259	261	263	266	269	271	274	277	279	282	284	287	290	292	295	298	300
51000	264	266	269	271	274	277	279	282	285	287	290	293	296	298	301	304	306
52000	270	271	274	277	279	282	285	288	290	293	296	299	301	304	307	310	312
53000	275	276	279	282	285	288	290	293	296	299	302	304	307	310	313	316	318
54000	280	282	284	287	290	293	296	299	302	304	307	310	313	316	319	321	324
55000	285	287	290	293	296	298	301	304	307	310	313	316	319	322	325	327	330
56000	290	292	295	298	301	304	307	310	313	316	319	322	325	328	330	333	336
57000	295	297	300	303	306	309	312	315	318	321	324	327	330	333	336	339	342
58000	301	303	306	309	312	315	318	321	324	327	330	333	336	339	342	345	348
59000	306	308	311	314	317	320	323	326	330	333	336	339	342	345	348	351	354
60000	311	313	316	319	322	326	329	332	335	338	341	345	348	351	354	357	360

Step 2

With the product flow rate, use Table 2 to determine Factor B. Use the table product flow rate value that is closest to the actual value.

Table 2. Factor B.

Product Flow gpm	Factor B		Product Flow gpm	Factor B		Product Flow gpm	Factor B
15.0	2.35		19.5	2.51		24.0	2.71
15.5	2.36		20.0	2.53		24.5	2.73
16.0	2.38		20.5	2.55		25.0	2.76
16.5	2.40		21.0	2.57		25.5	2.78
17.0	2.41		21.5	2.59		26.0	2.81
17.5	2.43		22.0	2.61		26.5	2.84
18.0	2.45		22.5	2.63		27.0	2.87
18.5	2.47		23.0	2.66			
19.0	2.49		23.5	2.68			

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0083 00**
SUPPORTING INFORMATION
REVERSE OSMOSIS % CLEAN CALCULATION

Step 3

With the Feed Temperature, use Table 3 to determine Factor TCF. TCF is the **T**emperature **C**orrection **F**actor that converts the actual performance to what it would be at 77 degrees F.

Table 3. Factor TCF.

Feed Temp	TCF		Feed Temp	TCF		Feed Temp	TCF		Feed Temp	TCF
32	0.50		52	0.68		72	0.93		92	1.26
33	0.51		53	0.69		73	0.94		93	1.28
34	0.52		54	0.70		74	0.96		94	1.30
35	0.53		55	0.71		75	0.97		95	1.32
36	0.53		56	0.72		76	0.98		96	1.34
37	0.54		57	0.74		77	1.00		97	1.36
38	0.55		58	0.75		78	1.02		98	1.38
39	0.56		59	0.76		79	1.03		99	1.40
40	0.57		60	0.77		80	1.05		100	1.42
41	0.58		61	0.78		81	1.06		101	1.45
42	0.58		62	0.79		82	1.08		102	1.47
43	0.59		63	0.81		83	1.10		103	1.49
44	0.60		64	0.82		84	1.11		104	1.51
45	0.61		65	0.83		85	1.13		105	1.54
46	0.62		66	0.84		86	1.15		106	1.56
47	0.63		67	0.86		87	1.17		107	1.58
48	0.64		68	0.87		88	1.18		108	1.61
49	0.65		69	0.88		89	1.20		109	1.63
50	0.66		70	0.90		90	1.22		110	1.66
51	0.67		71	0.91		91	1.24			

Step 4

Calculate:

Factor AB = (Factor A) x (Factor B).

Factors A and B are determined from steps 1 and 2 above. Factor AB is the average osmotic pressure of the feed water as it is concentrated within the RO elements.

Step 5

Calculate:

NDP = RO Feed Pressure – 45 – AB

NDP is the **n**et **d**riving **p**ressure. This is the average pressure driving the product water through the RO elements.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0083 00**
SUPPORTING INFORMATION
REVERSE OSMOSIS % CLEAN CALCULATION

Step 6

Calculate:

C = TCF x NDP

C is the net driving pressure that would be required at 77 degrees F.

Step 7

Calculate:

P(TWPS) = Product Flow Rate / C

P(TWPS) is the actual TWPS RO membrane **p**ermeability (GPM per PSI)

Step 8

Calculate:

P = 0.1628 – AB/10,000

P is the expected new RO element membrane **p**ermeability (GPM/PSI)

Step 9

Calculate:

%Clean = 100 x P(TWPS)/P

Step 10

Enter the calculated value for %Clean in the Comments section of the Operating Data Log (WP 0080) in line with the data used. Compare this value with earlier values calculated while deployed on the current mission. A decreasing value is an indication of membrane fouling. If the decrease exceeds 10% (for example: a decrease from 95% to 85%), cleaning should be scheduled. Refer to WP0016.

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0083 00**
SUPPORTING INFORMATION
REVERSE OSMOSIS % CLEAN CALCULATION

Example

The following data from the Operational Data Log is recorded:

- Feed TDS (mg/l): 35,800
- RO Feed Pressure (psig): 780
- Product Flow (gpm): 20.5
- Feed Temperature (^{0}F): 80

From table 1, Factor A = 205

From Table 2 Factor B = 2.55

From Table 3, Factor TCF = 1.05

Factor AB = 523

NDP = 780 – 45 – 523 = 212

C = 212 x 1.05 = 223

P(TWPS) = 20.5/223 = 0.092

P = 0.1628 – 523/10000 = 0.11

% Clean = 100 x 0.092/0.11 = 83.6%

TACTICAL WATER PURIFICATION SYSTEM (TWPS) **0084 00**
SUPPORTING INFORMATION
ADDITIONAL AUTHORIZATION LIST

THERE ARE NO ADDITIONAL ITEMS
YOU ARE AUTHORIZED FOR THE SUPPORT OF THE TWPS.

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GLOSSARY

Alkali – Various soluble salts, principally of sodium, potassium, magnesium, and calcium, that have the property of combining with acids to form neutral salts and may be used in chemical water treatment processes.

Brackish Water – Water that is unfit for drinking because of salty or unpleasant tastes caused by the presence of excessive amounts of dissolved chemicals, chlorides, sulfates, and alkalis.

Chlorine – A chemical that is applied in water purification processes to product water to disinfect the water and prevent microbial growth in the water. As a gas, its color is greenish-yellow and is about 2 ½ times heavier than air. As a liquid, it is amber in color and is about 1-½ times heavier than water. Chlorine is toxic to all organisms and is corrosive to most metals.

Filtrate – Raw water that has had particles and microscopic organisms removed from it using a process of micro filtration.

Micro filtration – A filtration system capable of filtering particles and bacteria measuring as small as a micron or a portion of a micron.

Palatable Water – Water that is pleasing to the taste and significantly free from color, turbidity, taste, and odor. Does not imply potability.

Permeate – Filtrate (filtered water) that has had dissolved solids (salts and minerals) removed from it using the process of reverse osmosis.

Potable – (1) Water that does not contain any objectionable substances or pollution and is suitable for human consumption. (2) Water that is free from disease-producing organisms, poisonous substances, chemical or biological agents, and radioactive contaminants which make it unfit for human consumption and many other uses. Potable water may or may not be palatable.

Priming – (1) The action of starting the flow in a pump or siphon. (2) The first coat applied to a surface to prevent corrosion to protect the surface.

Product Water – Water that has been treated in the water purification system and is ready to be consumed (also called finished water, permeate, or potable water.)

Raw Water – Untreated water; usually the water entering the first treatment unit of a water purification system. Water used as a source of water supply taken from a natural or impounded body of water, such as a stream, lake, pond, or ground water aquifer.

Reverse Osmosis – The process in which pressure is applied to a concentrated solution to force liquid from the concentrated solution through a semi-permeable membrane. The membrane allows the passage of solvent (water) but not dissolved solids (solutes). The liquid produced is de-mineralized water called product water or permeate.

Sodium Bisulfite – A chemical used in the tactical water purification system when the raw water contains chlorine. Chlorine will rapidly damage MF filter membranes and slowly degrade RO elements. Sodium bisulfite neutralizes chlorine.

Turbidity – (1) A condition in water caused by the presence of suspended matter resulting in the scattering and absorption of light rays. (2) A measure of fine suspended matter in liquids.

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END OF WORK PACKAGE

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SFA, Inc. WARRANTY TERMS AND PROCEDURE for the END-USER of the 1500 TWPS

Contract No. DAAE07-02-D-T001

THIS END-USER WARRANTY PROCEDURE IS NOT THE COMPLETE WARRANTY DOCUMENT. YOUR POC WILL ADMINISTER THIS WARRANTY, AND HAS A COPY OF THE COMPLETE WARRANTY, "**SFA, Inc. WARRANTY TERMS AND PROCEDURE – 1500 TWPS,**" WHICH CONTAINS OTHER APPLICABLE EXCLUSIONS AND LIMITATIONS.

WARNING THIS PRODUCT MUST BE HANDLED AND OPERATED WITH CARE AND IN STRICT ACCORDANCE WITH THE TECHNICAL MANUAL. FAILURE TO DO SO MAY RESULT IN SERIOUS INJURY OR DEATH.

This End-User statement is provided by SFA, Inc. ("Manufacturer") to the United States Army and the United States Marine Corps ("Customer") with respect to the Product under Contract No. DAAE07-02-D-T001.

Definitions

In addition to the other terms defined herein, the following definitions shall apply:

"A-Warranty POC" shall mean the United States Army Warranty Point of Contact who administers this Warranty through the Program Office at TACOM:
Karen Arnold, (586) 574-4213 / DSN 786, **karen.arnold@us.army.mil**

"MC-Warranty POC" shall mean the United States Marine Corps Point of Contact who administers this Warranty through the Program Office at MARCORSYSCOM:
Jerry Stanchina, (229) 639-6984 / DSN 567-6984, Email **jerry.stanchina@usmc.mil**

"POC" shall mean either the A-Warranty POC or the MC-Warranty POC.

"End-user" shall mean the United States Army or United States Marine Corps person or unit, or field-representative of such person or unit, who uses the Product in the field and discovers or records the potential warranty claim during such use.

"Product" shall mean A-TWPS units (NSN 4610-01-488-9656), MC-TWPS units (NSN 4610-01-4888-6961), or Marine Corps Extended Capability Modules provided under **Contract No. DAAE07-02-D-T001**

"Vendor" shall mean any merchant, manufacturer, company or person, other than Manufacturer, whose component or part is included in the Product.

SFA, Inc. WARRANTY TERMS AND PROCEDURE for the END-USER of the 1500 TWPS

Contract No. DAAE07-02-D-T001

Warranty

Manufacturer warrants for 12 months from date of DD Form 250 signature the workmanship, materials, design, and essential performance characteristics of the Product under normal use and operation in strict accordance with the Technical Manual. To be considered for warranty, any defect must be discovered within the warranty period and meet the criteria herein.

Excluded from Warranty

Exclusions from warranty include, but are not limited to, the following:

a. Workmanship defects that can be corrected following Technical Manual instructions without repair parts or replacement components (Example: Leaking pipe connection or loose electrical wire);
b. Any damage or defect occurring, at any time, during shipment of products. When returning products to Manufacturer for repair or replacement, Customer assumes all risk of loss or damage;
c. Any components of the Product that are not manufactured by Manufacturer (Wherever possible, Vendor-supplied component warranties will be passed through to Customer);
d. Repair, damage or increase in service time caused by the use, operation, modification, repair, installation, or storage of the Product in a manner not in accordance with the Technical Manual, including, but not limited to: (i) neglect or misuse, (ii) a failure or sudden surge of electrical power, (iii) storage outside of the temperature range of -28^0F to 160^0F, or (iv) any other cause other than ordinary use in accordance with the Technical Manual;
e. Repair, damage or increase in service time caused by accident by anyone other than Manufacturer personnel, fire, flood, earthquake, water, wind, lightning or other natural disaster, strike, inability to obtain materials or utilities, war, civil disturbance or any other cause beyond Manufacturer's reasonable control;
f. Normal wear parts replacement.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT, AND OF ANY OTHER SIMILAR OBLIGATION ON THE PART OF MANUFACTURER.

SFA, Inc. WARRANTY TERMS AND PROCEDURE for the END-USER of the 1500 TWPS

Contract No. DAAE07-02-D-T001

Claim Procedure

Manufacturer's obligation under this warranty is limited to, at Manufacturer's option, replacing or repairing, at its facility or Vendor's facility, as applicable, any Product or part thereof that is found by Manufacturer not to conform to this warranty. Manufacturer shall have a reasonable period of time to make such replacements or repairs.

1. End-user shall immediately report the potential warranty claim to the appropriate POC.
2. Identify the Unit Serial number, hour meter reading and current location.
3. Describe the failure and the troubleshooting conducted to identify the failed component.
4. Only the POC shall contact Manufacturer's Defense Product Division, Quality Assurance Department, as soon as practicable after discovering the defect. The POC shall follow claim procedure as provided in SFA, Inc. WARRANTY TERMS AND PROCEDURE – 1500 TWPS.
5. Manufacturer shall have no obligations under this warranty with respect to any defect unless it receives such notice within 30 days following the expiration of the warranty period.

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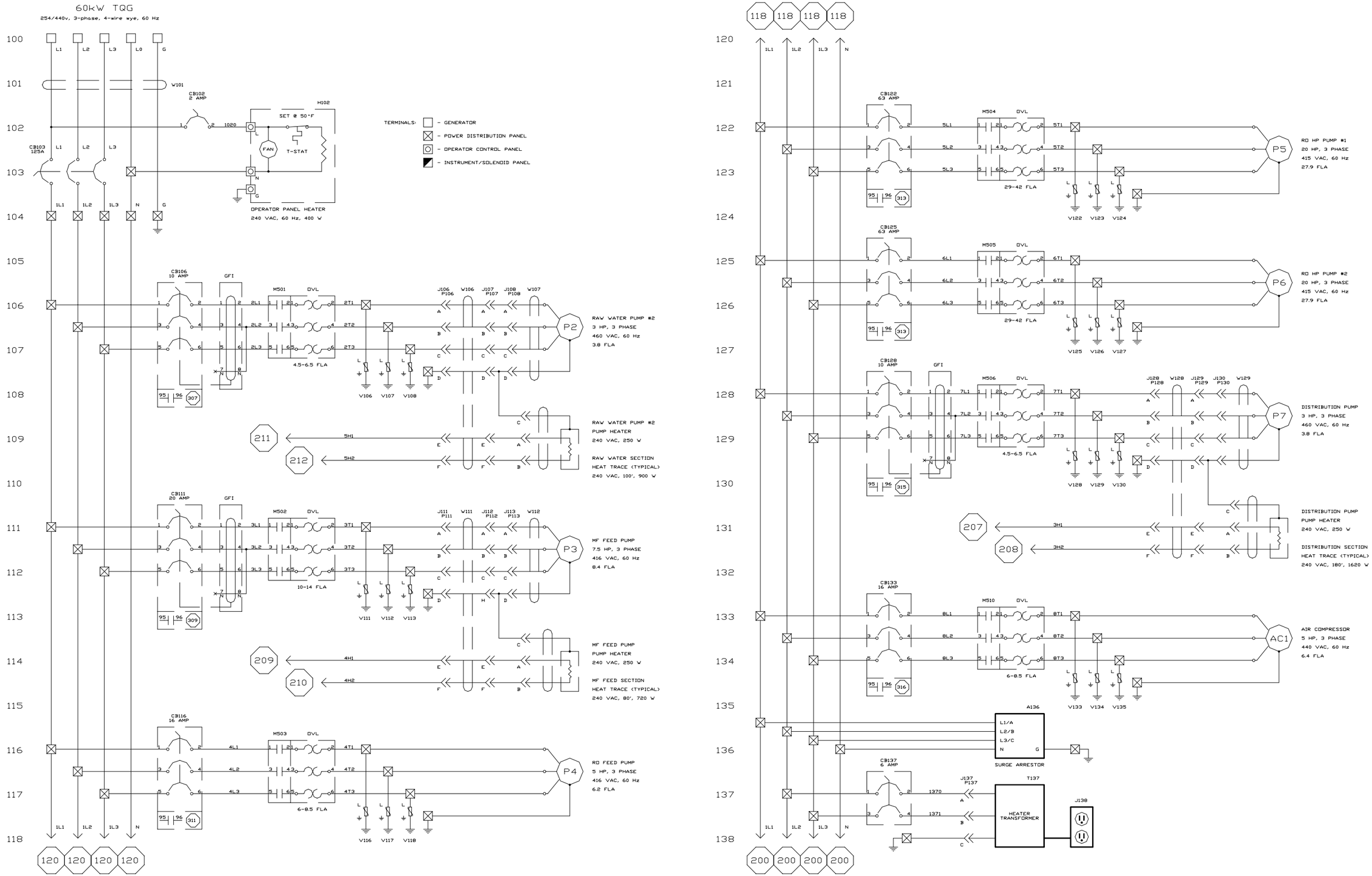


Figure 1. TWPS Schematic Diagrams (Sheet 1 of 8).

FOLDOUT-1

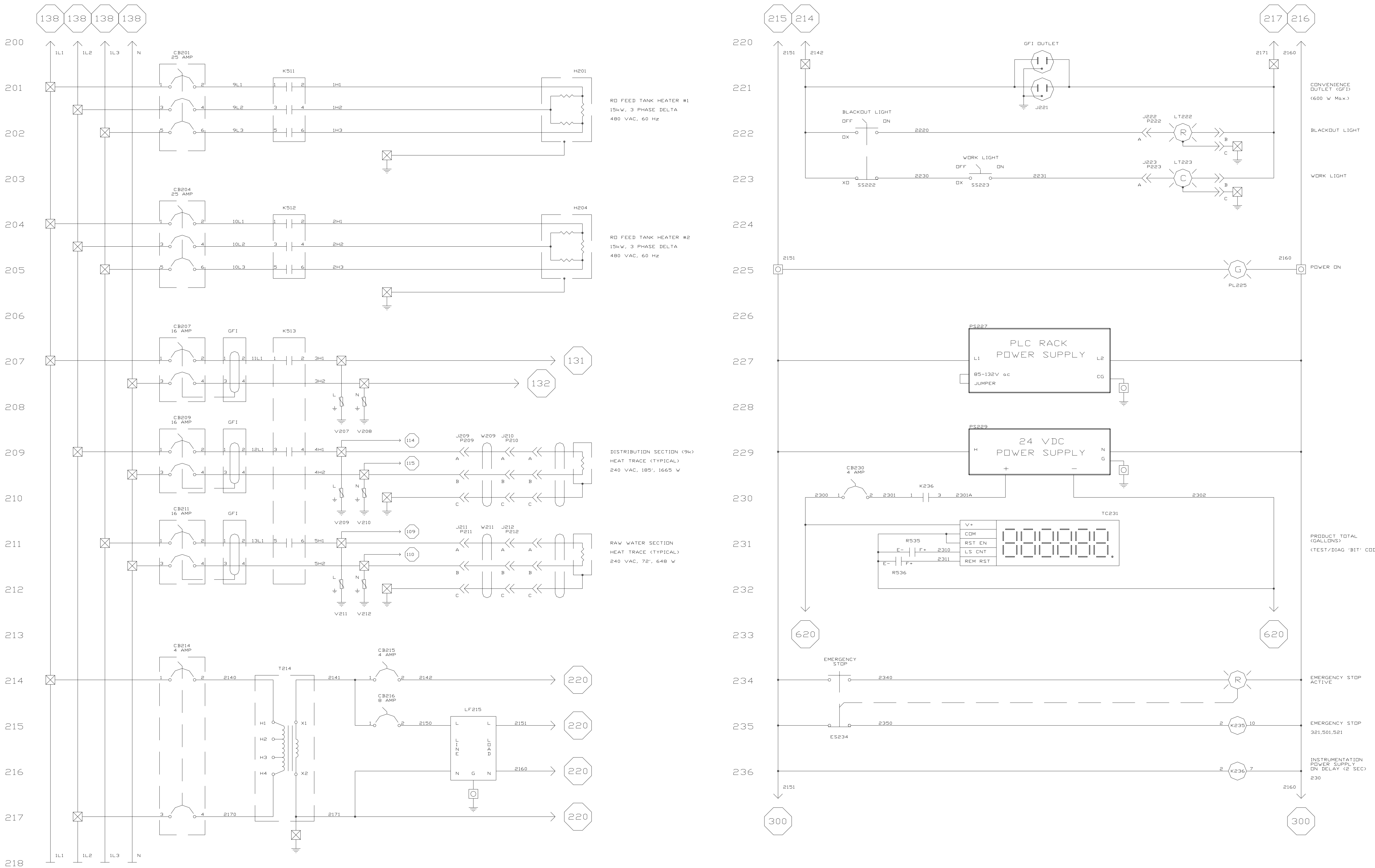


Figure 1. TWPS Schematic Diagrams (Sheet 2 of 8).

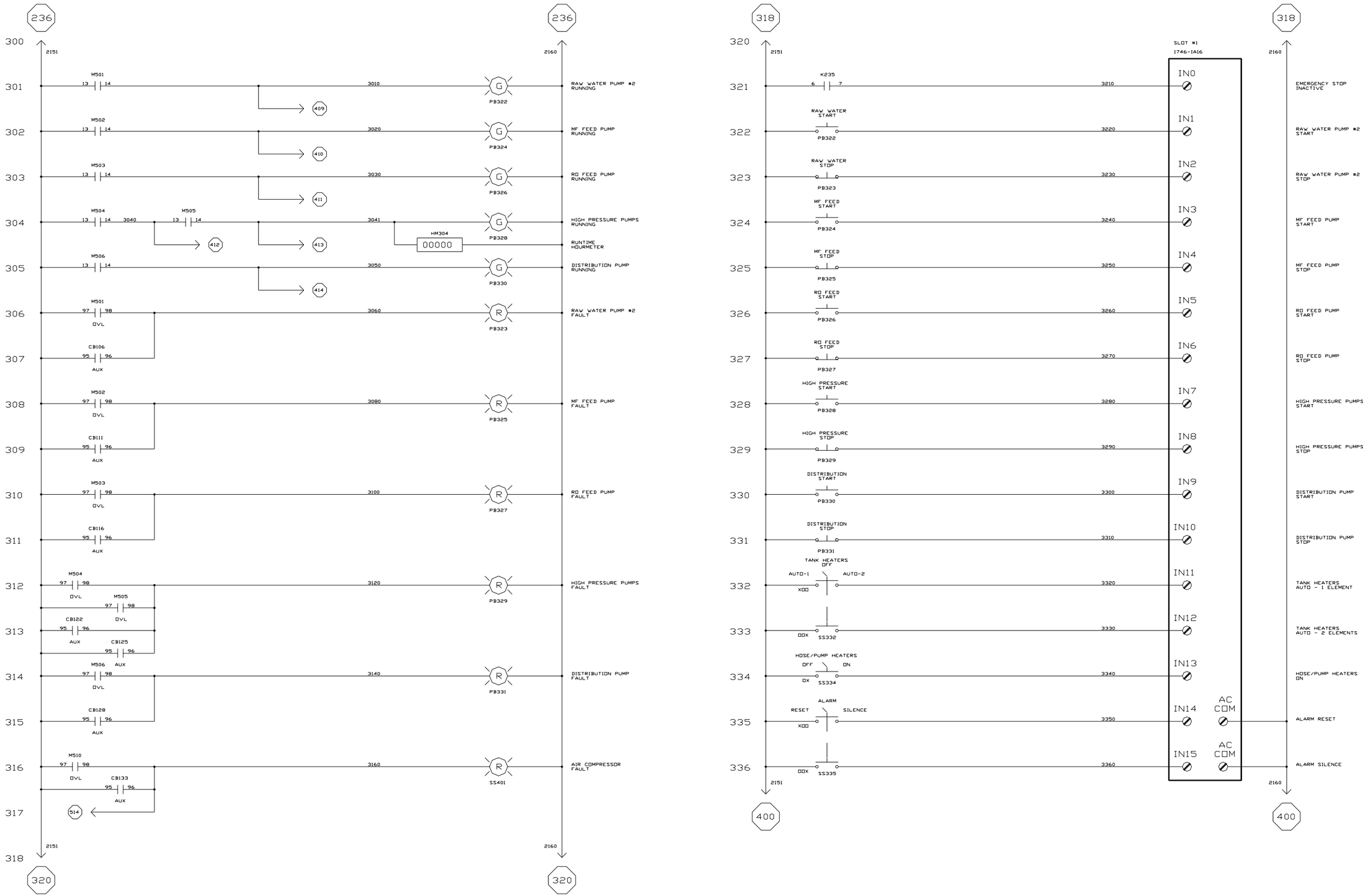


Figure 1. TWPS Schematic Diagrams (Sheet 3 of 8).

FOLDOUT-3

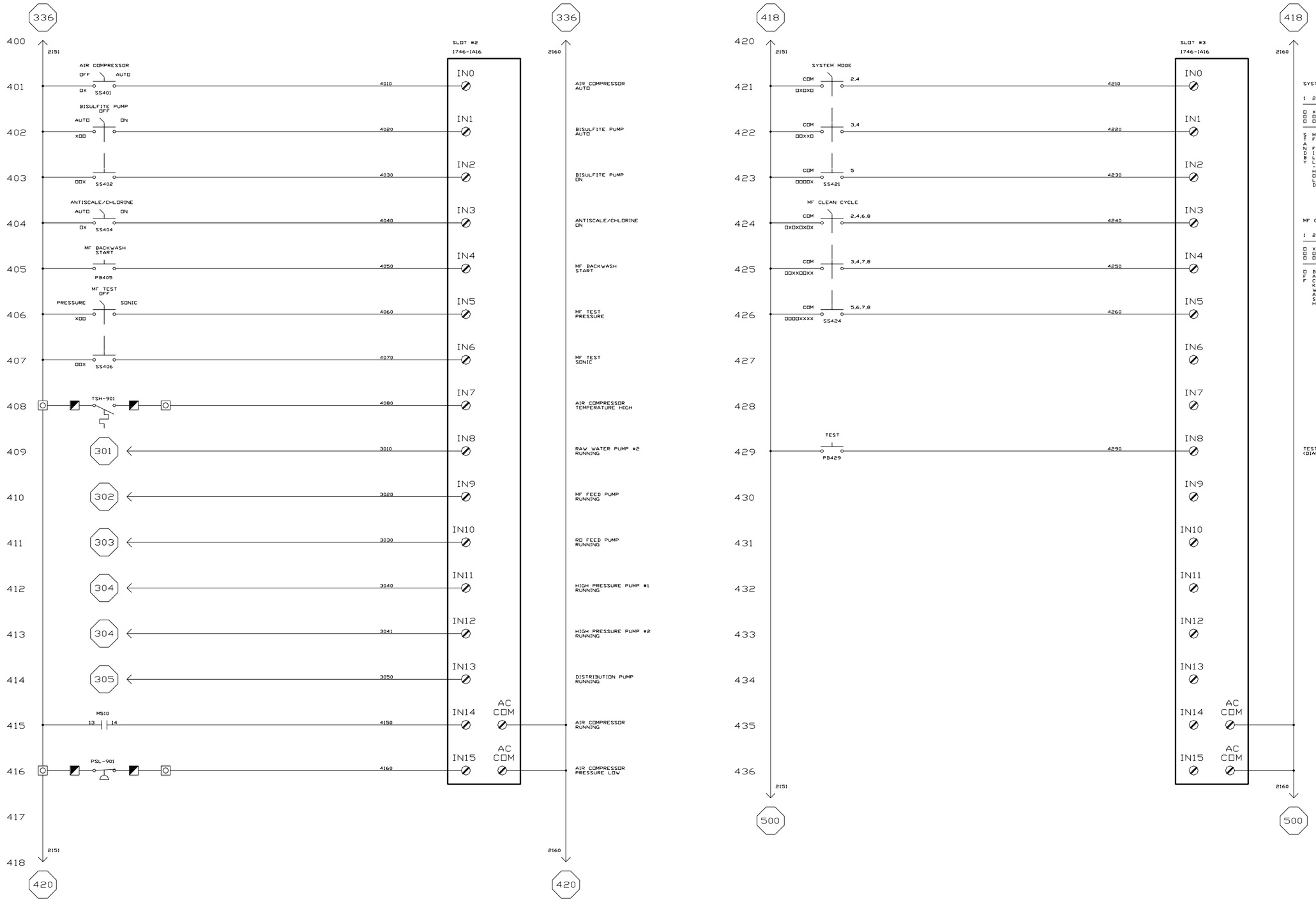


Figure 1. TWPS Schematic Diagrams (Sheet 4 of 8).

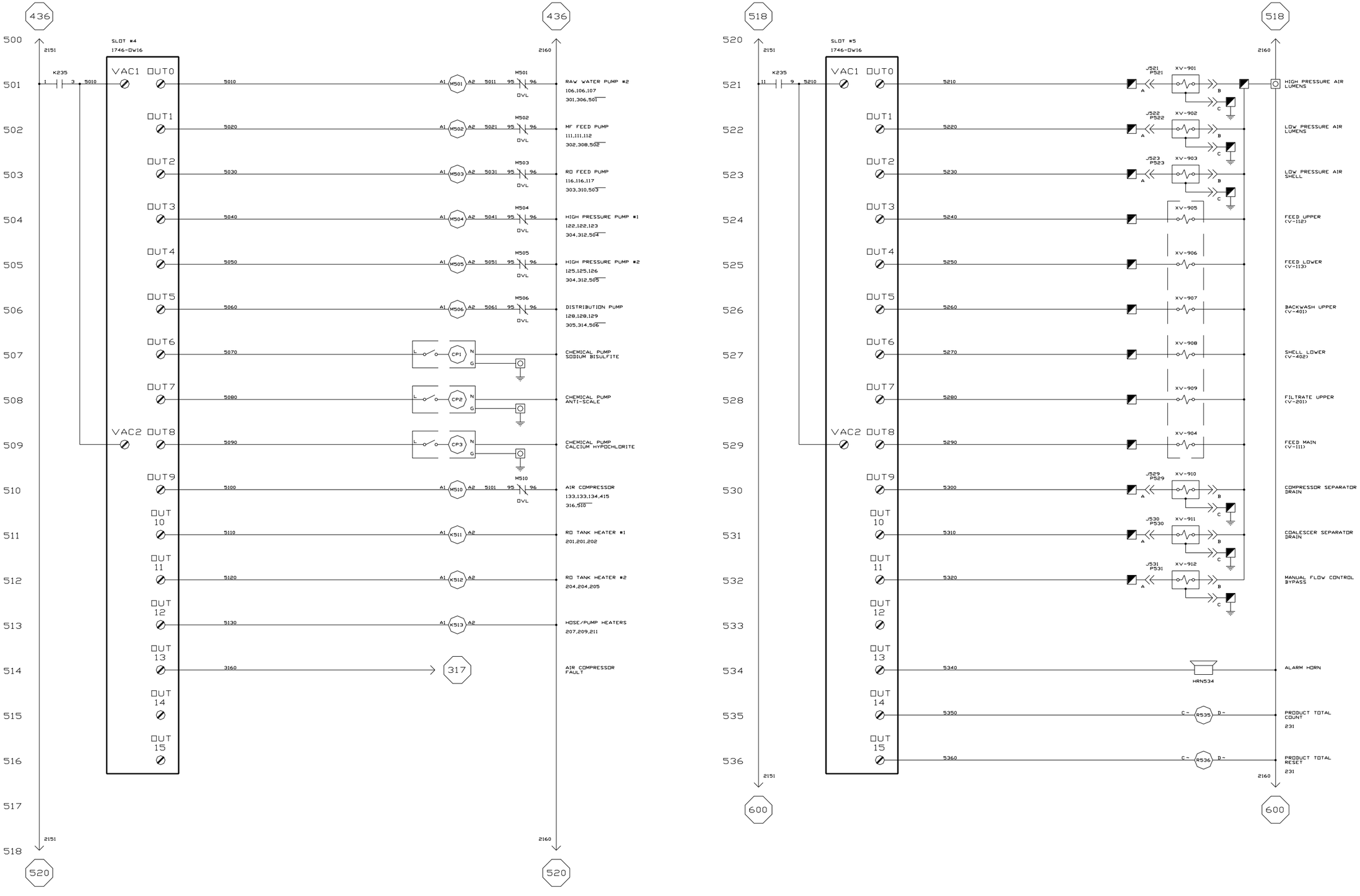


Figure 1. TWPS Schematic Diagrams (Sheet 5 of 8).

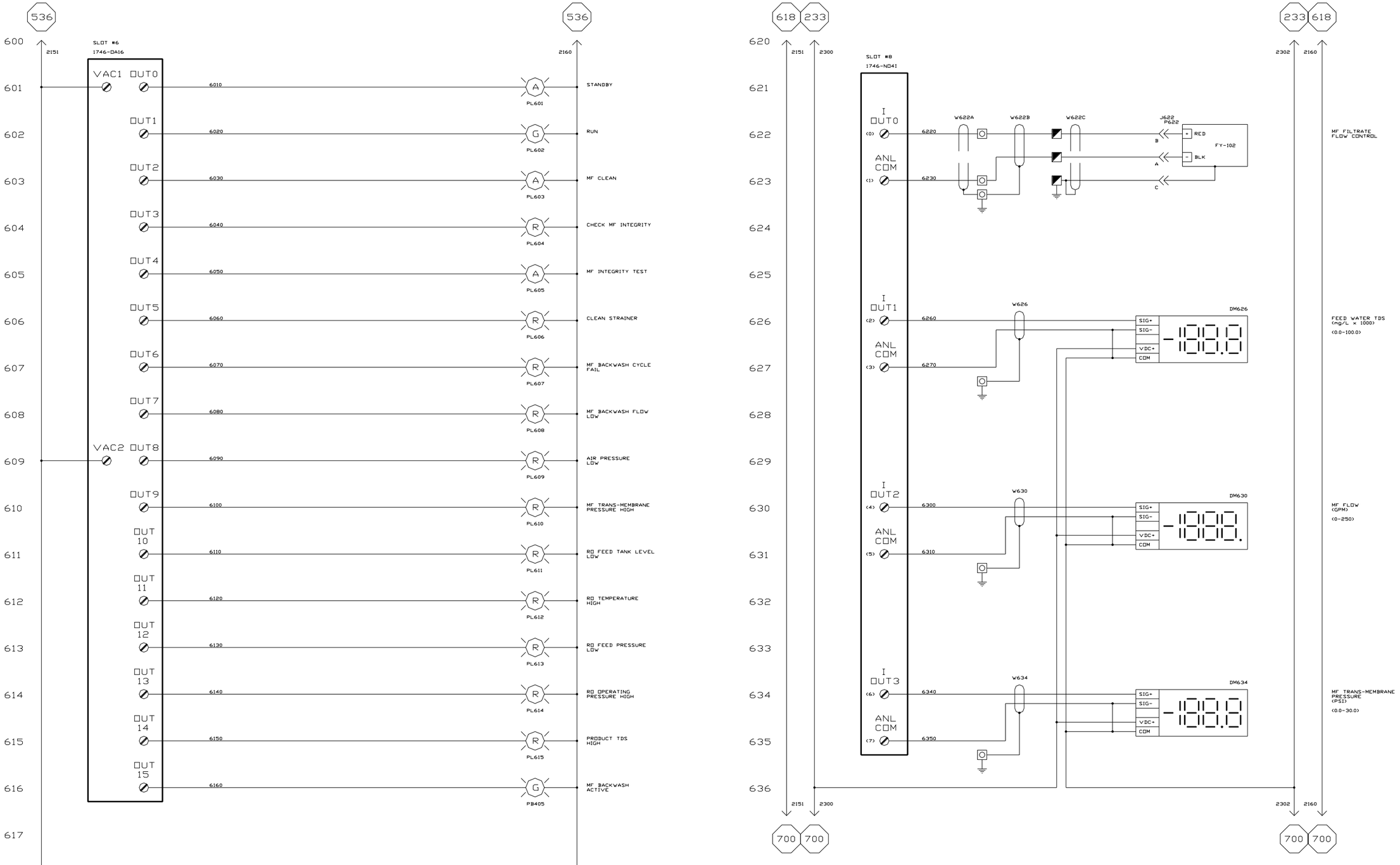


Figure 1. TWPS Schematic Diagrams (Sheet 6 of 8).

FOLDOUT-6

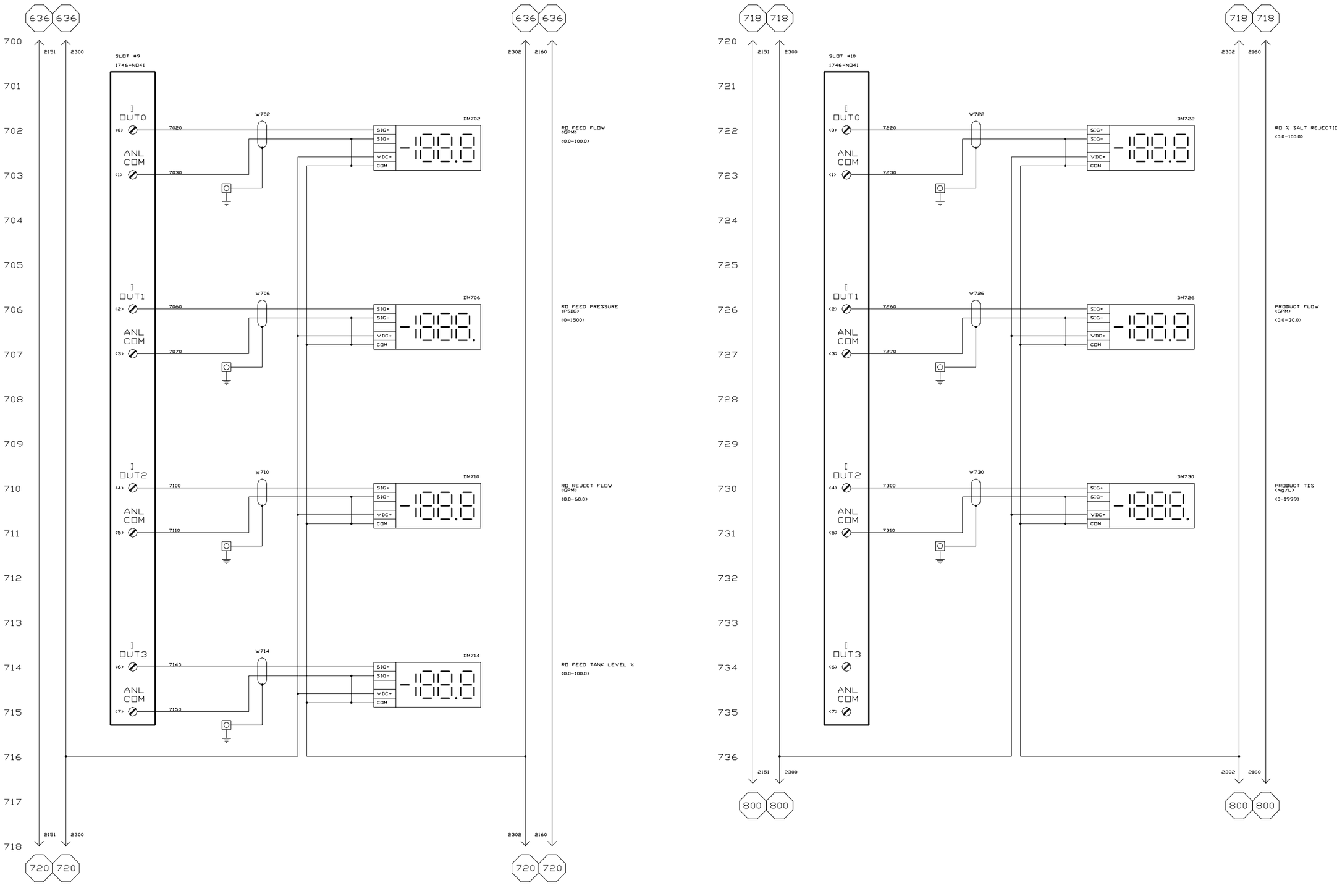


Figure 1. TWPS Schematic Diagrams (Sheet 7 of 8).

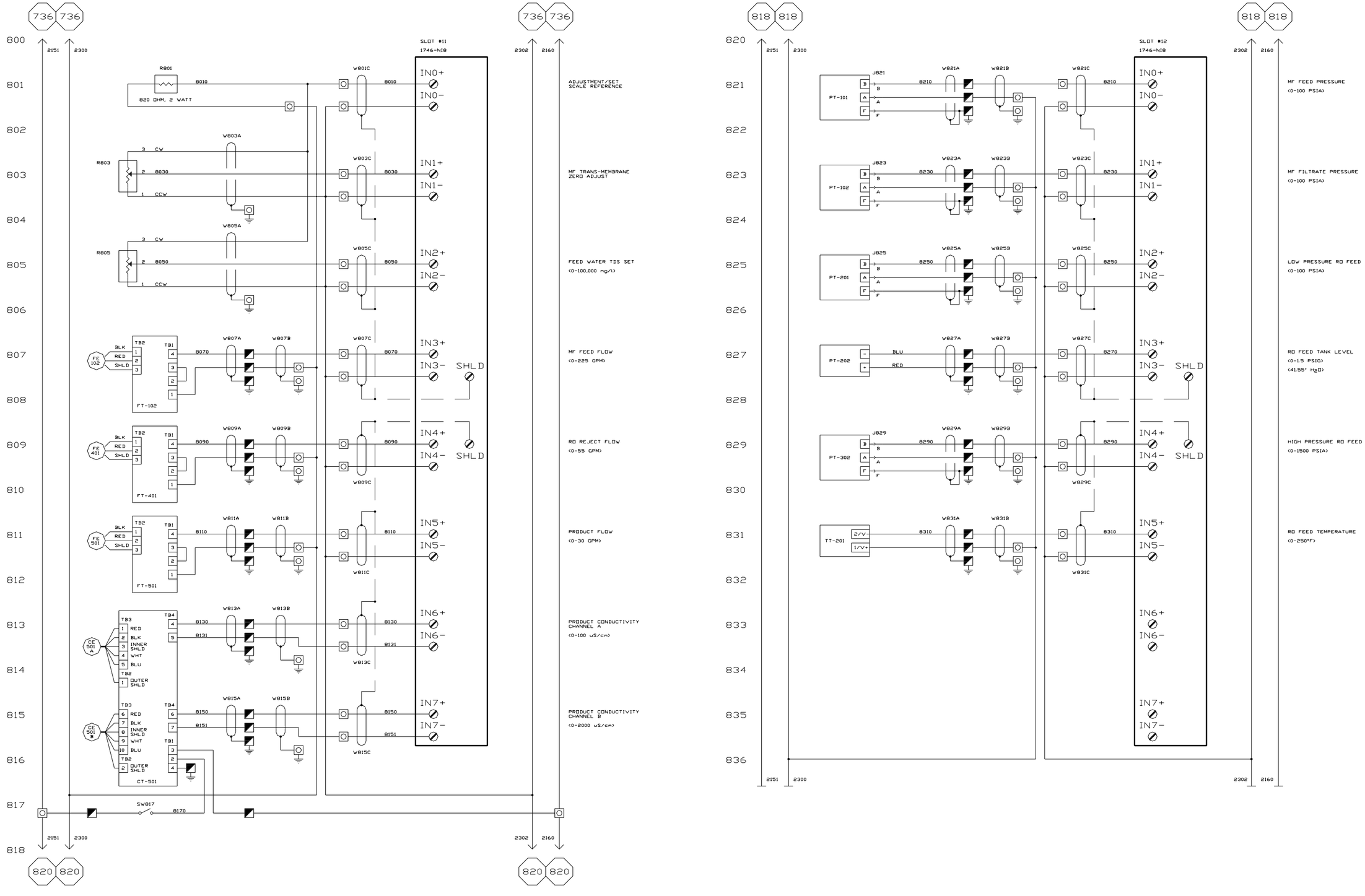


Figure 1. TWPS Schematic Diagrams (Sheet 8 of 8).

FOLDOUT-8

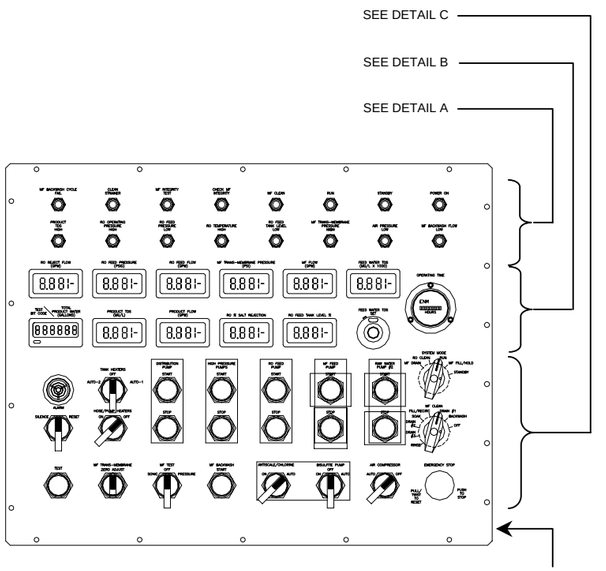
NOTES:

1. ALL WIRES TO BE #18, EXCEPT FOR THE WIRE CORDS LABELED WITH A WXXX NUMBER.
2. TIGHTEN ALL WIRES PER TORQUE VALUE CHART.

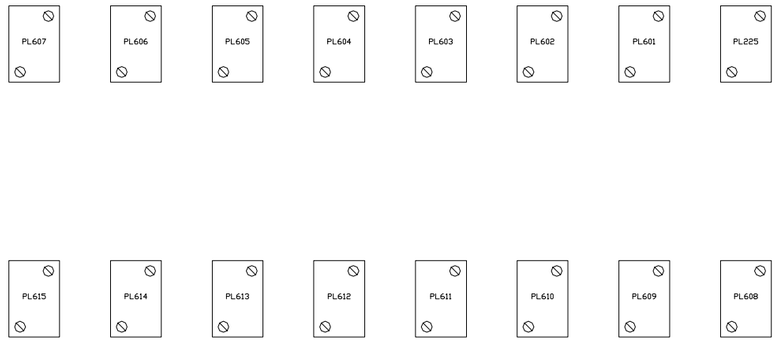
TORQUE VALUES	
WIRE TYPE	IN/LBS
ALL WIRES	6.00

WIRE LEGEND

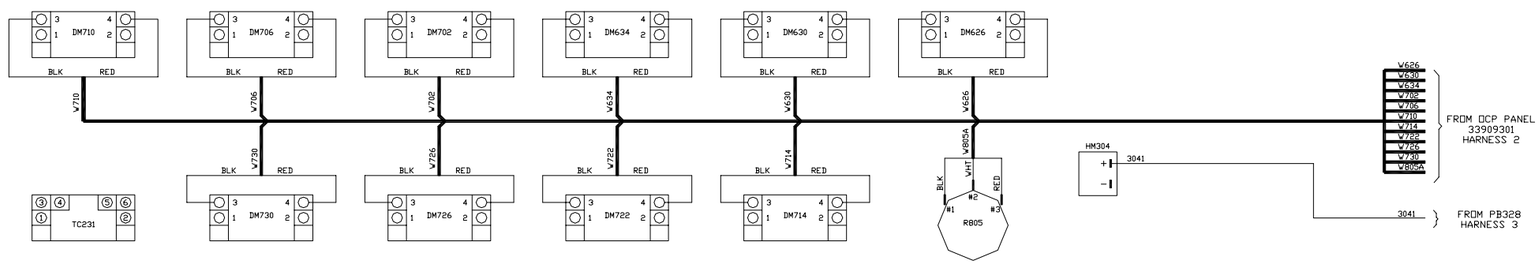
- BLACK WIRE
- WHITE WIRE
- RED WIRE
- BLUE WIRE
- WIRE CORD (CONSISTING OF RED, BLACK, WHITE WIRES)
- WIRE BUNDLE
- NYLON TIE WRAP



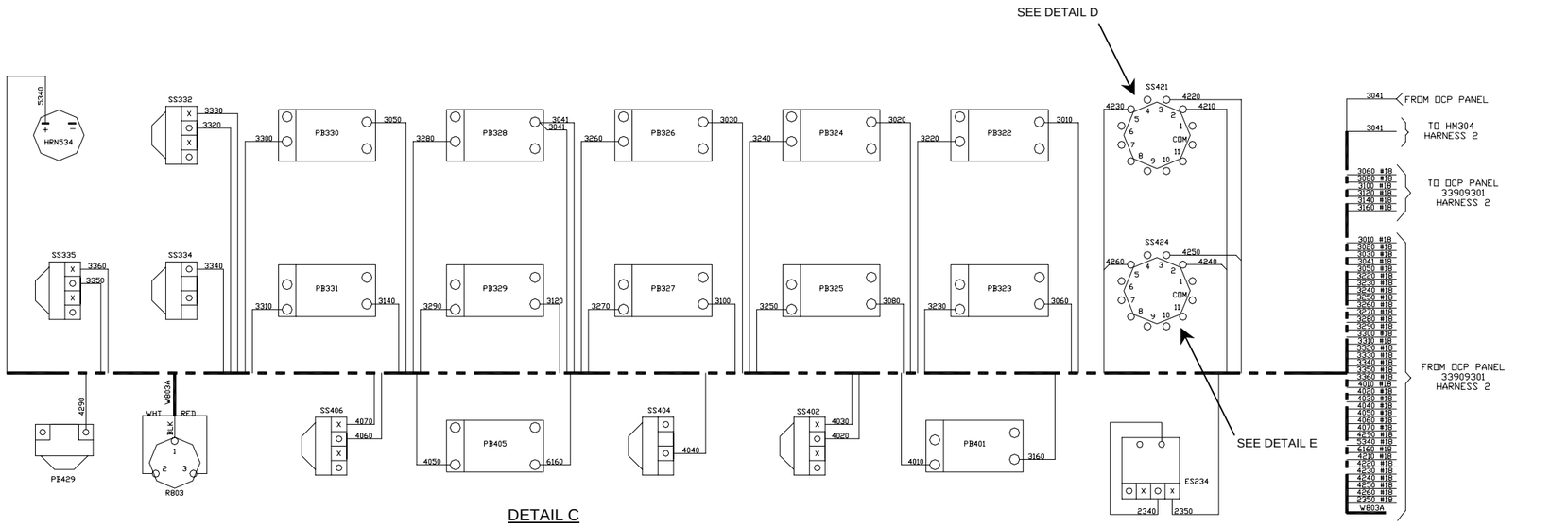
REAR OF PANEL
FOR COMPONENT REF. ONLY



DETAIL A

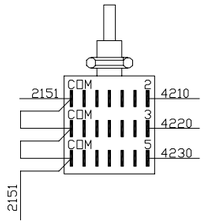


DETAIL B

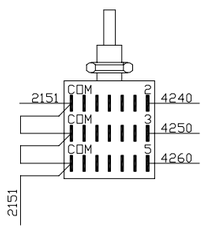


DETAIL C

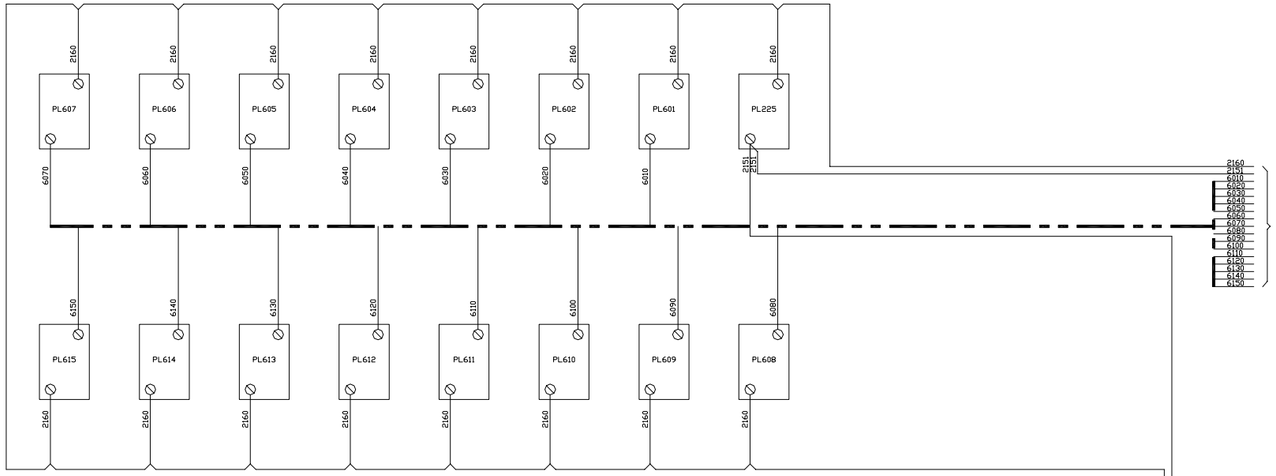
Figure 2. TWPS Point-to-Point Wiring Diagrams – OCP Front Panel – Power (Sheet 1 of 2).



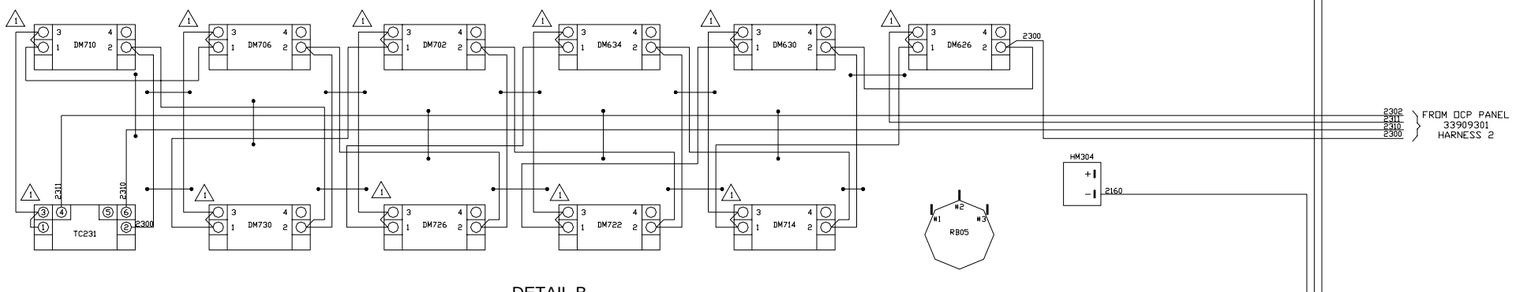
DETAIL D
MF CLEAN CYCLE SS421



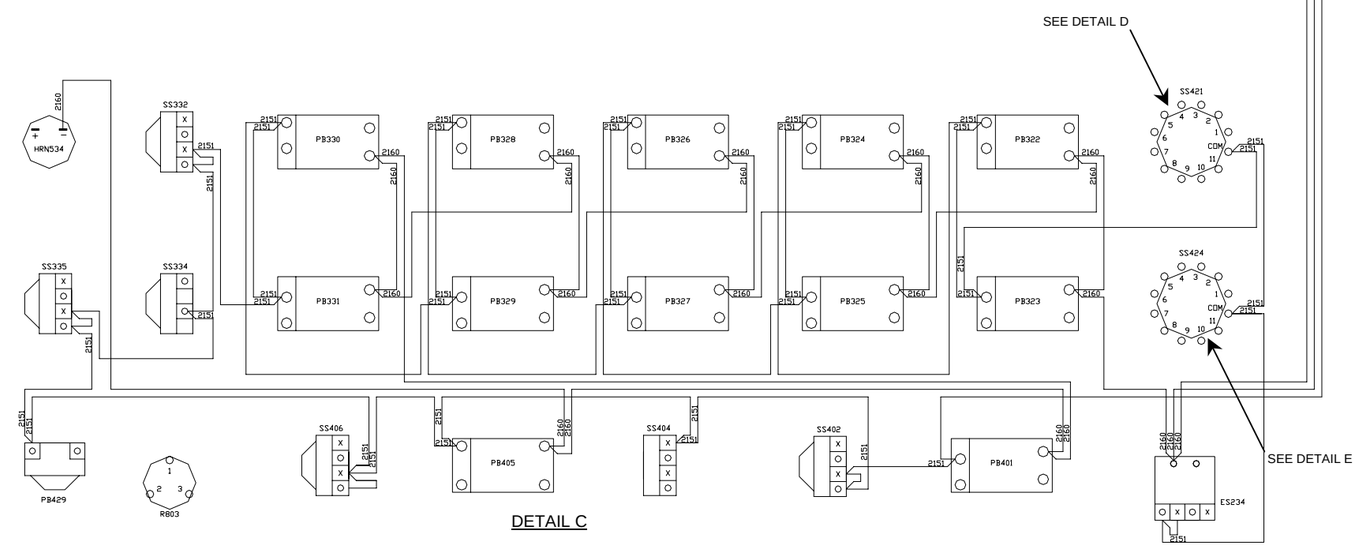
DETAIL E
SYSTEM MODE SS424



DETAIL A



DETAIL B



DETAIL C

Figure 2. TWPS Point-to-Point Wiring Diagrams – OCP Front Panel – Signal (Sheet 2 of 2).

NOTES:

1. CORDS W801, W803B, W805B, W807C SHIELD CONNECTION TO BE TOP SHIELD CONTACT.
   CORDS W809C, W811C, W813C, W815C SHIELD CONTACT TO BE BOTTOM SHIELD CONTACT.
   CORDS W821C, W823C, W825C, W827C SHIELD CONTACT TO BE TOP SHIELD CONTACT.
   CORDS W829C, W831C SHIELD CONTACT TO BE BOTTOM SHIELD CONTACT.

2. TIGHTEN ALL WIRES PER TORQUE VALUE CHART.

TORQUE VALUES	
WIRE TYPE	IN/LBS
TERMINAL WIRES	6.00

WIRE LEGEND

- BLACK WIRE
- WHITE WIRE
- RED WIRE
- GREEN WIRE
- BLUE WIRE
- BROWN WIRE
- ORANGE WIRE
- YELLOW WIRE
- WIRE CORD (CONSISTING OF RED, BLACK & WHITE WIRES)
- WIRE BUNDLE
- GROUND WIRE

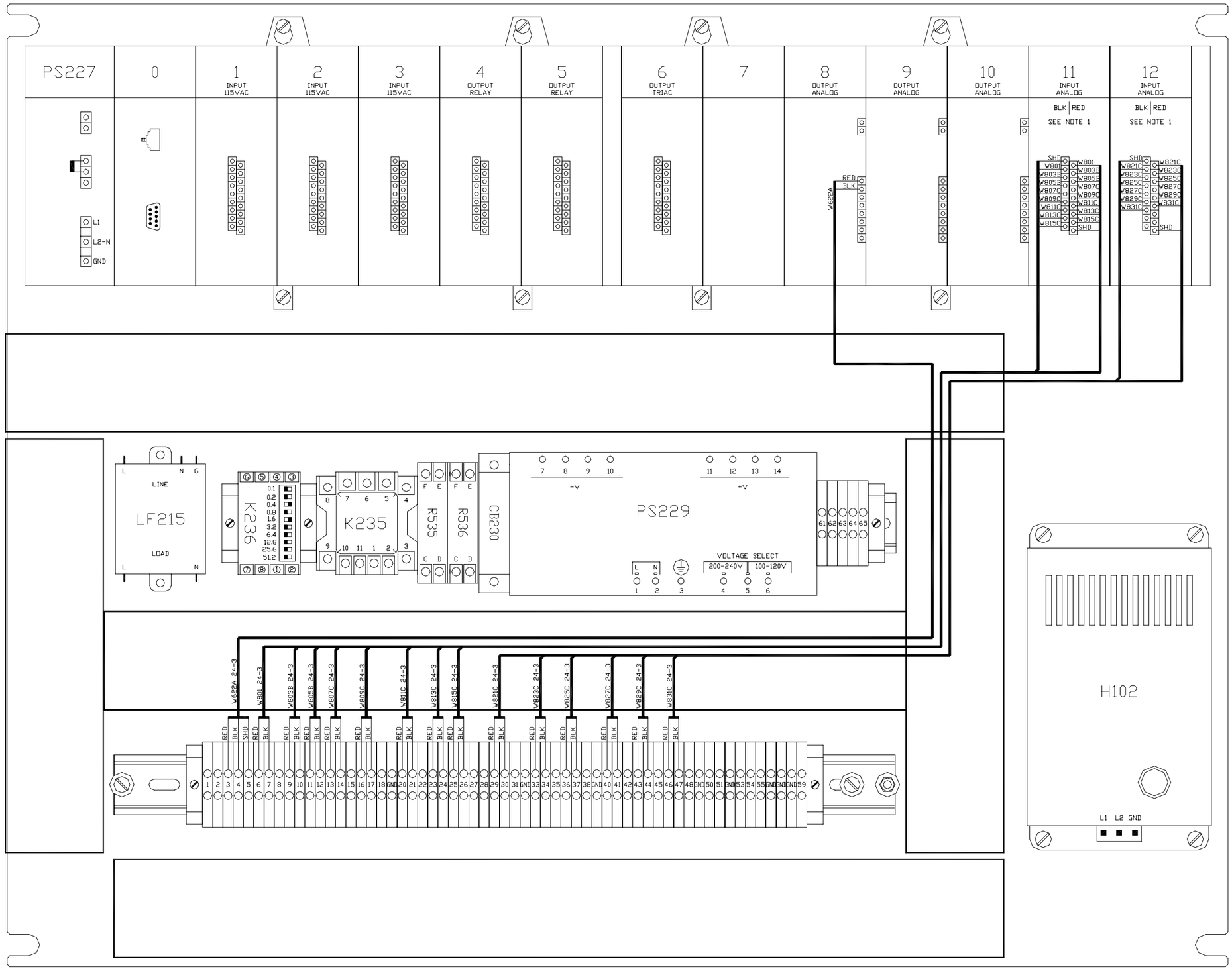


Figure 3. TWPS Point-to-Point Wiring Diagrams – OCP Sub-Panel – OCP Inputs (Sheet 1 of 5).

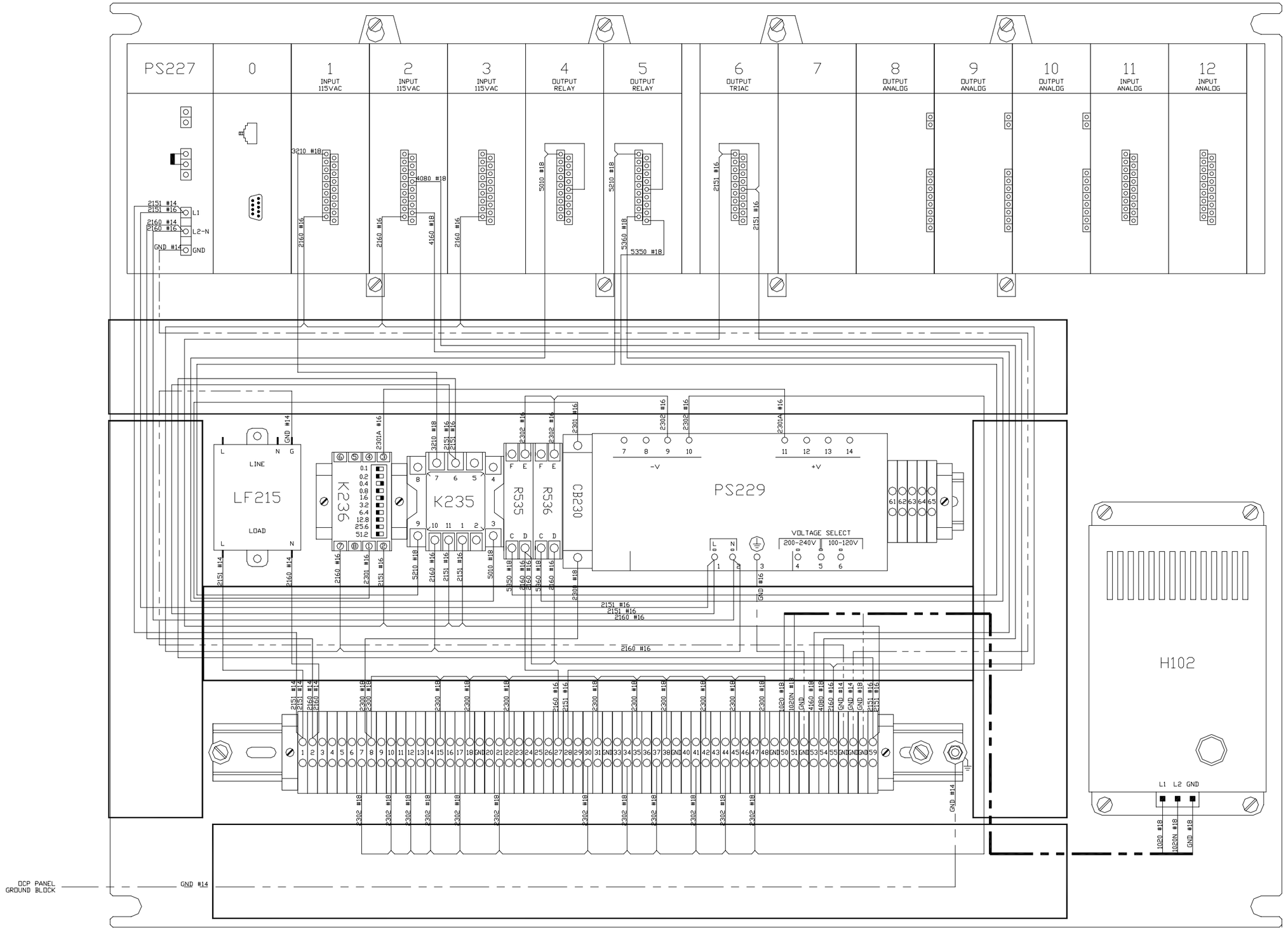


Figure 3. TWPS Point-to-Point Wiring Diagrams – OCP Sub-Panel – OCP Outputs (Sheet 2 of 5).

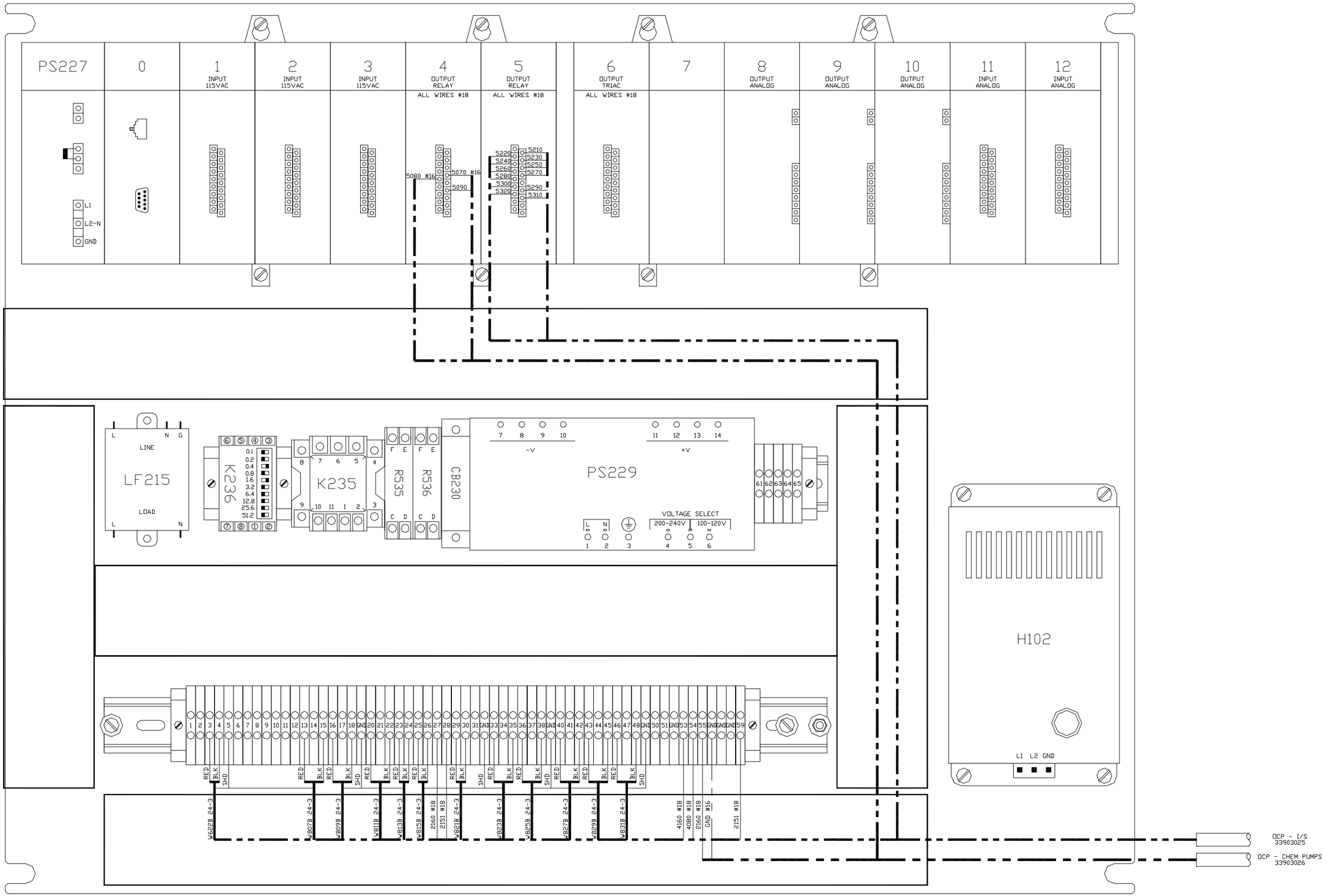


Figure 3. TWPS Point-to-Point Wiring Diagrams – OCP Sub-Panel – OCP to ISP (Sheet 3 of 5).

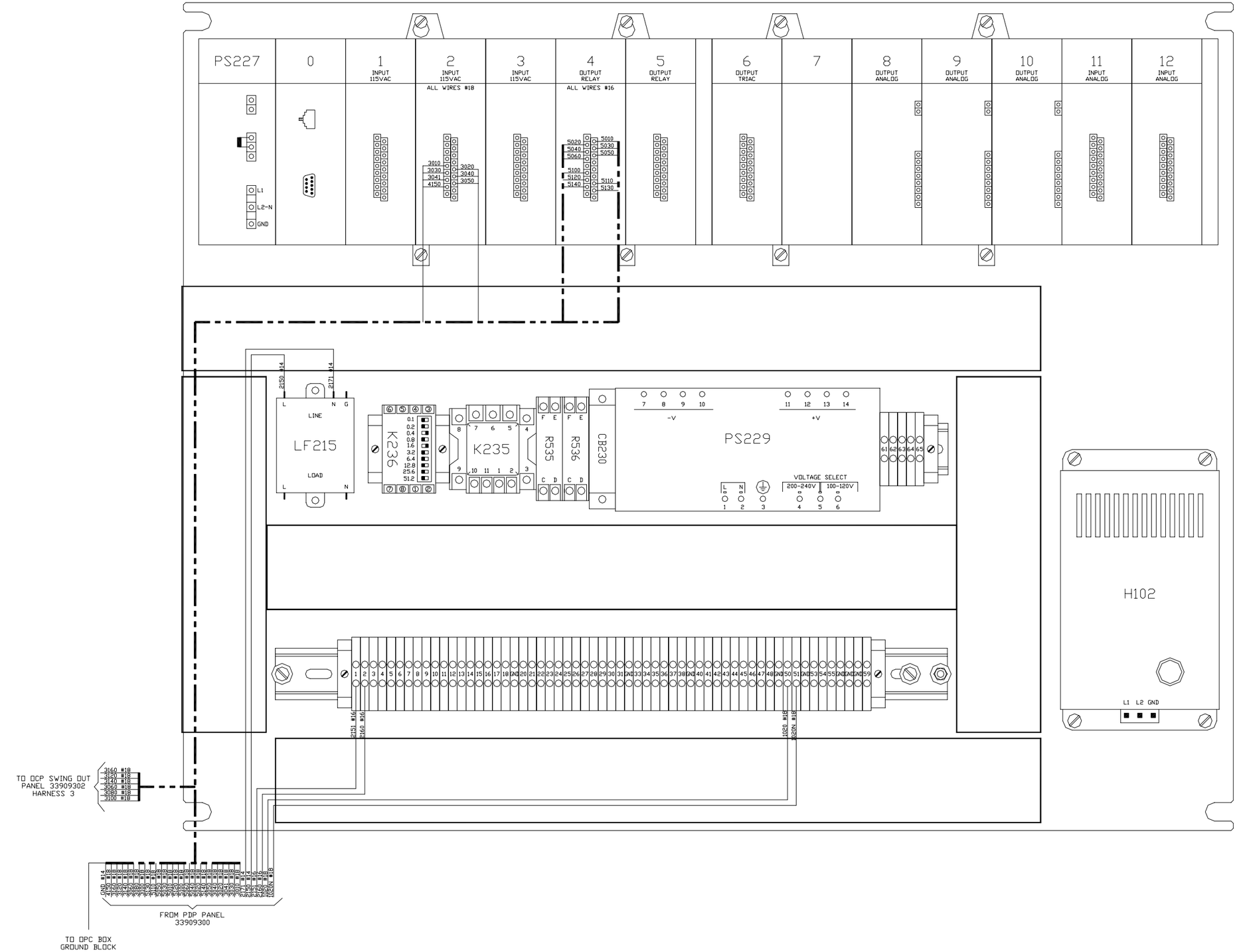


Figure 3. TWPS Point-to-Point Wiring Diagrams – OCP Sub-Panel – OCP to PDP (Sheet 4 of 5).

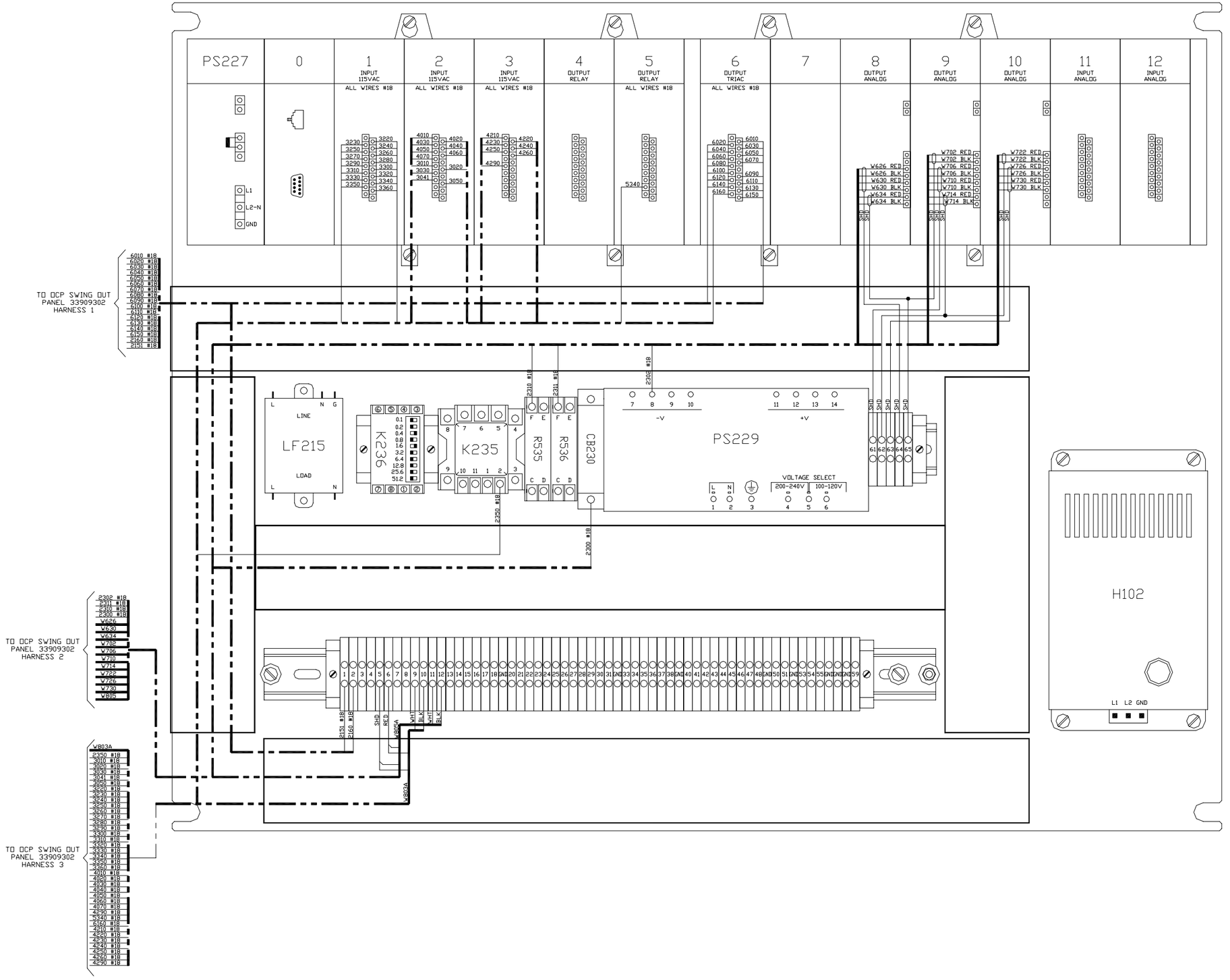


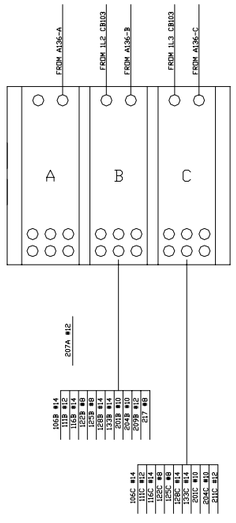
Figure 3. TWPS Point-to-Point Wiring Diagrams – OCP Sub-Panel – OCP to OCP Door (Sheet 5 of 5).

NOTES:
1. TIGHTEN ALL WIRES PER TORQUE VALUE CHART.

TORQUE VALUES		
WIRE TYPE	IN/LBS	
CONTROL WIRES	6.00	
POWER WIRES	16.00	$
DIST. BLOCK WIRES	30.00	*
MAIN CIRCUIT BREAKER WIRES	35.00	#

WIRE LEGEND

- BLACK WIRE
- WHITE WIRE
- RED WIRE
- GREEN WIRE
- BLUE WIRE
- BROWN WIRE
- ORANGE WIRE
- YELLOW WIRE
- WIRE BUNDLE
- GROUND WIRE



DETAIL A

DETAIL B

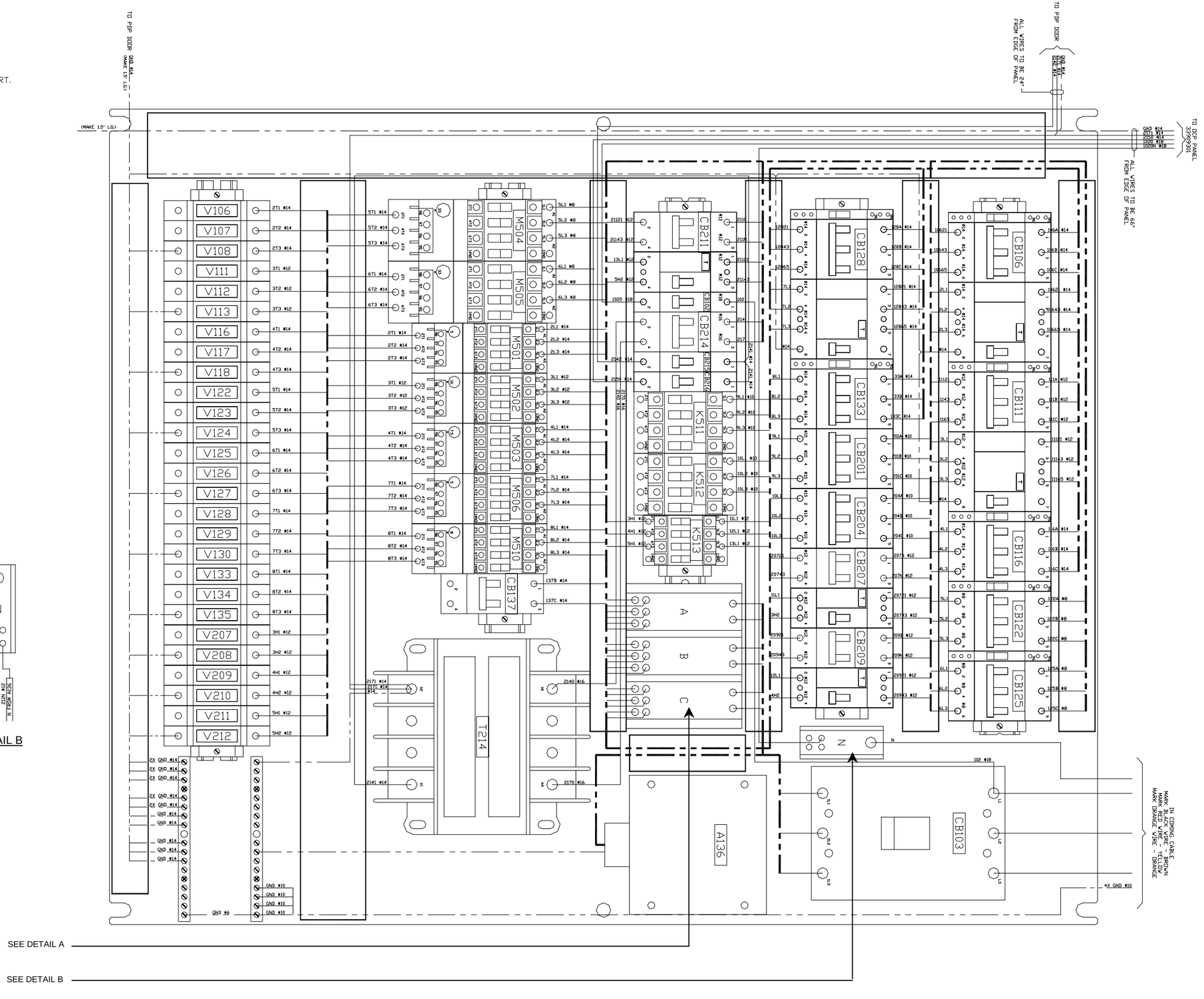


Figure 4. TWPS Point-to-Point Wiring Diagrams – PDP Sub-Panel – Power (Sheet 1 of 4).

Figure 4. TWPS Point-to-Point Wiring Diagrams – PDP Sub-Panel – Signal (Sheet 2 of 4).

Figure 4. TWPS Point-to-Point Wiring Diagrams – PDP Sub-Panel – Coil (Sheet 3 of 4).

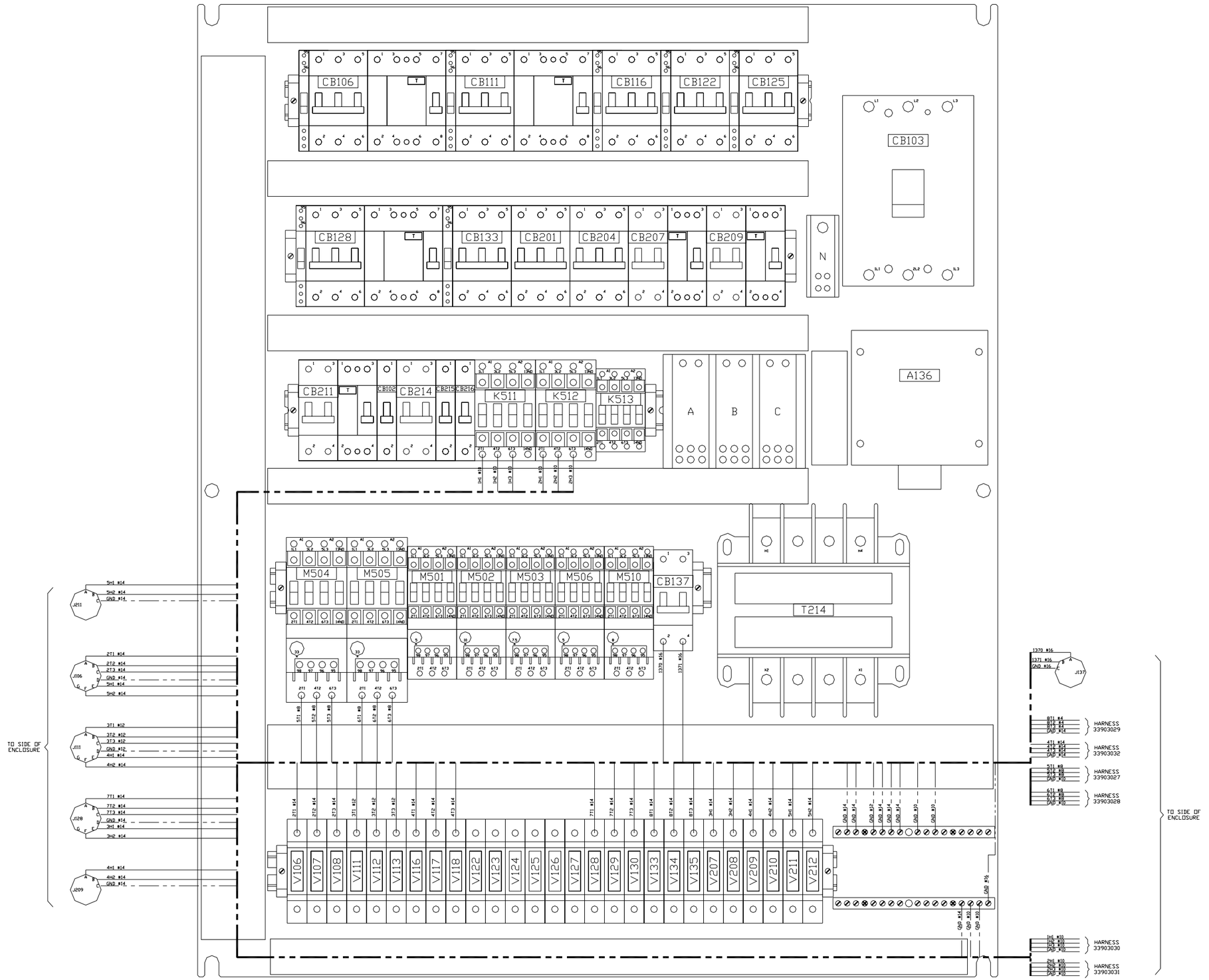


Figure 4. TWPS Point-to-Point Wiring Diagrams – PDP Sub-Panel – External Power (Sheet 4 of 4).

NOTES:

⚠ ALL WIRES COMING FROM THE VALVE SOLENIODS ARE BLACK.

2. TIGHTEN ALL WIRES PER TORQUE VALUE CHART.

TORQUE VALUES	
WIRE TYPE	IN/LBS
TERMINAL WIRES	6.00

WIRE LEGEND

- BLACK WIRE
- WHITE WIRE
- RED WIRE
- GREEN WIRE
- BLUE WIRE
- BROWN WIRE
- ORANGE WIRE
- YELLOW WIRE
- WIRE CORD (CONSISTING OF RED, BLACK & WHITE WIRES)
- WIRE BUNDLE
- GROUND WIRE

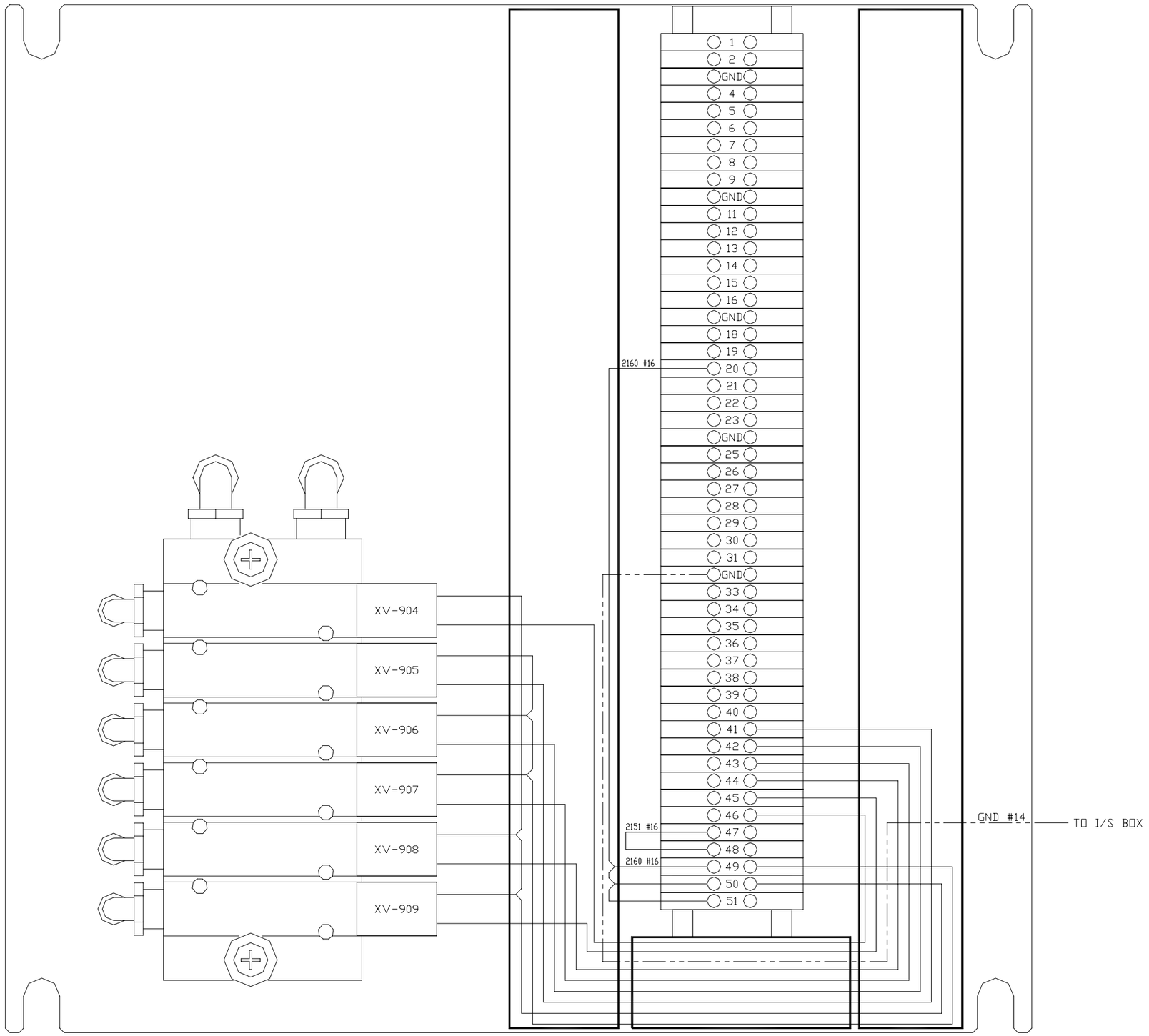


Figure 5. Instrument / Solenoid Sub-Panel – OCP Inputs (Sheet 1 of 5).

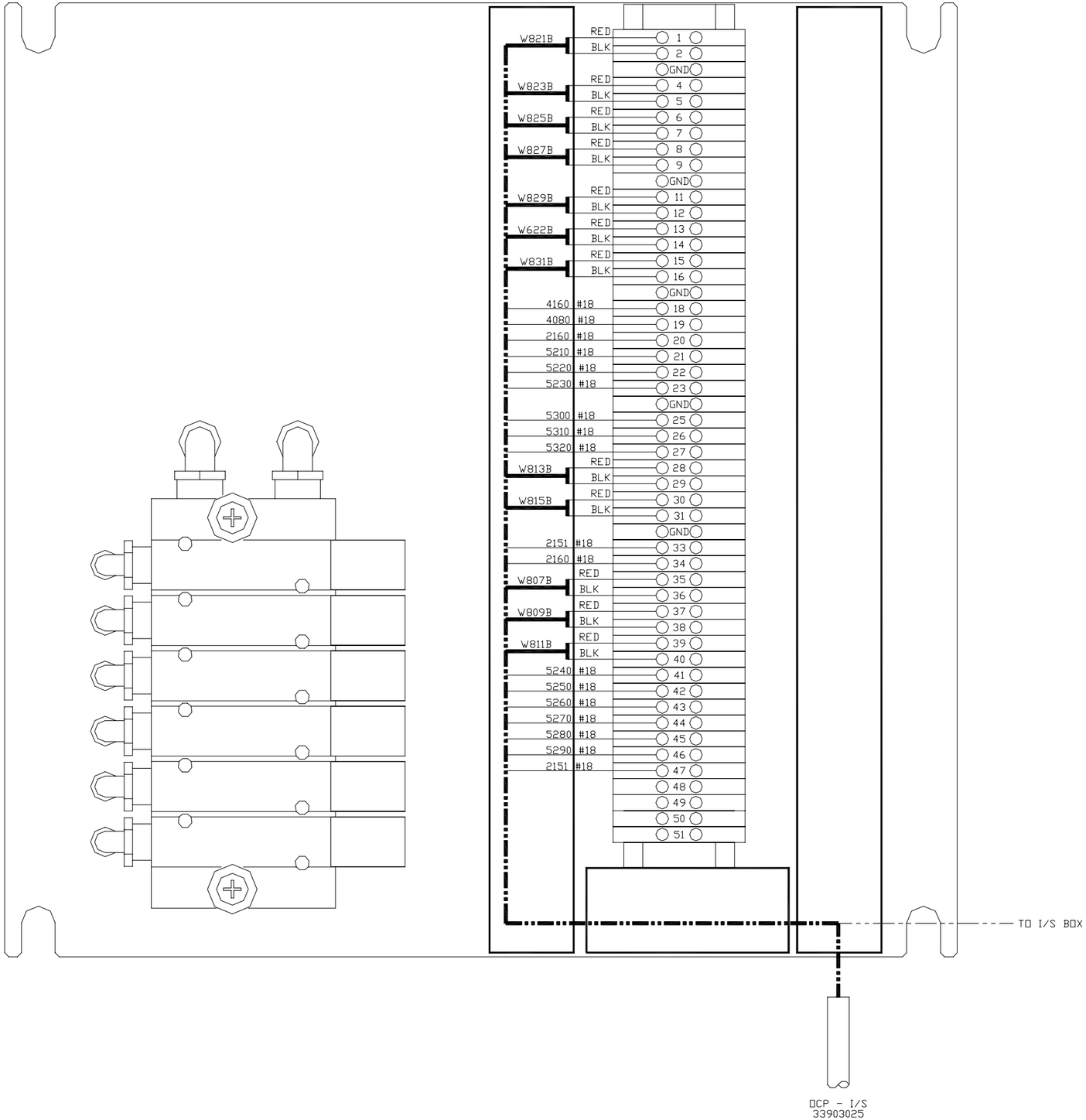


Figure 5. Instrument / Solenoid Sub-Panel – OCP Inputs (Sheet 2 of 5).

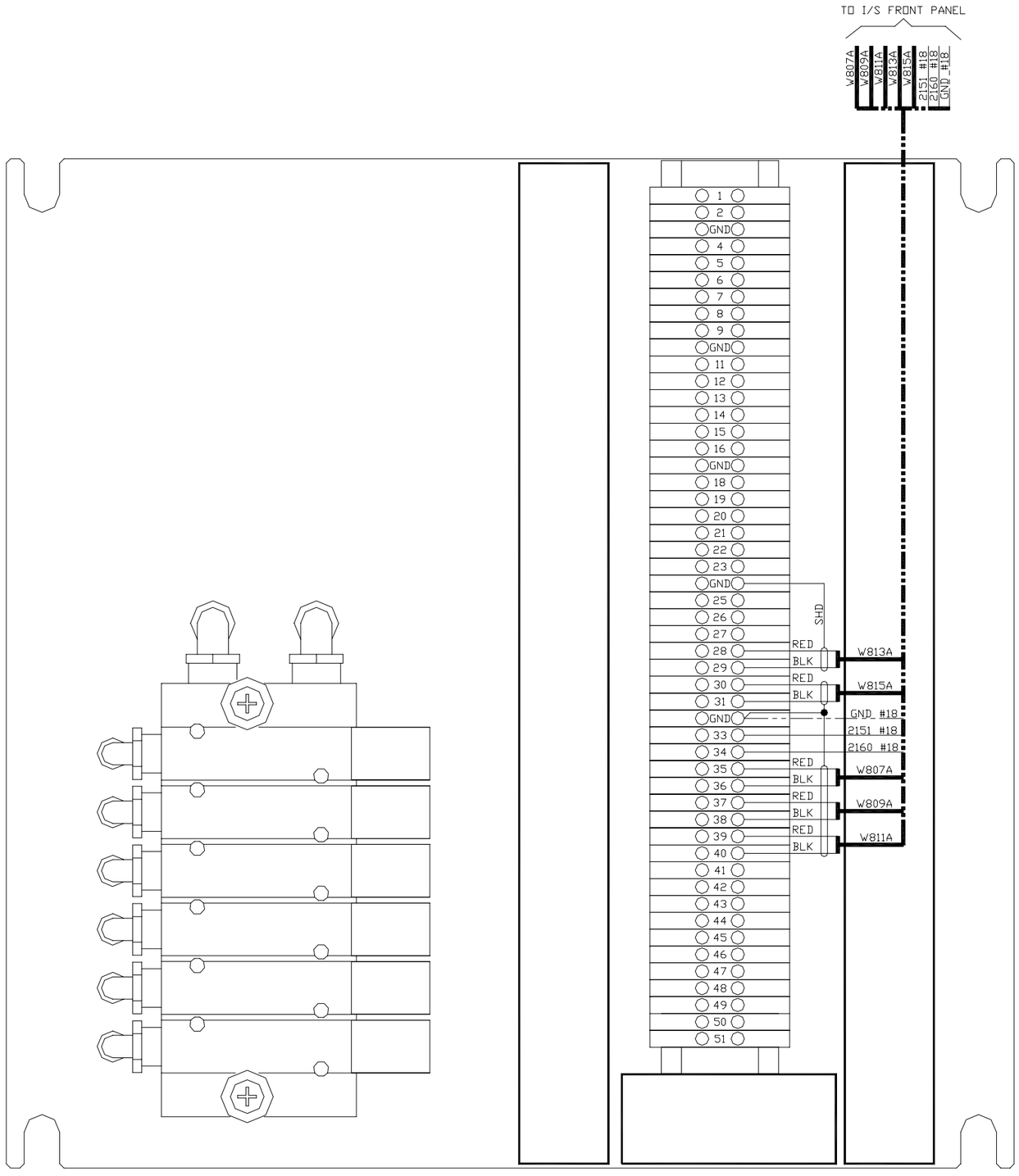


Figure 5. Instrument / Solenoid Sub-Panel – OCP Inputs (Sheet 3 of 5).

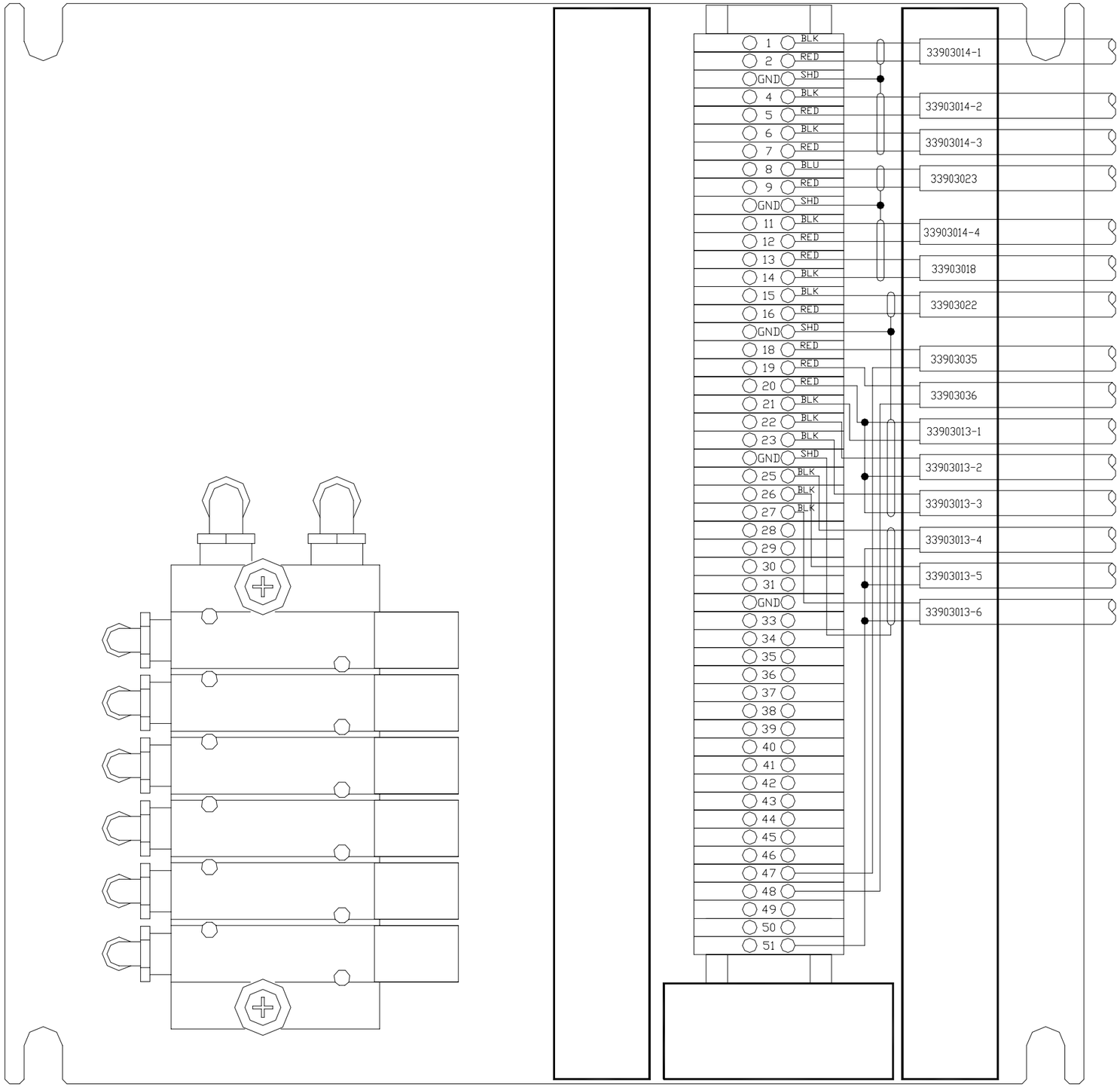


Figure 5. Instrument / Solenoid Sub-Panel – OCP Inputs (Sheet 4 of 5).

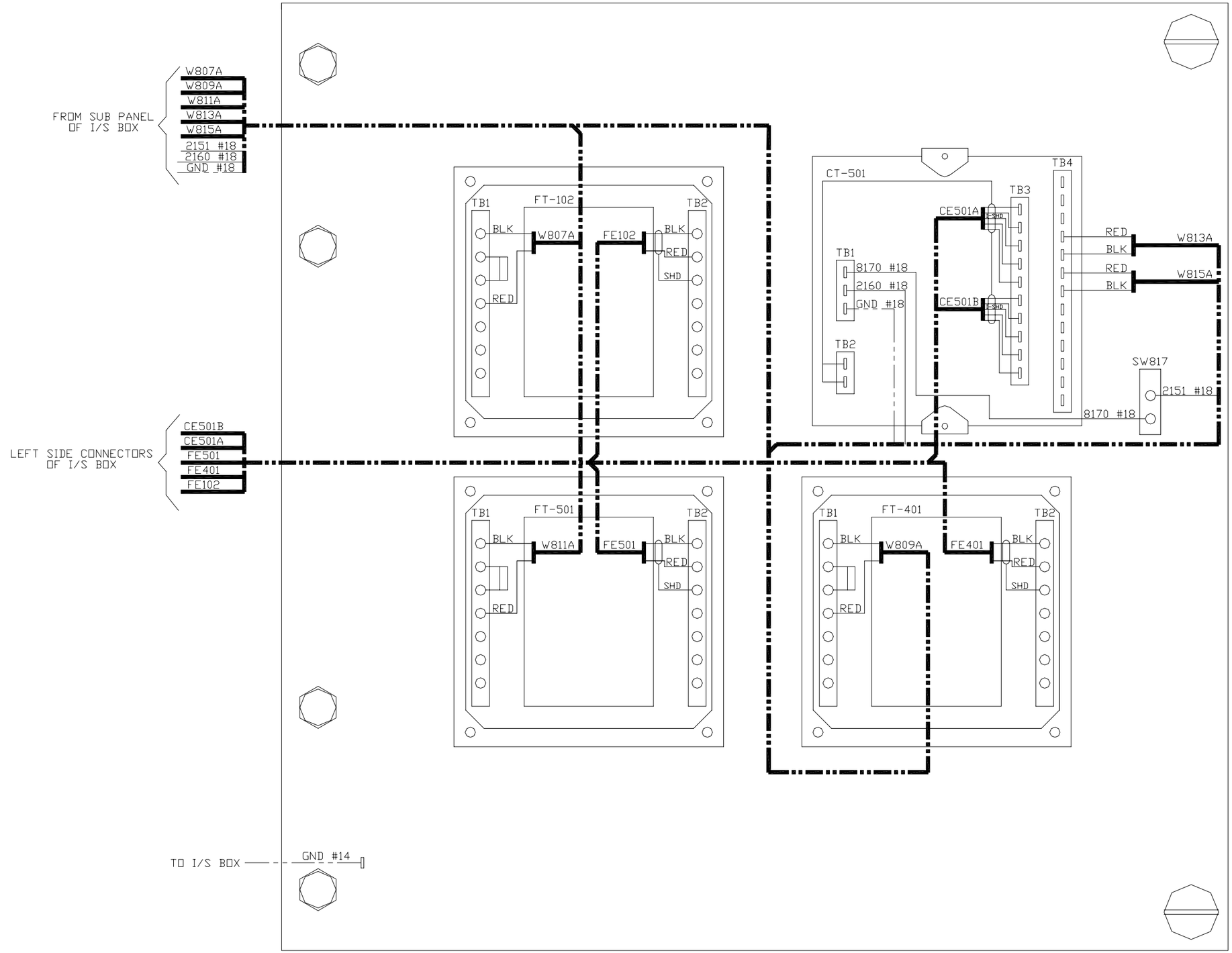


Figure 5. Instrument / Solenoid Sub-Panel – Rear View of Panel (Sheet 5 of 5).

These are the instructions for sending an electronic 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however only the following fields are mandatory:
1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" <whomever@avma27.army.mil>
To: TACOM-TECH-PUBS@ria.army.mil
Subject: DA Form 2028

1. From: Joe Smith
2. Unit: home
3. Address: 4300 Park
4. City: Hometown
5. St: MO
6. Zip: 77777
7. Date Sent: 19-OCT-93
8. Pub no: 55-2840-249-23
9. Pub Title: TM
10. Publication Date: 04-JUL-85
11. Change Number: 7
12. Submitter Rank: MSG
13. Submitter FName: Joe
14. Submitter MName: T
15. Submitter LName: Smith
16. Submitter Phone: 123-123-1234
17. Problem: 1
18. Page: 1
19. Paragraph: 3
20. Line: 4
21. NSN: 5
22. Reference: 6
23. Figure: 7
24. Table: 8
25. Item: 9
26. Total: 123
27. Text:

This is the text for the problem below line 27.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25-30; the proponent agency is OAASA	Use Part II *(reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	**DATE**
TO *(Forward to proponent of publication or form) (Include ZIP Code)*	**FROM** *(Activity and location) (Include ZIP Code)*	

PART I – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE

ITEM	PAGE	PARA-GRAPH	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

TO *(Forward direct to addressee listed in publication)*	**FROM** *(Activity and location) (Include ZIP Code)*	**DATE**

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	**DATE**	**TITLE**

PAGE NO.	**COLM NO.**	**LINE NO.**	**NATIONAL STOCK NUMBER**	**REFERENCE NO.**	**FIGURE NO.**	**ITEM NO.**	**TOTAL NO. OF MAJOR ITEMS SUPPORTED**	**RECOMMENDED ACTION**

PART III – REMARKS *(Any general remarks, recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	**TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION**	**SIGNATURE**

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25-30; the proponent agency is OAASA	Use Part II *(reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	**DATE**
TO *(Forward to proponent of publication or form) (Include ZIP Code)*	**FROM** *(Activity and location) (Include ZIP Code)*	

PART I – ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE

ITEM	PAGE	PARA-GRAPH	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

TO *(Forward direct to addressee listed in publication)*	**FROM** *(Activity and location) (Include ZIP Code)*	**DATE**

PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	**DATE**	**TITLE**

PAGE NO.	**COLM NO.**	**LINE NO.**	**NATIONAL STOCK NUMBER**	**REFERENCE NO.**	**FIGURE NO.**	**ITEM NO.**	**TOTAL NO. OF MAJOR ITEMS SUPPORTED**	**RECOMMENDED ACTION**

PART III – REMARKS *(Any general remarks, recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	**TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION**	**SIGNATURE**

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:

SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army
0508902

By Direction of the Commandant of the Marine Corps

Official:

L. V. BRADLEY
Director
Ground Transportation and Engineering Systems
Marine Corps Systems Command
Quantico VA 22134

DISTRIBUTION: To be distributed in accordance with the Initial Distribution Number (IDN) 256830, requirements for TM 10-4610-309-14

The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 decameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigrams = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decameter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 feet

Approximate Conversion Factors

To change	*to*	*multiply by*	*To change*	*to*	*multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

PIN: 082393-000