TECHNICAL MANUAL

OPERATOR, UNIT, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

FOR

WATER PURIFICATION BARGES (NSN 1930-01-234-2165) VOLUME 4 CHLORINATION SYSTEM

This technical manual is an authentication of the manufacturer's commercial literature and does not conform with the format and content requirements normally associated with the Army technical manuals. This technical manual does, however, contain all essential information required to operate and maintain the equipment.

Approved for public release; distribution is unlimited

*This manual supersedes TM 55-1930-209 14&P-4, 30 January 1989.

HEADQUARTERS, DEPARTMENT OF THE ARMY
15 OCTOBER 1992

WARNINGS AND SAFETY NOTICES
WARNING
DANGEROUS VOLTAGES AND HAZARDOUS MATERIALS ARE USED IN THIS EQUIPMENT
DO NOT TAKE CHANCES!

GENERAL WARNINGS

- Always redtag electrical equipment, controls, circuits, and switches before beginning repairs.
- Do not service or adjust high voltage electrical equipment when alone.
- Do not overload circuits.
- Always use authorized, insulated tools and test equipment when working on electrical equipment.
- Remove all jewelry before working on or around electrical equipment with exposed current-carrying areas.
- Do not wear clothing with exposed metal fasteners when working on electrical equipment.
- Always use approved breathing apparatus when working with chemicals.
- Avoid chemical contact with eyes, skin, and clothing.
- Always wear safety glasses, gloves, and rubber aprons when handling chemicals.
- Wear protective clothing and safety glasses as required when working on barge equipment.
- Always wear approved ear protection in noise hazard areas.

SPECIFIC WARNINGS

- Do not connect any new circuit to an existing circuit.
- Do not energize circuits if water condensation is present.
- If any sparks are seen, stop operation immediately. Determine cause and take corrective action.
- Never touch radio antennas of fixed-base radio transmitters. When transmitting, antennas contain high voltage.
- Always use approved breathing apparatus when handling material in multimedia filters and chlorination unit descailng acid crystals. Do not breathe dust from these materials.
- Avoid breathing vapors from coagulant aid chemicals. Use in a well-ventilated area. In case of chemical contact with skin, wash with water. For eyes, immediately flush at eyewash station and obtain medical help as soon as possible.
- Always wear work gloves and shirts with full length buttoned sleeves when handling fuel oil and gasoline.

- Do not smoke or have open flames within 10 feet when handling fuel oil or gas. Only minimum number of personnel necessary to conduct fueling operation is permitted in area.
- Before starting any repairs on compressed air system, always release pressure from air receiver and compressor and open and redtag circuit breakers.
- On air compressor, do not adjust automatic regulator switch (pressure switch) and pilot valve settings.
- To avoid flying particles lodging in eyes, do not use compressed air to dust-off clothing or workspace.
- Stay clear of anchor cables when operating anchor winches.
- Always wear safety glasses or face shield when using power tools.
- Always wear lifevests when on weatherdeck and throughout the barge during storm conditions.
- Lifevests are to be worn at all times aboard workboat.
- Only qualified persons will operate and maintain arc and fuel gas welders.
- When welding, always make sure those working with or near the welder wear proper clothing: heavy, hole-free gloves, heavy shirt, cuffless trousers, high shoes, and cap. Keep clothing dry and free of oil and other flammable substances.
- Use dry heavy canvas drop cloth to cover work area and adjacent deck when arc welding.
- Before welding on bulkheads, deck plating and similar surf aces, always check carefully to make sure that the other side of the surface to be welded does not hide fuel or compressed gas tanks, flammable or hazardous materials, or electrical equipment or wiring.
- When welding, keep your head out of the fumes and make sure area is well ventilated.
- Before welding on surfaces which have been cleaned with cleaning solutions containing chlorinated hydrocarbons, always wash with water, dry and ventilate area thoroughly.
- Use shield with proper filter lens when welding. Do not allow others near welding operations to assist or observe without proper eye protection. This must include side shields during slag chipping operations.
- Warn personnel in area during welding operations not to look at arc or expose themselves to hot spatter or metal.
- In an extreme emergency, when welding is required in void 2 port, shutdown chlorination system. Close all valves. Cover the parts of chlorination system not being welded with a heavy canvas drop cloth. Turn on vent 8 and, if available, provide additional forced air ventilation.

- Before welding on fuel oil or sludge tank, make sure tank is gas-free by: 1) removing all liquid from tank, 2) cleaning tank thoroughly, 3) seeing that tank is thoroughly dry, and 4) force ventilating tank.
- Connect arc welding work cable as close to welding area as possible. Work cables connected to barge framework or other locations far from welding site increase the possibility of the welding current passing through lifting chains, crane cables or other possible circuit paths. This can create fire hazards or weaken lifting chains or crane cables until they break or fall.
- Always weld with all doors, portholes, and hatches propped open and necessary ventilation systems operating.
- Take frequent breaks away from the area where you are welding.
- Do not take oxygen and acetylene tanks into confined areas when welding.
- Always use a friction lighter to start oxyacetylene torch.
- Always maintain all welding equipment in proper working condition. If you have any doubts about the safety of any welding equipment, do not Use the welder.

ELECTRICAL SHOCK SAFETY STEPS

Five safety steps to follow if someone is the victim of electrical shock.

1. Do not try to pull or grab individual.
2. Turn off electrical power when possible.
3. If you can not turn off electrical power, pull, push, or lift person to safety using a wooden pole, rope, or some other insulating material.
4. Get medical help as soon as possible.
5. After the injured person is free of contact with the source of electrical shock, move the person a short distance away and, if needed, start CPR immediately.

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INTRODUCTION TO

TM 55-1930-209-14&P-4

You can help improve this manual. It you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Troop Support Command, ATTN: AMSTR-MMTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1 798. A reply will be furnished directly to you.

1. SCOPE

TM 55-1930-209-14&P covers the Reverse Osmosis Water Purification Barges, Models 300-WPB-1, 300-WPB-2 and 300WPB-3, NSN 1930-01-234-2165. This manual consists of twenty-one volumes.

2. REVERSE OSMOSIS WATER PURIFICATION BARGES

The Reverse Osmosis Water Purification Barges provide up to 300,000 gallons of drinking water per 24 hour period. The drinking water, converted from seawater or brackish water, is for use by a Rapid Deployment Force in a forward area. When needed, the drinking water can be pumped to a shore facility or to another vessel. This manual provides operation and maintenance procedures for all the component systems on the barges.

3. VOLUME 1 -- NORMAL OPERATIONS

This volume provides information and procedures on normal Reverse Osmosis Water Purification Barge operations, including barge movement and deployment, communications and electrical power systems, drinking water production, shutdown, and required operational maintenance. Emergency shutdown procedures are also provided.

4. VOLUME 2 -- SEAWATER SYSTEM

This volume describes operation and maintenance of the seawater system which supplies seawater to the Reverse Osmosis Water Purification Units (ROWPUs) for processing to the air conditioning unit for r Doling to the ballast tank for barge trimming to the chlorination unit for priming and cooling, and to the diesel generators for cooling.

5. VOLUME 3 -- REVERSE OSMOSIS WATER PURIFICATION UNIT (ROWPU) SYSTEM

Volume 3 provides operation and maintenance procedures for the ROWPU System which processes seawater or brackish water to produce drinking water. Normally, this system processes seawater Applied by the seawater system (TM 55-1 930-209-1 4&P-2) to create product water. Chlorine is then prided to this product water by the chlorination system (TM 55-1930 20-14&P-4). The resultant drinking water is discharged into tour storage tanks that are part of the drinking water system (TM 55-1930-209 14&P-5).

6. VOLUME 4 -- CHLORINATION SYSTEM

Operation and maintenance procedures for the chlorination system onboard the Water Purification Barges are contained in this volume. This system produces chlorine in a sodium hypochlome solution, upon demand, to water processed by the ROWPU system just before the water enters the tour drinking water storage tanks.

7. VOLUME 5 -- DRINKING WATER SYSTEM

The drinking water system provides storage for water produced by the ROWPUs and includes pumps and valves to move this water from onboard storage tanks to the shore discharge system, to another vessel, or overboard. The drinking water system also provides a pressurized water supply for drinking and washing onboard the barges.

8. VOLUME 6 -- SHORE DISCHARGE SYSTEM

This volume provides operation and maintenance proredurer,forther,horedischarg0 system which transfers drinking water from barge storage tanks to holding/storage facilities ashore.

9. VOLUME 7 -- COMPRESSED AIR SYSTEM

Volume 7describes the operation and maintenance of the compressed air system which provides compressed air to five air stations in the ROWPU spar e, one in the workshop, and one on stem weatherdeck. This system also provides compressed air to two air stations for blow down of sear bests in void 2 starboard and void 4 port. Compressed air is used on the barges to operate air-powered impact tools, to propel air through the shore discharge hose, to blow down seachest, and for general cleaning Slowdown.

10. VOLUME 8 -- FUEL OIL SYSTEM

This volume provides operation and maintenance procedures for the fuel oil system which functions as a centralized receiving storage and distribution system for diesel fuel used for barge operations. This onboard fuel system provides fuel for two 155 kW diesel ship service generators, a 20 kW ship auxiliary generator, two ROWPU high-pressure pump diesel engines, and a fueling station for the barge workboat.

11. VOLUME 9 -- ELECTRICAL POWER SYSTEMS

Operation and maintenance procedures for the two electrical power systems installed aboard the Water Purification Barges are contained in Volume 9. The nominal electrical power system generates, controls and distributes all electrical power for operating the water purification system and its auxiliary systems. The emergency electrical system supplies 24 Vdc from a battery bank to 24 Vdc equipment and converts to 24 Vd through an inverter to 120 Vac to power emergency lighting and equipment.

12. VOLUME 10 -- LIGHTING SYSTEM

Volume 10 contains operation and maintenance procedures for the onboard lighting systems for the Water Purification Barges. This system supplies interior and exterior lighting. Normal and emergency interior lighting is provided in the deckhouse ROWPU space, dayroom, workshop, and voids. Exterior lighting consists of searchlights and floodlights for use at night or during reduced visibility. Lights on the weatherdecks and standard navigation and status lights are for use during operation and towing.

13. VOLUME 11 -- EQUIPMENT MONITORING SYSTEM

This volume provides operation and maintenance procedures for the equipment monitoring system which monitors the operation of several equipment components onboard the Water Purification Barges. This system monitors operating conditions such as amount of drinking water in storage tanks and temperature of diesel engine cooling water. Sensors detect unacceptable operating conditions, the main processor flashes at double intensity and remote alarms (hems, strobe lights and buzzer alert crewmembers that corrective action is necessary.

14. VOLUME 12 -- COMMUNICATIONS SYSTEM

Operation and maintenance procedures for the communications system are provided in Volume 12. This system consists of three separate communications methods, radio communications, foghorn and intercom telephones.

15. VOLUME 13 -- HANDLING EQUIPMENT

This volume contains operation and maintenance procedures for handling equipment used for lifting, transporting and repositioning equipment and materials onboard the barges. The system induces a bridge crane, bow crane and a void 4 trolley hoist.

16. VOLUME 14 -- ANCHOR, MOORING, AND TOWING EQUIPMENT

Volume 14 describes the operation and maintenance procedures for the anchor mooring, and towing equipment on the Water Purification Barges. This equipment provides a method to hold (anchor) the barges in a fixed position offshore, at dockside, or next to another vessel and a method to move the barges from one location to another.

17. VOLUME 15 -- MISCELLANEOUS EQUIPMENT (DAYROOM, WORKSHOP, ACCESSES, AND SANITATION SYSTEMS)

Volume 15 addresses operation and maintenance procedures for miscellaneous equipment installed on the Water Purification Barges. This equipment includes the dayroom on the forward starboard she of deckhouse, the workshop on the forward portside of deckhouse, accesses such as deckhouse doors and portholes and various accesses to and from the vows, and two separate sanitation systems (toilets and bilge). Additional equipment addressed in this volume includes: guard rails, Rubber tendering, removable Rubber floor mats, eyewash stations, component labels, caution, warning and danger signs, and storage areas.

18. VOLUME 16 -- VENTILATION, HEATING, AND AIR CONDITIONING SYSTEMS

This volume contains operation and maintenance procedures for the deckhouse and voids ventilation systems and the heating and air conditioning (HAC) system installed on the Water Purification Barges. The ventilation system provides fresh air circulation in the deckhouse and voids with 17 hatches and 10 ventilation fans. The HAC controls the temperature in the dayroom and deckhouse.

19. VOLUME 17 -- WORKBOAT, LIFESAVING, AND FIREFIGHTING EQUIPMENT

Volume 17 includes procedures for the operation and maintenance of:

a. Workboat -- provides water transportation for mew members and visitors, small cargo items, transportation of the messenger line for the shore discharge hose and similar work-related tasks associated with operating the Water Purification Barges.

b. Lifesaving Equipment -- installed on the barges and consisting of 2 liferafts, 15 Type II and 24 Type V lifevests and 4 lifesaving rings.

c. Firefighting Equipment -- installed on the barges and consisting of Halon 1301 system, 2 CO2 hose reel units, a smoke detector system, 17 portable CO2 fire extinguishers, 5 dry Chemical fire extinguishers, 5 self-contained breathing apparatuses, and 0 portable, engine driven firefighting pump. The workboat also has a 10-pound, portable, dry Chemical fire extinguisher.

20. VOLUME 18 -- SUPPORTING APPENDICES FOR VOLUMES 1-17.

Volume 18 contains the Maintenance Allocation Chad, Components of End item List, Tools and Test Equipment List, Expendable/Durable Supplies and Materials List and the Repair Pads and Special

All of the information contained in this volume is common to volumes 1-17 and does not appear in each individual volume.

Appendix A in volumes 1-17 provides information unique to each volume. Appendix B in volumes 1-17 provides manutactur0rs manuals and instructions unique to the system described in each volume. Appendixes C-G are located in Volume 18.

21. VOLUME 19 -- PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

Volume 19 contains PMCS pertinent to all onboard systems for the Reverse Osmosis Water Purification Barges.

22. VOLUME 20 -- SUPPLEMENTAL DATA

Volume20containsthe Basic issue items List, and additional Authorization List for all on board systems for the Reverse Osmosis Water Purification Barges.

23. VOLUME 21 -- WINCH, DOUBLE DRUM, DIESEL

This volume contains operation and maintenance procedures for the 20-ton double drum diesel engine winch used on the Water Purification Barges. Appendix B of Volume 21 contains the Maintenance Allocation Chart and the Repair Parts and Special Tools list for the winch.

TECHNICAL MANUAL
NO.55-1930 209-14&P-4

HEADQUARTERS
DEPARTMENT OF THE ARMY,
WASHINGTON D.C., 15 O TOBER 1992

TECHNICAL MANUAL

OPERATORS', UNIT, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

FOR

WATER PURIFICATION BARGES (NSN 1930-01-234-2165) VOLUME 4 CHLORINATION SYSTEM

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

Your an help improve this manual. It you find any mistakes or it you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA From 2028-2 located in the bar k of this manual direr t to: Commander, US Army Troop Support Command, ATTN: AMSTR-MMTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

*Supersedes TM 55-1930-209-1 4&P-4, 30 January 1989

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TABLE OF CONTENTS
VOLUME 4

TABLE OF CONTENTS (Continued)
VOLUME 4

TABLE OF CONTENTS (Continued)
VOLUME 4

TABLE OF CONTENTS (Continued)
VOLUME 4

LIST OF APPENDICES

NOTE

The following appendices, common to all TM's in this series, are in TM-55-1930-209-14&P-18. MAINTENANCE ALLOCATION CHART (MAC) TOOLS AND TEST EQUIPMENT LIST (TTEL) EXPENDABLE /DURABLE SUPPLIES AND MATERIALS LIST (ESML) REPAIR PARTS AND SPECIAL TOOLS LIST (RPSTL) REPAIR PARTS LIST TO FIGURE NUMBER CROSS-REFERENCE LIST

NOTE

The following appendices, common to all TM's in this series, are in TM 55-1930-209-14&P-20. COMPONENTS OF END ITEM LIST (COEIL) and BASIC ISSUE ITEMS LIST (BIILL) ADDITIONAL AUTHORIZED ITEMS LIST (AAL)

LIST OF ILLUSTRATIONS

TABLE OF CONTENTS (Continued)
VOLUME 4
LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1 INTRODUCTION

Section I. General Information

1-1 Purpose. This technical manual (TM) describes the operation and maintenance of the chlorination system on Water Purification Barges. Information on other systems onboard is in TM 55-1930-209-1 4&P-1 thru P-3 and P-5 thru P-1 7. TM 55-1930-209-14&P-18 and TM 55-1930-209-14&P-20 contain appendices common to all TM's. Location of major barge components is shown in Figure 1-1.

1-2 Scope. The chlorination system generates a strong solution of sodium hypochlorite (commonly called chlorine) for treating water produced by the Reverse Osmosis Water Purification Units (ROWPU's). Adding this solution to the water makes it safe for human consumption.

1-3 Warranties and guarantees. Warranty and guarantee information is in Chapter 7.

1-4 Maintenance forms and records. Required maintenance forms and records are explained in DA PAM 738750, The Army Maintenance Management System (TAMMS).

1-5 Destruction of Army materiel to prevent enemy use. This shall be as directed in TM 750-244-3.

1-6 Storage. For storage procedures concerning this system, refer to Chapter 5.

Section II. Description and data

1-7 Description. The chlorination system produces chlorine in a sodium hypochlorite solution. A metering pump adds this solution, upon demand, to water processed by the ROWPU system just before the water enters the tour drinking water storage tanks. The chlorination system's major components are shown in Figure 1-2 for Barge 1 and in Figure 1-3 and for Barges 2 and 3. Major components are listed in Table 1-1. A chlorination system general working (block) diagram is in Figure 1-4, and a system flowchart is in Figure 1-5. Chlorination system installation is shown on drawings listed in Appendix A.

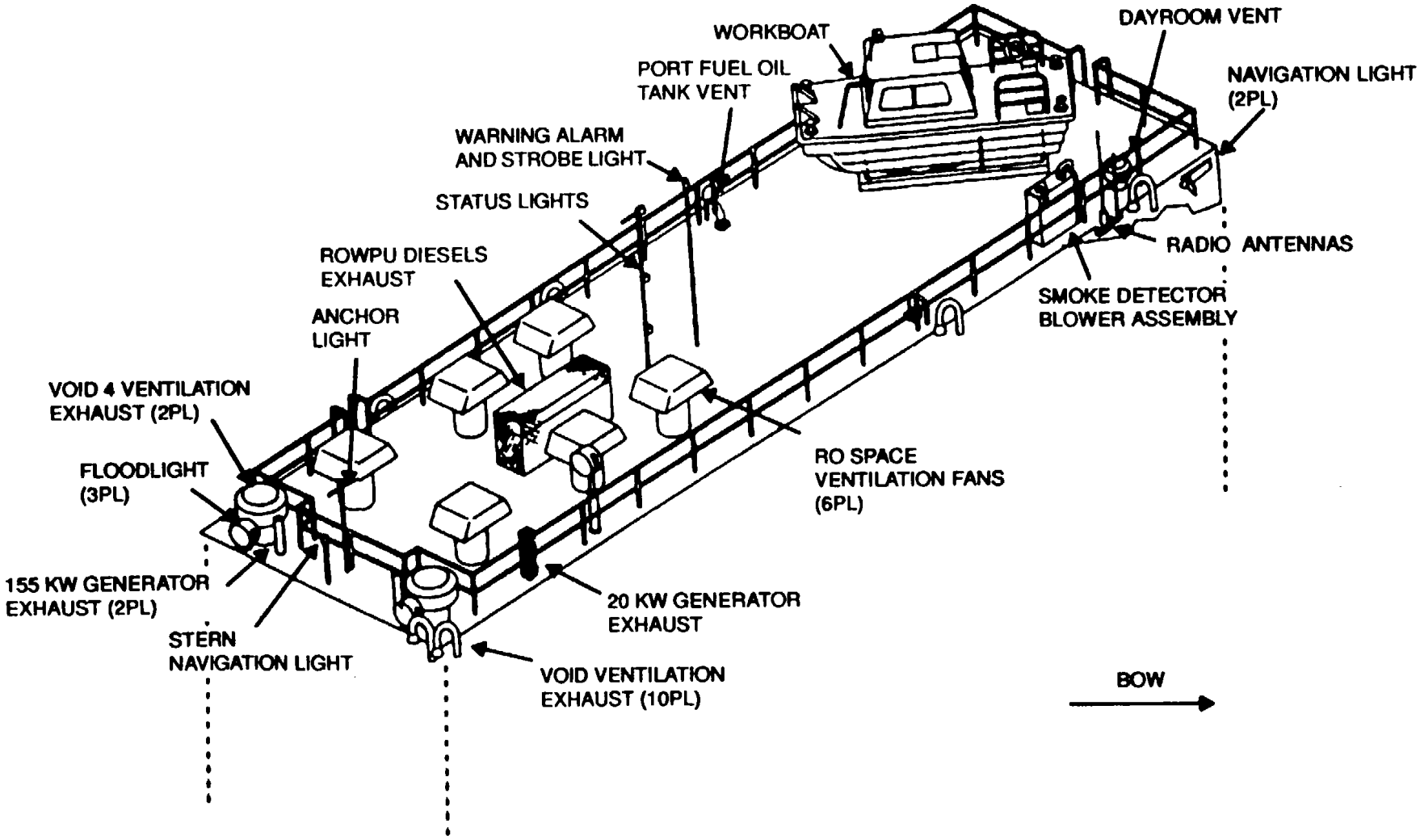


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment - Deckhouse Roof (Sheet 1 of 3)

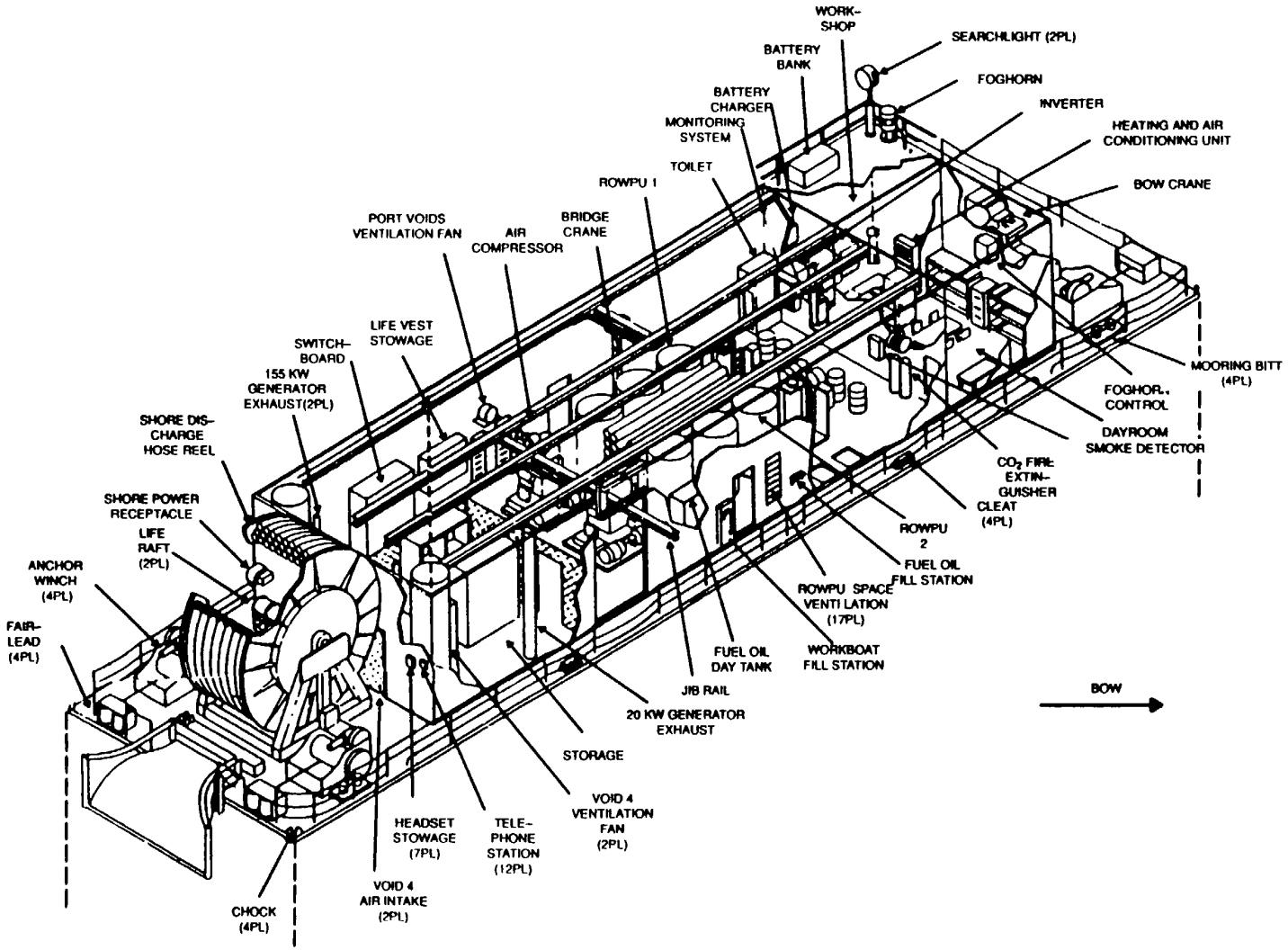


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment - Deckhouse (Sheet 2 of 3)

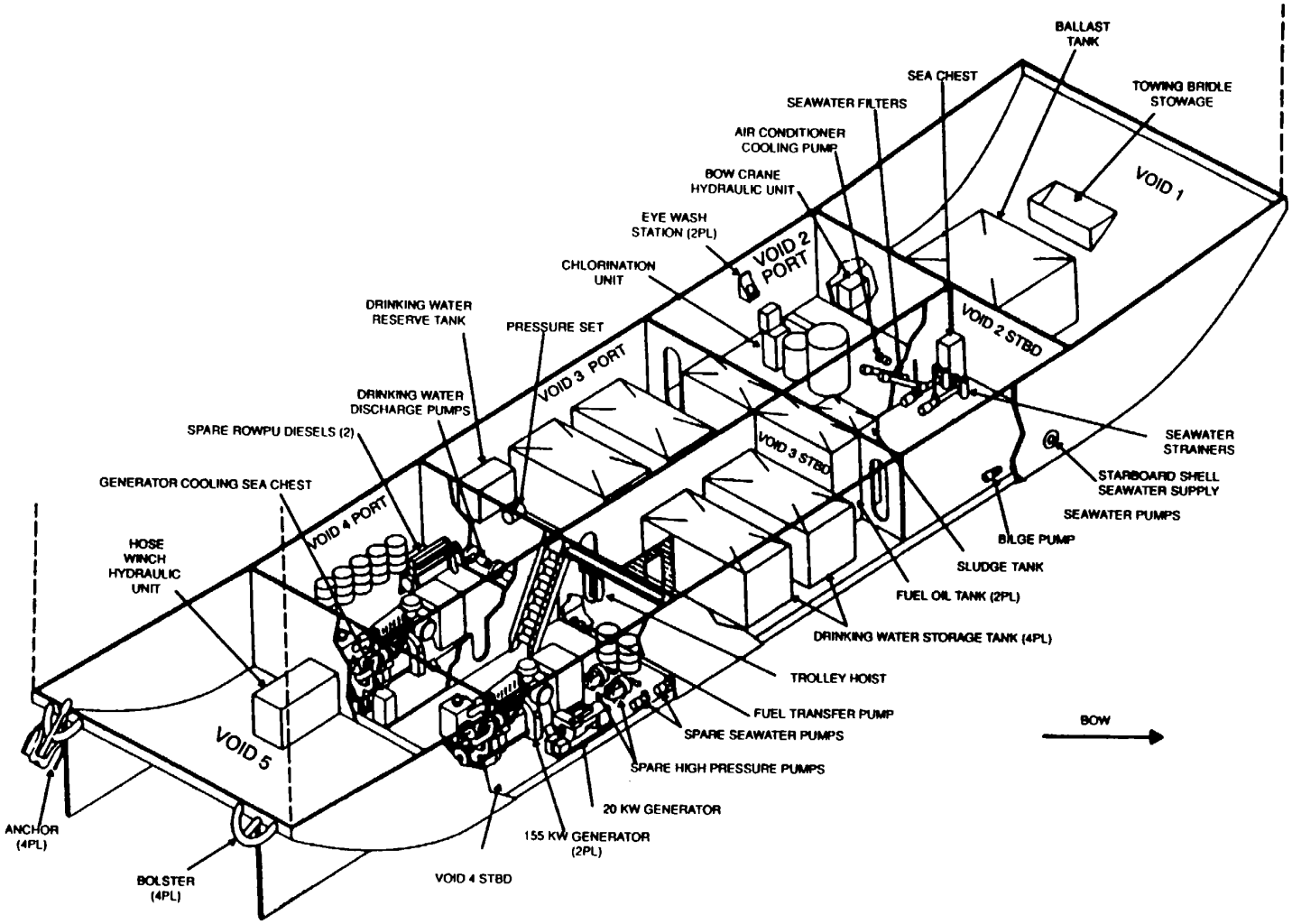


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment - Voids (Sheet 3 of 3)

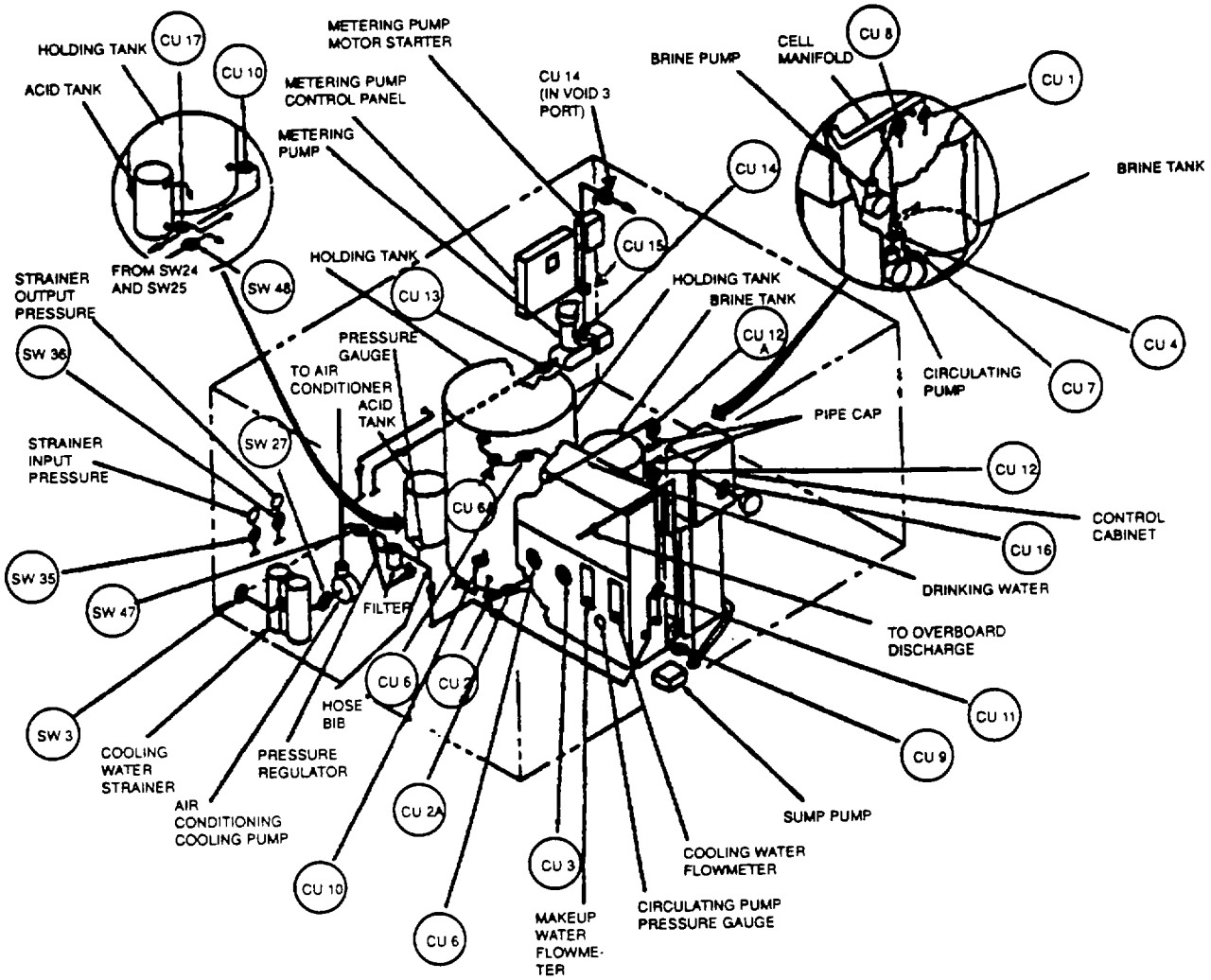


Figure 1-2. Chlorination System Installation (Barge 1)

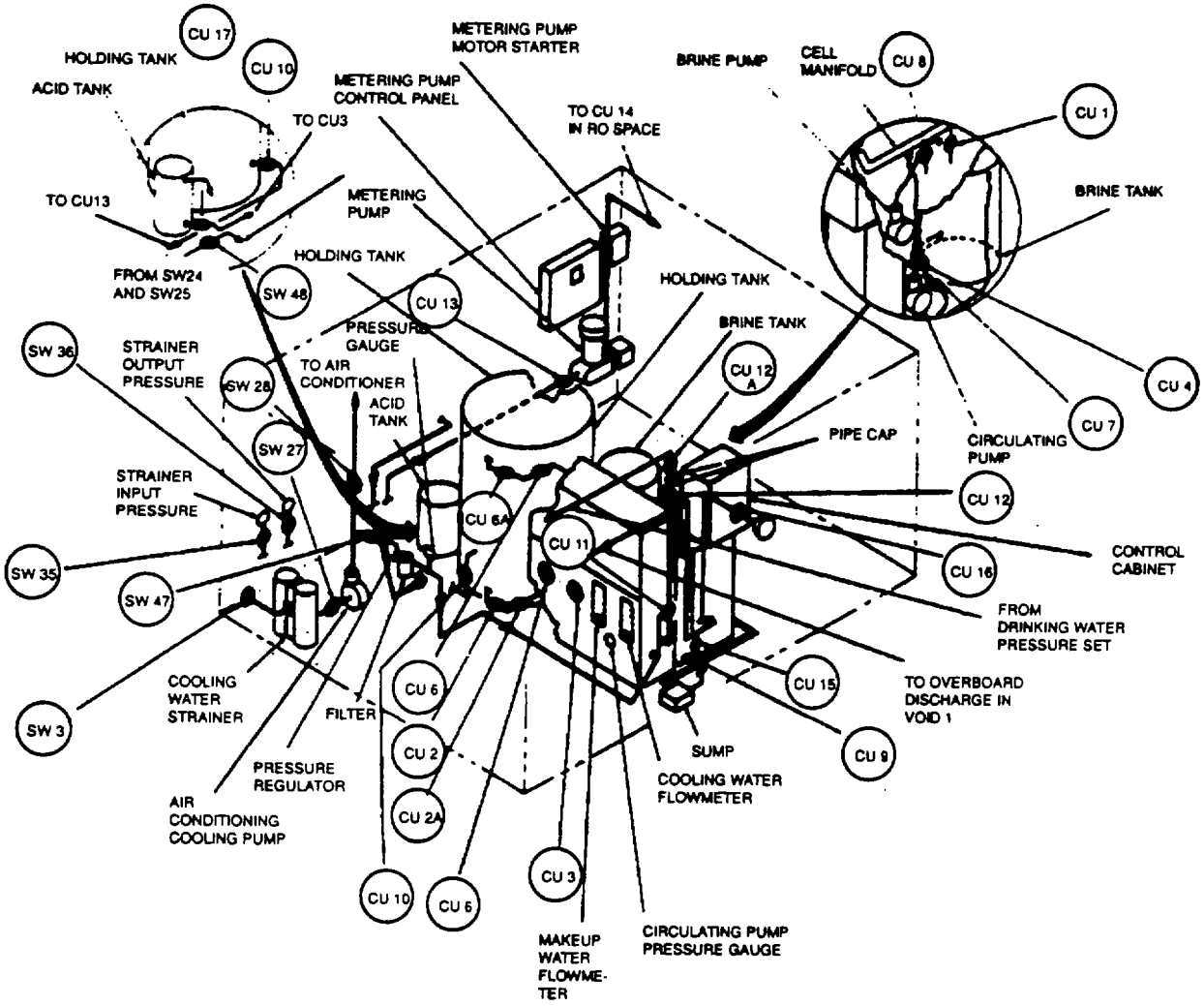


Figure 1-3. Chlorination System Installation (Barges 2 and 3)

Table 1-1. Major Components of Chlorination System

Component	Quantity	Function	Location
Chlorination unit	1	Generates and automatically maintains a hypochlorite solution for treatment of ROWPU product water entering drinking water tanks	Void 2 port
Chlorination unit holding (recycle) tank	1	Holds hypochlorite solution which is circulated to the cell assembly by the recirculating pump, and provides chlorine to the metering pump	Void 2 port on chlorination unit skid, inboard of brine tank
Chlorination unit brine tank	1	Holds brine solution which is automatically added to the holding tank by the brine pump when needed	Void 2 port on chlorination unit skid outboard of holding tank
Chlorination unit acid tank	1	Holds acid which is used to remove cell assembly scale during scale flushing operation	Void 2 port on chlorination unit skid outboard of holding tank
Chlorination unit circulating pump	1	Recirculated solution from holding tank through cell assembly and back to holding tank	Void 2 port on chlorination unit skid
Chlorination unit brine pump	1	Automatically provides brine solution to the holding tank when needed	Void 2 port on chlorination unit skid
Chlorination unit control cabinet	1	Controls chlorination unit operation of power supply	Void 2 port on chlorination unit skid on top
Drip pan sump tank and pump	1	Discharges drainage from chlorination unit directly overboard	Void 2 port outboard of chlorination unit skid
Metering pump	1	Injects measured amounts of chlorine into ROWPU product water stream	Void 2 port on inboard bulkhead forward
Chlorine sensor	1	Senses amount of chlorine being injected into ROWPU product water stream	Void 3 port in product water overhead piping
Metering pump motor controller	1	Starts and stops metering pump	Void 2 port on inboard bulkhead forward
Metering pump control unit	1	Controls amount of chlorine being injected into ROWPU product water by controlling metering pump operation	Void 2 on inboard bulkhead forward
Paddle flow switch	1	Automatically starts and stops metering pump when motor controller is in AUTO mode	Void 3 port in product water overhead piping

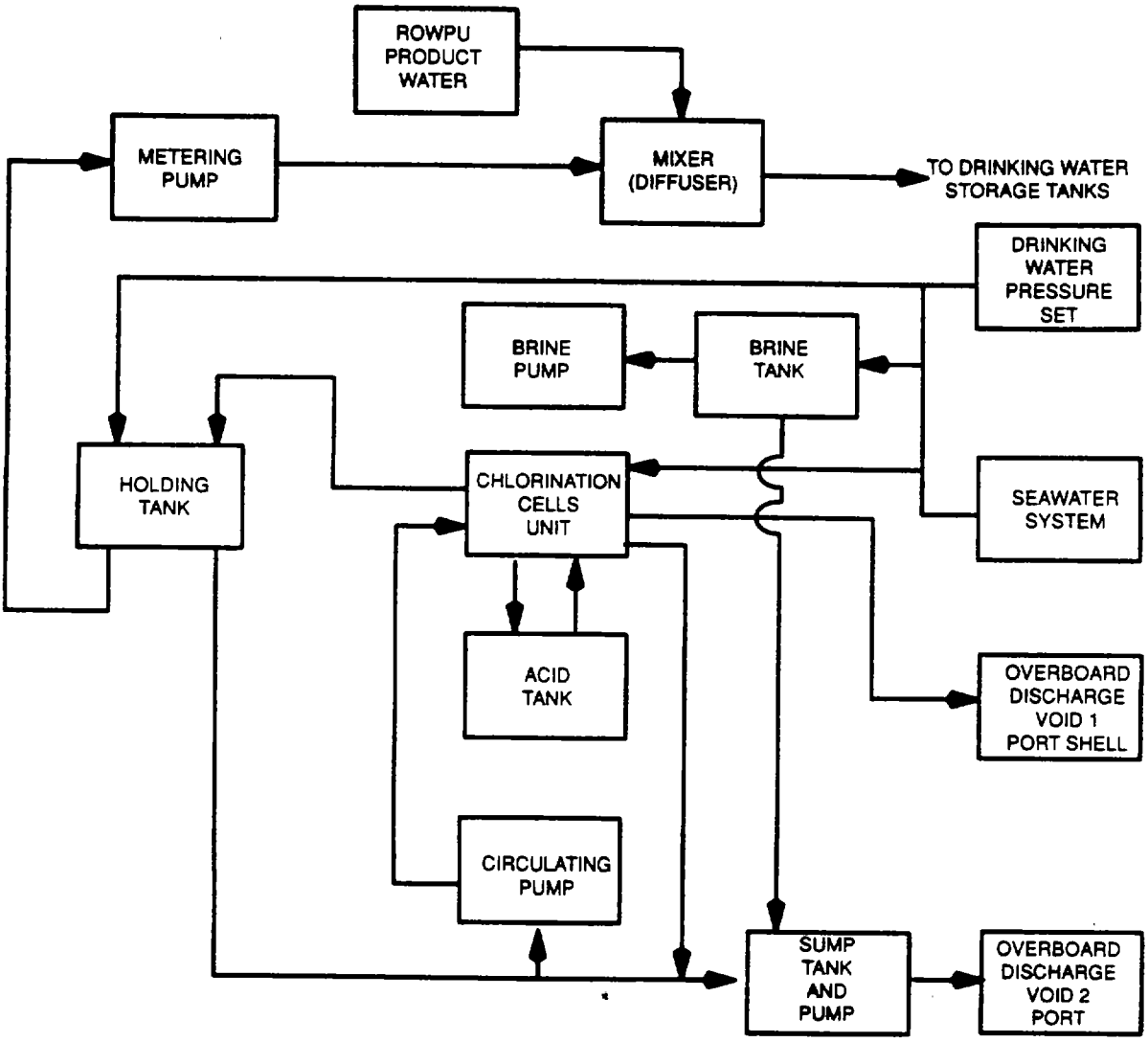


Figure 1-4. Chlorination System General Working (Block) Diagram

1-8 Capabilities. The system generates and maintains a 5000 to 6000 parts per million (ppm) solution of chlorine and then meters this solution into product water from the ROWPU system to obtain a chlorine concentration of 5 to 7 ppm in the drinking water.

1-9 Special limitations. For normal operation, the chlorination system requires seawater with a 3 to 4 percent salt concentration. If the available seawater has a salt concentration less than this, refer to paragraph 3-5j to increase concentration.

1-10 Performance characteristics

Production rate	40.5 gallons per hour (gph)
Holding tank capacity	310 gallons
Approximate time to reach concentration	4 hours

1-11 Equipment specifications

a. Chlorination unit

Manufacturer	Scienco, Inc.
CAGEC	8W173
Part no. 49R/A	
Type	Biocidal hypochlorite
Power	440 Vac, 3ph, 60 Hz
Quantity	1

b. Metering pump

Manufacturer	M. Roy Co., Flow Control Division
CAGEC	52147
Part no. R162-96	
Supplier	Scienco, Inc.
CAGEC	8W173
Capacity	57 gph w/electric actuator @100 psi

c. Drive motor

Manufacturer	Reliance Electric Co.
CAGEC	50380
Horsepower	1/2
Speed	1725 rpm
Power	1/2 HP, 208 Vac, 3 ph, 60 Hz
Quantity	1

d. Chlorination control unit (part of electrical package)

Manufacturer	Scienco, Inc.
CAGEC	8W1 73
Part no. 924	
Measuring range	0-10 ppm
Accuracy	+1% full scale
Quantity	1

e. Chlorine sensor

Manufacturer	Scienco, Inc.
CAGEC	8W173
Part no. 931-XXX series	
Type	Amperometric (insertion w/switch)
Range	0-20 ppm
Minimum sample flow	1 foot per sec
Electrolyte	
Type	R-448
Capacity	60 ml
Life expectancy	Approximately 6-9 months
Quantity	1

f. Flow switch

Manufacturer	Transamerica DeLaval Gems Sensors Division
CAGEC	04034
Series no. FS-550	
Material	Stainless steel
Part no. 29609	
Type	Paddle
Quantity	1

g. Sump pump

Manufacturer	Scienco, Inc.
CAGEC	8W173
Type	Magnetically driven w control switch and sump tank
Power	120 Vac, 3 ph, 60 Hz
Quantity	1

h. Chlorination unit recirculating (circulating) pump

Manufacturer	March Manufacturing, Inc.
CAGEC	21198
Part no. TE-7R-MD	
Assembly no. 155-011-02	
Supplier	Scienco, Inc.
Motor	
Manufacturer	Marathon Electric
CAGEC	38151
Model no. RVB56T34F423EW	
Horsepower	0.75/0.6
Speed	3450/2850
Power	440 Vac, 3 ph, 60 Hz
Type	TS
Code	H
Duty	Continuous at 40°C
Quantity	1

i. Air escape valve

Manufacturer	Robert H. Wager Co., Inc.
CAGEC	79128
Part no. Type 1600W	
Size	3-in. nominal
Connection	Welded
Material	Steel
Quantity	1

j. Globe valve

Supplier	McMaster-Carr Supply Co.
CAGEC	39428
Part no. 4889K13	
Size	1/2-in. nominal
Rating	150 lb
Connection	Silver braze
Material	Bronze
Quantity	2

k. Gate valve

Supplier	McMaster-Carr Supply Co.
CAGEC	39428
Part no.	9762K41
Size	1/2-in. nominal
Connection	Cement joint
Material	PVC
Quantity	1

l. Check valve

Manufacturer	R & Sloan Manufacturing Co., Inc.
CAGEC	14889
Part no.	1101-005-PVC1
Size	112-in. nominal
Connection	Cement joint
Material	PVC
Quantity	2

m. Globe valve

Manufacturer	William Powell Co.
CAGEC	48422
Part no.	Figure 150
Size	1-in. nominal
Rating	150 lb
Connection	Silver braze
Material	Bronze
Quantity	1

n. Chlorination unit brine pump

Manufacturer	M. Roy Co., Flow Control Division
CAGEC	52147
Supplier	Scienco, Inc.
CAGEC	8W1 73
Model no.	5R132-73
Capacity	12.3 gph at 100 psi; 12.2 gph at 150 psi
Motor	
Manufacturer	Leeson Electric Corporation
CAGEC	56065
Model no.	100516-00
Horsepower	1/4
Speed	1725/1425
Power	440 Vac, 3 ph, 60 Hz
Frame	J48Y
Type	IN
Code	L
Design	B
Duty	Continuous at 40°C
Quantity	1

o. Metering pump control unit

Manufacturer	Xertex Corp. Delta Analytical
CAGEC	29924
Supplier	Scienco, Inc.
CAGEC	8W173
Part no.	924
Type	Chlorine FAC/TFC Analyzer/Transmitter
Quantity	1

p. Swing check valve

Military specification	MIL-V-18436
CAGEC	81349
Type	Grade A, Type 1
Size	1 in. nominal
Rating	125 lb
Connection	Silver braze
Material	Bronze
Quantity	1

q. Drain cock

Supplier	McMaster-Carr Supply Co.
CAGEC	39428
Type	Boiler
Size	1/2 in. nominal
Rating	100 psi maximum
Material	Brass
Quantity	1

r. Metering pump motor controller

Manufacturer	Square D Co., Bell Electric Products Division
CAGEC	81487
Part no. 8558 SBA-21 AFT-440/110 V, 3 ph, 60 Hz	
Type	Non-reversing w/non-fusible disconnect switch
Rating	5 Hp, 440 Vac, 3 ph, 60 Hz
Quantity	1
Thermal unit	
Part no. B1.45	
Quantity	3

1-12 Items furnished

1-12.1 Components installed as part of the chlorination system are listed on the parts lists of drawings referenced in Appendix A and in the Components of End Item List in Appendix F of TM 55-1930-209-14 & P-18.

1-12.2 Common and bulk items are listed in the Expendable Supplies and Materials List in Appendix E of TM 55-1930-209-14&P-18.

1-12.3 Repair parts and special tools are listed in the Repair Parts and Special Tools List in Appendix G of TM 55-1930-209-14&P-18.

1-13 Items required but not furnished. All required items are furnished.

1-14 Tools and test equipment. Use existing tools and equipment. A complete list of tools and test equipment is in the Tools and Test Equipment List in Appendix D of TM 55-1930-209-14&P-18.

CHAPTER 2 DESCRIPTION OF OPERATION

2-1 General. The chlorination system generates and automatically maintains chlorine in the form of a sodium hypochlorite solution with a strength of 5000 to 6000 ppm expressed as total available chlorine equivalent. This strength is maintained by constantly recirculating the solution from the holding tank through a series of nine electrolytic cells and back to the holding tank for a predetermined period of time. A metering pump draws chlorine from the holding tank and injects it into product water flowing from the ROWPU's. This combination of product and chlorine flows through a mixer just before the water enters the drinking water storage tanks. The mixer evenly distributes the chlorine throughout the product water. A sensor measures the amount of chlorine in the treated water downstream of the mixer and causes the metering pump to inject either more or less chlorine to maintain the amount of chlorine in the drinking water at 5 to 7 ppm. As chlorine is withdrawn from the holding tank and the chlorine solution level drops, a float switch activates the brine pump, which pumps brine solution from the brine tank to the holding tank. In the holding tank, the brine solution is mixed and circulated with the chlorine solution from the electrolytic cells. When the level of chlorine solution in the holding tanks reaches the proper level, the float switch turns the brine pump and circulating pump off. This process of recirculating and replenishing continues as long as the chlorination unit and brine pump are activated and the metering pump withdraws chlorine solution from the holding tank. On/Off operation of the metering pump is controlled by a flow switch located in the ROWPU product water line. When the metering pump motor controller is in the AUTO mode, this flow switch automatically starts the pump when ROWPU product water is flowing and stops the pump when product water stops flowing.

2-2 Preparation for operation. Both the holding tank and the brine tank have to be primed before the system can prepare the chlorine solution. Either seawater or fresh water may be used to prime both tanks. If seawater is used, it may be supplied from either the seawater pumps in void 2 starboard or from the cooling pump in void 2 port. Fresh water, if available, is obtained from the drinking water pressure set. Paragraph 3-5 gives details on priming the system. After priming, this system takes about 4 hours to produce a chlorine solution of the proper strength in the holding tank. The system can be placed in operation before this 4-hour period, but the metering pump will inject a larger amount of solution into the product water to raise the chlorine level to the proper concentration. If the system must start injecting chlorine into the product water as soon as the seawater and ROWPU systems are placed in operation, a commercial hypochlorite solution (household bleach) can be added to the holding tank to create a usable solution.

2-3 Non-operating chlorination system. ROWPU barges have only one chlorination system. If this system cannot be operated, arrangements must be made for an onshore water processing facility to add chlorine to the ROWPU barge product water when the water comes ashore. To provide safe onboard drinking water during such a situation, water in the reserve tank must be manually treated with chlorine according to instructions in TM 55-1930209-14&P-5 Drinking Water System.

CHAPTER 3 OPERATING INSTRUCTIONS

Section I. Operating controls and Indicators

3**-1 Operating controls and Indicators**. Information about the chlorination system operating controls and indicators is in Table 3-1. Information about chlorination system valves indicated in Figure 1-2 and 1-3 is in Table 3-2.

Section II. Prestart procedures

3-2 Prestart procedures

a. Before operating the chlorination system, be sure to check system for damage and perform before operation preventive maintenance (paragraph 4-3).

NOTE

Equipment Monitoring System (EMS) Indicates amount of chlorine in drinking water and percentage of metering pump capacity being used.

b. Make sure EMS is operating. If not operating, start up according to instructions in TM 55-1930-20914&P-**1**.

NOTE

Chlorination unit will operate unless void blower fan 8 is operating. Fan 8 circuit breaker 8P8 is on power panel 2 (amidships in ROWPU space starboard side).

c. Make sure that chlorine gas detector is operational. Detector is located in void 2 port, centerline bulkhead. Alarm is located on ROWPU space bulkhead, forward.

d. Make sure switchboard circuit breakers P5 and P8 are closed to provide power to panels 1 and 2. Provide power to chlorination unit control cabinet by closing power panel 1 circuit breaker 9P5. Provide power to metering pump motor controller by closing power panel 1 circuit breaker 1 0P5. Provide power to vent fan 8 motor controller by closing power panel 2 circuit breaker 8P8. Start vent fan 8 by pressing START button on motor controller.

NOTE

Seawater can be provided by seawater pumps or cooling water pump.

e. Make sure seawater system is ready for operation. If not operating, start by following procedures in TM 55-1930-209-14 & P-2. Seawater, can be provided by either seawater pumps or cooling water pump.

f. Make sure seawater filter in line to chlorination system is clear and seawater pressure regulator is set to 10 pounds per square inch (psi).

g. When using drinking water, connect drinking water line to chlorination unit by connecting hose between valves CU12 and CU12A. Make sure drinking water system holding tanks contain water and pressure set is ready for operation. If not operating, start drinking water system by following procedures in TM 55-1930-209-14 & P-5.

h. Make sure ROWPU system is operational and can be started when chlorine solution is strong enough to provide necessary chlorine to the product water. If not operational, follow maintenance procedures in TM 55-1930-209-14 & P-3.

i. Check oil level on chlorination unit circulating pump (void port 2) to make sure oil is up to the mark. Add oil if necessary.

Table 3-1. Operating Controls and Indicators

Control/Indicator	Figure	Location
Makeup water flowmeter with valve	3-1	Void 2 port on chlorination unit panel
Cooling water flowmeter with valve	3-1	Void 2 port on chlorination unit panel
Heat exchanger pressure gauge	3-1	Void 2 port on chlorination unit panel
Cooling water pressure regulator	3-1	Void 2 port on chlorination unit panel
Cooling water pressure gauge	3-1	Void 2 port on chlorination unit panel
Chlorine metering pump motor controller	3-2 3-4	Void 2 port - center bulkhead
Metering pump function selector	3-3	Void 2 port - center bulkhead aft on metering pump control unit
Metering pump display selector	3-3	Void 2 port - center bulkhead aft on metering pump control unit
Metering pump chlorine range selector	3-3	Void 2 port - center bulkhead aft on metering pump control unit
Metering pump light-emitting diode (LED) display	3-3	Void 2 port - center bulkhead aft on metering pump control unit
Metering pump control	3-3	Void 2 port - center bulkhead aft on metering pump control unit
Metering pump chlorine content (manual)	3-3	Void 2 port - center bulkhead aft on metering pump control unit
Alarm switch	3-5	Void 2 port on chlorination unit control cabinet
Function switch	3-5	Void 2 port on chlorination unit control cabinet
Ammeter	3-5	Void 2 port on chlorination unit control cabinet
Voltmeter	3-5	Void 2 port on chlorination unit control cabinet
Power supply failure light	3-5	Void 2 port on chlorination unit control cabinet
Circulating (recirculating) pump failure light	3-5	Void 2 port on chlorination unit control cabinet
Low salinity light	3-5	Void 2 port on chlorination unit control cabinet
Brine pump switch	3-	Void 2 port on chlorination unit control cabinet
EMS keyboard	3-7	ROWPU space - forward bulkhead outboard of workshop door
EMS CHLORINE STATUS display page	3-8	ROWPU space - forward bulkhead outboard of workshop door
EMS SYSTEM STATUS display page	3-9	ROWPU space - forward bulkhead outboard of workshop door

Table 3-2. System Valves

Type	Figures 1-2 & 1-3 Callout	Location	Label Identification and Valve Function
2-way	CU1*	In chlorination unit manifold drain line	CHLORINATION PRESSURE RELIEF (PRESET): Allows relief drainage from manifold to sump in case of pressure build-up in chlorination unit cells
2-way	CU2*	In recirculating (circulating) pump suction line from holding tank (recycle tank)	CHLORINATION SYSTEM HOLDING TANK OUTPUT TO RECIRCULATING PUMP: Allows flow from holding tank to recirculating pump during normal operation
3-way	CU3*	In acid tank outlet line	CHLORINATION DESCALING OPERATION FLOW CONTROL: In WATER position, allows flush water to flow to recirculating pump to flush out both residual hypochlorite (before flushing with acid), and acid (during scale flushing operation). In ACID position, allows acid to flow from acid tank to recirculating pump during scale flushing operation. Closed (OFF) during normal operation
3-way	CU4*	In recirculating pump discharge line	CHLORINATION RECIRCULATING PUMP OUTPUT CONTROL: Allows recirculating pump discharge to flow to heat exchangers and cells during normal operation and, when 50% open, during scale flushing operation
3-way	CU5*	In acid tank inlet line	CHLORINATION DESCALING OPERATION FLOW CONTROL: In ACID position, allows acid to flow back to acid tank during scale removal operation. In DRAIN position, allows flush water to drain overboard during scale flushing operation. Closed (OFF) during normal operation
2-way	CU6*	In holding tank cell input line	CHLORINATION SYSTEM HOLDING TANK CELL OUTPUT: Allows cell output to flow to holding tank during normal operation
2-way	CU6A	In holding tank cell output line	CHLORINATION HOLDING TANK INPUT: Allows cell output to flow from valve CU6 to holding tank
3-way	CU*	In brine tank outlet line	CHLORINATION BRINE FLOW CONTROL: Allows brine to flow from brine tank to brine pump and allows draining in brine tank

Table 3-2. Chlorination System Valves (Continued)

Type	Figures 1-2 & 1-3 Callout	Location	Label Identification and Valve Function
2-way	CU8*	In chlorination unit manifold vent line	CHLORINATION AIR VENT: Allows venting of chlorination unit during normal operation and descaling and flushing
2-way	CU9*	In chlorination unit drain line to sump	CHLORINATION DRAIN: Allows draining to sump from chlorination unit, circulating pump, acid tank, and holding tank
2-way	CU10*	In chlorination unit holding tank supply line to metering pump	CHLORINATION HOLDING TANK CHLORINE FLOW: Allows chlorinated water to flow to metering pump from holding tank and isolates tank
3-way	CU11*	In makeup water line on discharge side of pressure set	CHLORINATION INPUT WATER CONTROL: Allows either sea water from cooling pump or drinking water from pressure set to flow to holding tank
2-way	CU12	In drinking water line from pressure set in void 2 port near valve CU11	CHLORINATION DRINKING WATER INPUT: Isolates drinking water supply from chlorination system until hose is connected between valves CU12 and CU12A
2-way	CU12A	In drinking water line from pressure set in void 2 port above valve CU12	CHLORINATION DRINKING WATER INPUT: Allows valve drinking water to flow pressure set to chlorination unit when hose is connected between valves CU12 and CU12A
2-way	CU13	In chlorination unit holding tank supply line to metering pump flow to metering pump from holding tank and isolates metering pump	CHLORINATION SYSTEM METERING PUMP INPUT: Allows chlorinated water to
2-way ball	CU14 (There are two valves CU14 on Barge 1)	In metering pump discharge line between pump and mixer of chlorinated water to flow into ROWPU product waterstream	CHLORINATION SYSTEM METERING PUMP OUTPUT: Allows measured amounts
2-way	CU15* (Barge 1)	In metering pump discharge line between two valves labeled CU14	CHLORINATION SYSTEM CHLORINE FLOW TO DRINKING WATER: Allows chlorinated water to flow from metering pump to mixer
2-way	CU15* (Barges 2 and 3)	In line connected to valve CU1 to cell drain line and circulating pump drain line	CHLORINATION DRAIN CONTROL: Allows drain of chlorine from valve CU1 to sump tank
2-way globe	CU16	Void 2 port overboard discharge	CHLORINATION SUMP TO OVERBOARD: Allows sump tank to discharge overboard
2-way ball	CU17	In the discharge line from acid tank	CHLORINATION ACID TANK DRAIN: Allows drain of acid tank to sump

*Indicates valve is part of chlorination unit

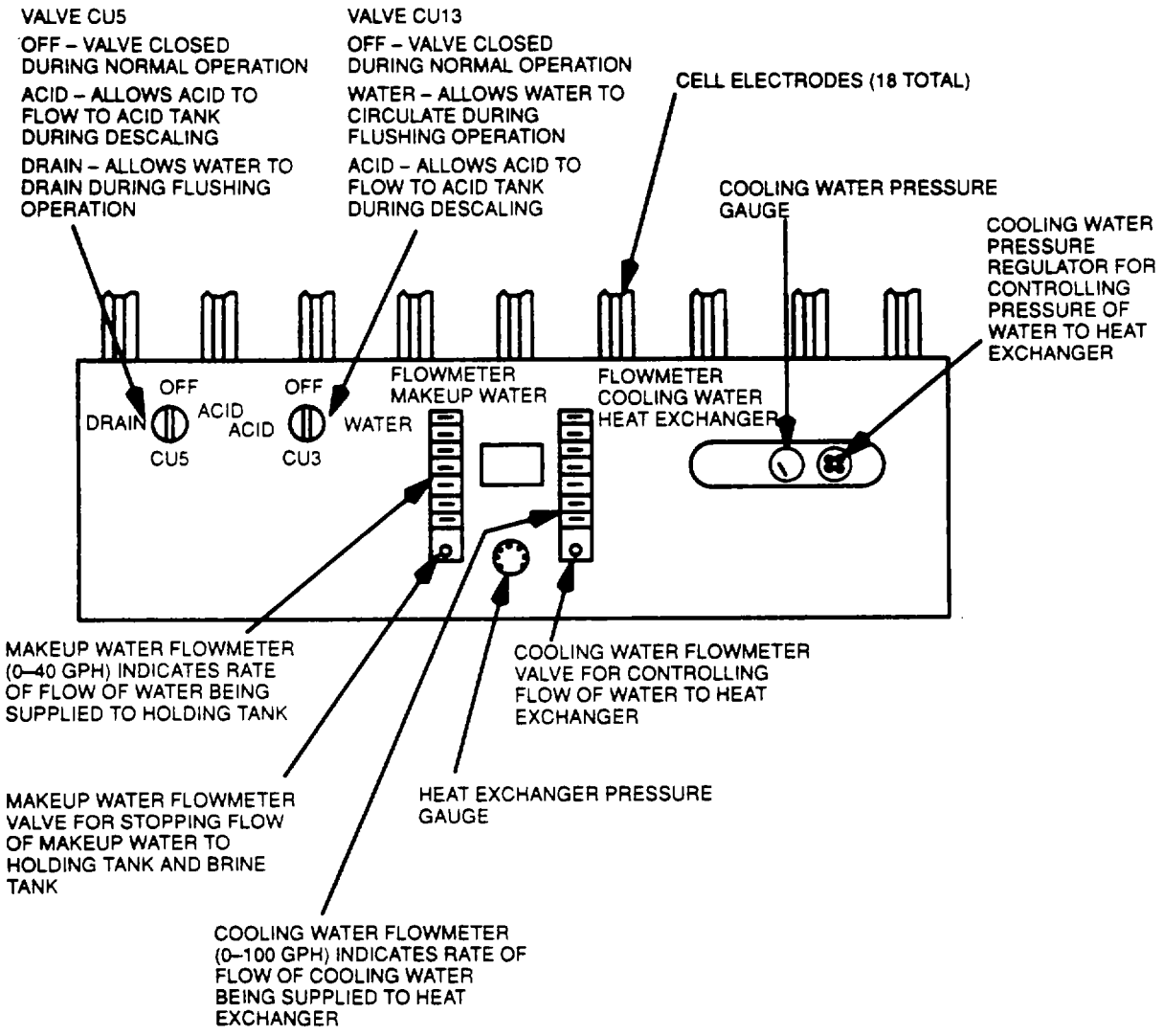


Figure 3-1. Chlorination Unit Controls and Indicators

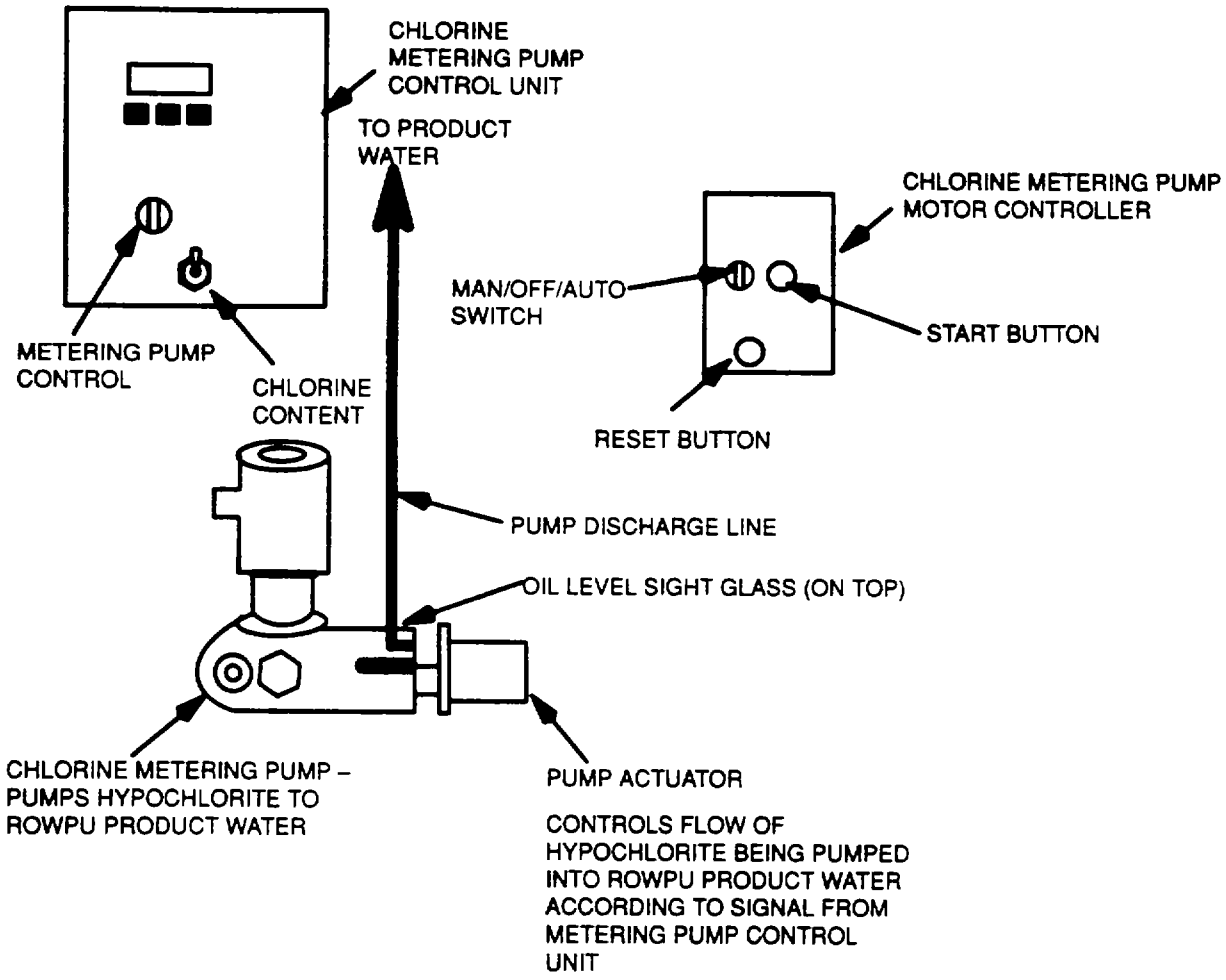


Figure 3-2. Chlorine Metering Pump Controls

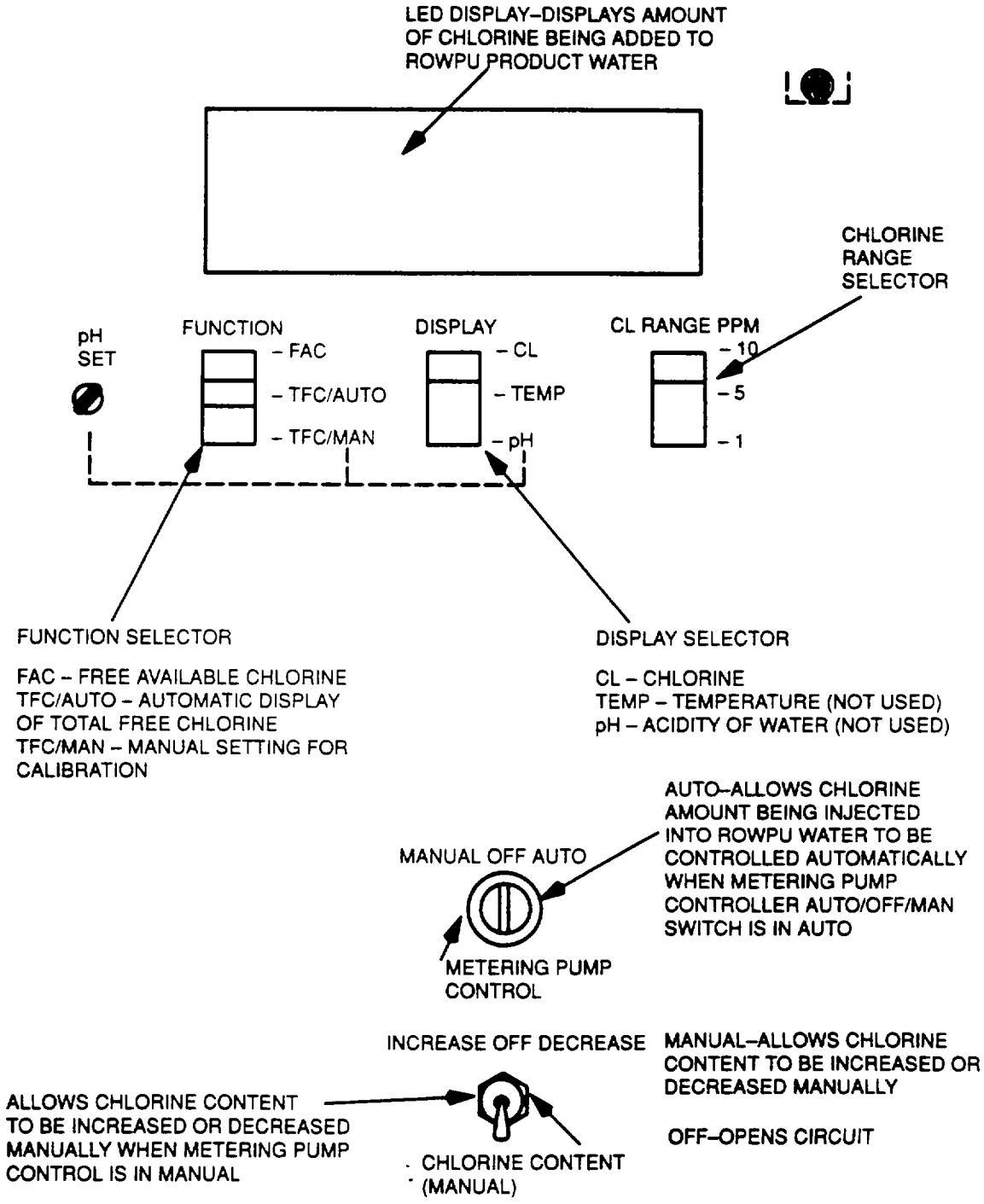
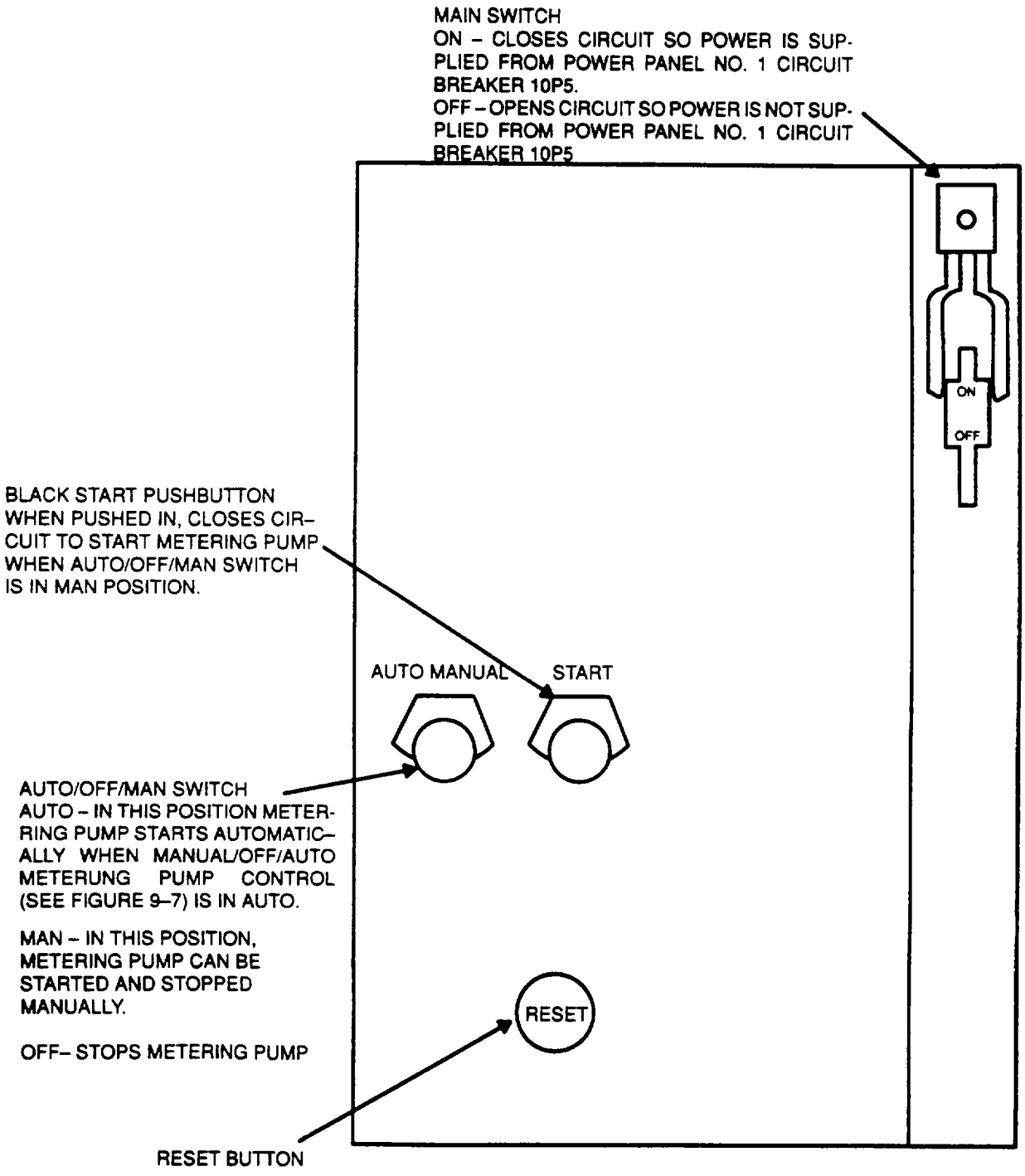


Figure 3-3. Chlorine Metering Pump Control Unit Controls and Indicators



LOCATED IN VOID 2 PORT ON INBOARD BUKHEAD FORWARD

Figure 3-4. Chlorine Metering Pump Motor Controller

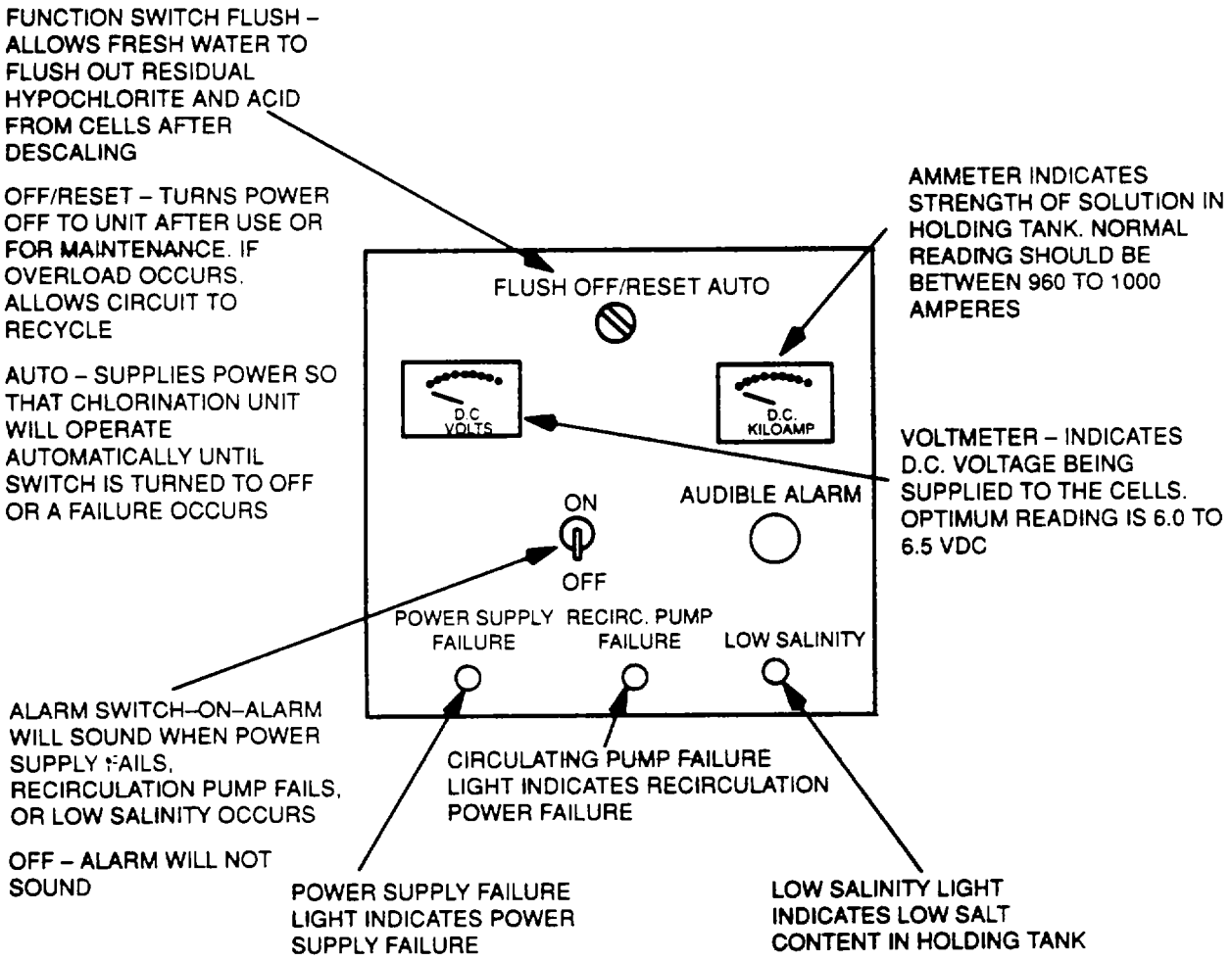


Figure 3-5. Chlorination Unit Control Cabinet Controls and Indicators

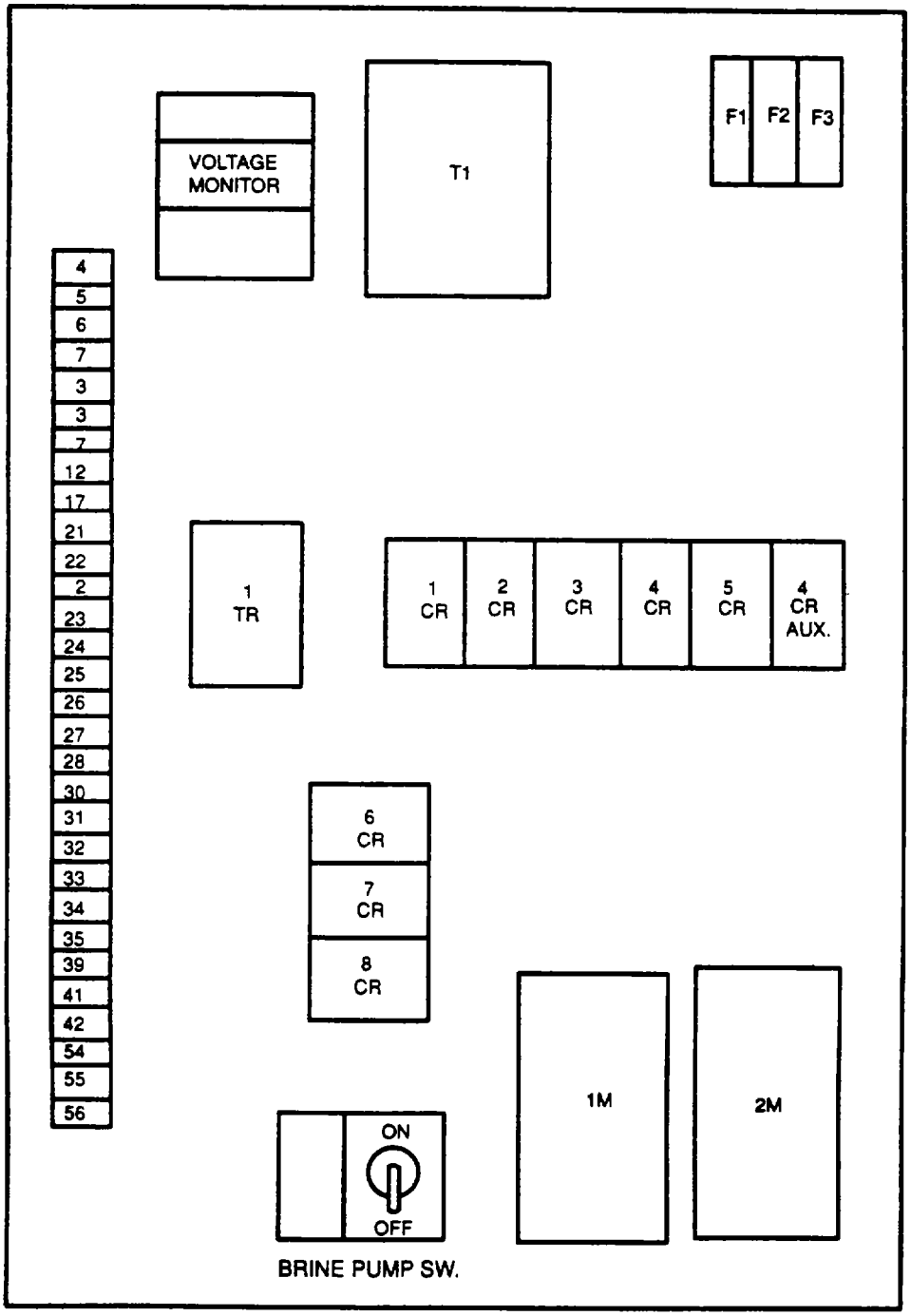


Figure 3-6. Interior of Chlorination Unit Control Cabinet

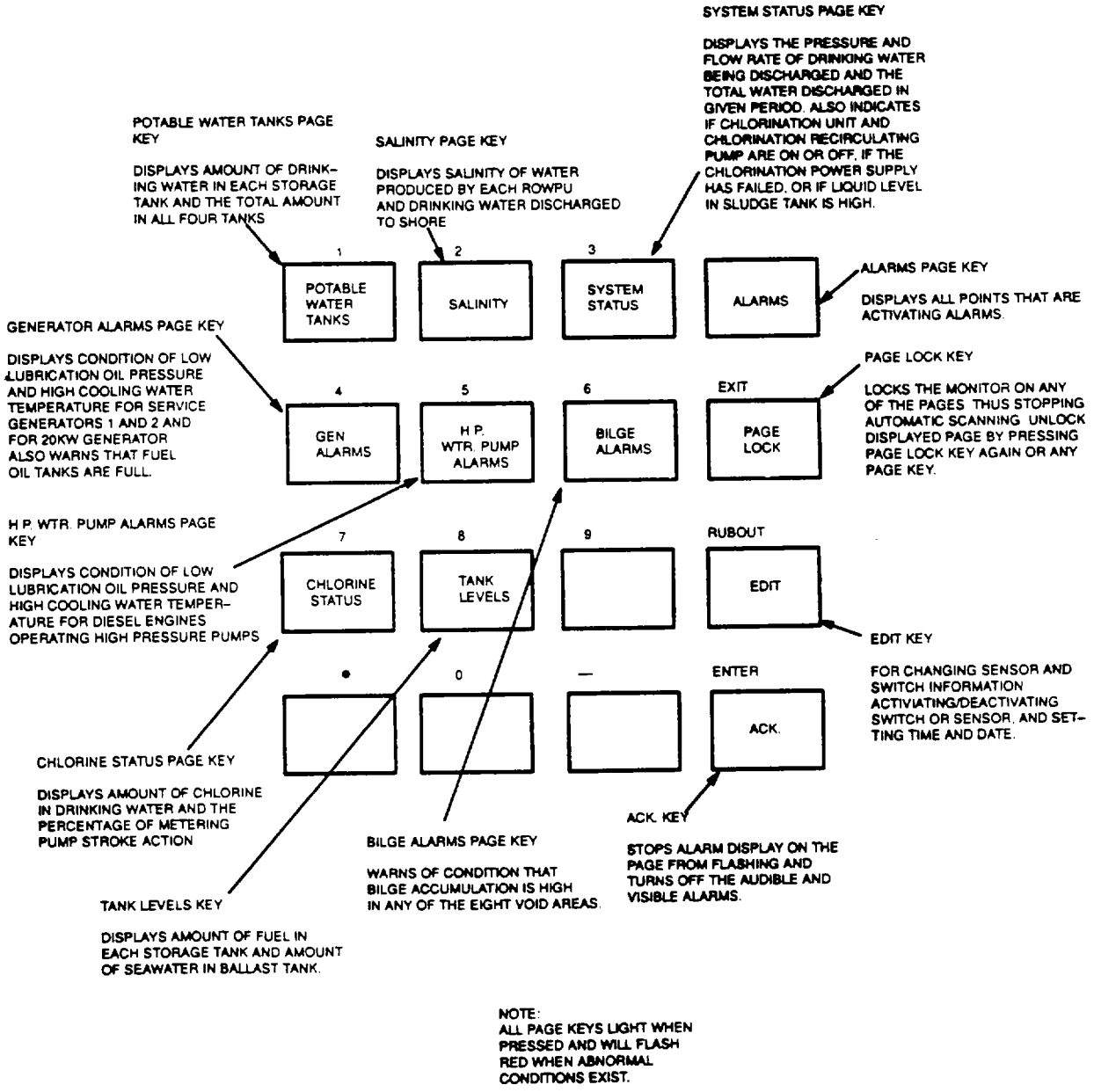


Figure 3-7. EMS Keyboard

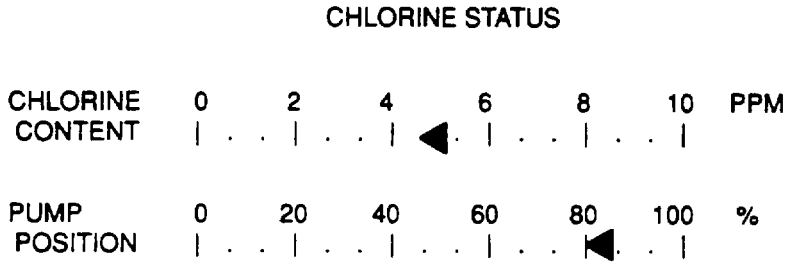


Figure 3-8. EMS Chlorine Status Display Page

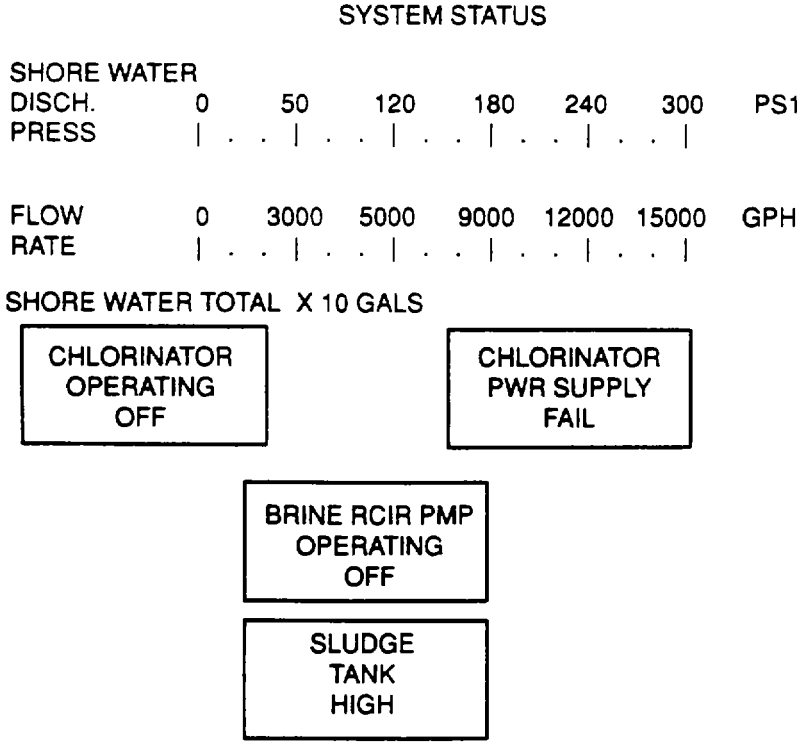


Figure 3-9. EMS Status Display Page

Section III. Operating procedures

WARNING

In an emergency, follow emergency procedures posted on bulkheads and vacate void 2 port.

3-3 Operating procedures. Chlorination system operating procedures are provided as follows:

a. Normal operations - paragraph 3-4.
b. Priming brine tank and holding tank - paragraph 3-5.
c. Chlorine generation and recirculation - paragraph 3-6.
d. Chlorination unit descaling - paragraph 3-7.
e. Initial flushing with seawater - paragraph 3-7.1.
f. Flushing with acid - paragraph 3-7.2.

3-4 Normal chlorination system operation

a. Perform prestart procedures in paragraph 3-2.
b. Make sure brine tank and holding tank are primed and holding tank is producing enough chlorine. If not, prime tanks according to paragraph 3-5 and start generating and recirculating chlorine according to paragraph 3-6.
c. Check sight on metering pump to ensure oil level is up to mark. Add oil if necessary.
d. Turn alarm ON/OFF switch on control cabinet (Figure 3-5) ON.
e. Turn brine pump ON/OFF switch inside control cabinet (Figure 3-) ON.

NOTE

There are two valves CU14 on Barge 1. Ensure that both are opened.

f. Position barge Chlorination Unit (CU) valves as indicated below:

o = open x = closed A = position A B = position B C = position C

CU VALVE NO.	2	2A	3	4	5	6	6A	7	8	9	10	13	14	15	16
POSITION	o	o	C	A	C	o	o	A	x	x	o	o	o	x	o

g. For makeup water using seawater system or drinking water system, position chlorination unit valves CU11, CU12, and CU12A as indicated below:

o = open x = closed A = position A B = position B

MAKEUP WATER USED: CU Valves:	11	12*	12A*
SEAWATER	A	x	x
DRINKING WATER	B	o	o

*Connect hose between valves CU12 and CU12A before opening valves.

h. Adjust chlorination unit cooling water flowmeter and pressure regulator (Figure 3–1) to 80 gallons per hour (gph) at 10 psi.

NOTE

A semiannual adjustment should be made using higher flow rate In summer and lower flow rate in winter. Local climatic conditions should determine final flow rate.

i. Set Chlorination unit makeup water flowmeter (Figure 3-1) to 36 gph.
j. Turn function switch on control cabinet (Figure 3-5) to AUTO.

NOTE

When metering pump motor control MANUAL/OFF/AUTO witch Is In AUTO, paddle flow switch In ROWPU product water line automatically starts and stops metering pump. This action controls amount of chlorine the pump Injects into the product water. When product water starts flowing, pump starts and when product water stops flowing, metering pump stops.

k. Turn chlorine metering pump motor controller AUTO/OFF/MAN switch (Figure 3-2) to AUTO.

NOTE

chlorination unit operates best when temperature of solution In holding tank Is between 75 and 95 °F. Increasing cooling water flow decreases temperature; decreasing flow increases temperature.

l. Turn metering pump control MANUAL/OFF/AUTO switch (Figure 3-3) to AUTO.

m. Chlorination system is now operating in conjunction with the seawater system, ROWPU system, and drinking water system to provide correct amount of chlorine solution to ROWPU product water.

n. While chlorination system is operating, monitor the following for normal indications:

(1) Chlorination unit panel (Figure 3-1)
- (a) Makeup water flowmeter - 36 gph
- (b) Cooling water flowmeter - 80 gph
- (c) Cooling water pressure gauge - 20-40 psi
- (d) Heat exchanger pressure gauge - 30-60 psi
- (e) When reading not normal, troubleshoot as necessary.

(2) Metering pump control unit (Figure 3-3)
- (a) Chlorine status on LED display.

(3) Chlorination unit control cabinet (Figure 3-5)
- (a) Ammeter - reading is between 950 to 1000 amperes (amps) (0.95-1.0 kilo amps)
- (b) Voltmeter - reading is between 6.0 to 6.5 Vdc
- (c) Alarm - When alarm sounds, turn ON/OFF switch to OFF. Check if one of the following goes out and troubleshoot as necessary:
  - (1) Power supply failure light
  - (2) Circulation (recirculation) pump failure light
  - (3) Low salinity light

(4) EMS
- (a) CHLORINE STATUS display page (Figure 3-8)
  - (1) Chlorine content
  - (2) Pump position
- (b) SYSTEM STATUS display page (Figure 3-9) - check the following:
  - (1) CHLORINATOR OPERATING OFF is normal
  - (2) CHLORINATOR PWR SUPPLY FAIL is normal
  - (3) BRINE RCIR PMP OPERATING OFF is normal

o. If these indicators are not as listed in step n, take corrective action.

p. If EMS alarms indicate abnormal conditions, acknowledge alarms according to instructions below and take corrective action.

NOTE

if abnormal condition occurs, EMS activates horn and strobe light In ROWPU space and buzzer in dayroom. In addition, EMS keyboard alarm sounds and EMS video monitor automatically switches to ALARM page which shows abnormal condition In flashing double intensity. The affected keyboard key, CHLORINE STATUS or SYSTEM STATUS, flashes red.

(1) Press red flashing key on keyboard to change ALARMS display page back to CHLORINE STATUS or SYSTEMS STATUS display pages.

(2) Press ACK key on keyboard to stop alarms, to automatically change red flashing key to white, and to change flashing display on video monitor screen display page to double intensity.

NOTE

Display stays double Intensity until abnormal condition causing ala rm is corrected.

3-5 Brine tank and holding tank priming

NOTE

If brine tank and/or holding tank are empty, tanks must be primed according to these instructions. Valves are located In void 2 port unless otherwise Indicated.

a. Perform prestart procedure in paragraph 3-2.

b. Turn function switch on control cabinet (Figure 3-5) to OFF/RESET. This opens level sensors in holding tank and solenoid valves which stops flow of water to brine tank.

c. Turn alarm ON/OFF switch on control cabinet (Figure 3-5) to OFF.

d. Turn brine pump ON/OFF switch inside control cabinet (Figure 3-6) to OFF.

e. Close chlorination valves CU2 and CU10 to isolate holding tank.

f. When priming tanks with water from seawater system cooling pump:

(1) Make sure cooling pump is operating. If not operating, open valves SW3, SW27, SW35, and SW36 to provide seawater from seawater strainer 3 to strainer pressure gauges and cooling pump. Start pump by pressing START button on pump motor controller.

(2) Open seawater valve SW47 to allow seawater flow to chlorination unit.

(3) Close seawater valve SW48 to stop seawater flow from seawater pump.

(4) Attach hose to hose bib on seawater to chlorination system line in void 2 port.

(5) Go to step i to prime brine tank or to step j to prime holding tank.

g. When priming tanks with water from seawater system pump(s) 1 and/or 2:

(1) Open seawater valve(s) SW24 and/or SW25 in void 2 starboard to provide seawater from seawater pump(s).
(2) Open seawater valve SW48 to allow seawater flow to chlorination unit.
(3) Close seawater valve SW47 to prevent seawater flow from cooling pump.
(4) Attach hose to hose bib on seawater to chlorination system line in void 2 port.
(5) Go to step i to prime brine tank or to step j to prime holding tank.

h. When priming tanks with water from drinking water system pressure set:
   (1) Open drinking water system valve DW17 in void 3 port to allow drinking water to flow to hose bib in void 2 port.
   (2) Attach hose to hose bib on drinking water to chlorination system line in void 2 port.
   (3) Proceed to step i to prime brine tank or to step j to prime holding tank.

i. Prime brine tank as follows:
   (1) Remove lid from brine tank and turn chlorination valve CU7 to position C (close) to isolate brine tank.
   (2) Using hose previously attached to bib, fill brine tank half full of water.
   (3) Add salt to brine tank and stir manually until no more salt will dissolve in water (about 500pounds).
   (4) Replace lid on brine tank.

j. Prime holding tank as follows:
   (1) Open cap on Y-connection on top of holding tank and using hose previously attached to bib, fill to low level mark (90 gallons).
   (2) Use manual salinity tester (Total Dissolved Solids Tester) according to TM 5-6630215-12 to test seawater salt concentration. If test indicates seawater is about a 4% brine solution (40 per 1000 ppm), no additional salt is needed in the holding tank. However, if tests indicate additional salt is necessary, refer to chart below for amount of salt to add to holding tank.

Salt concentration of seawater per 1000 ppm:	1	10	20	30	40
Salt required in lb:	28	20	15	7	0

   (3) If necessary, add proper amount of salt to agree with salt concentration as determined by salinity tester.
   Then replace cap on connection of holding tank.
   (4) Generate and circulate chlorine according to paragraph 3-6.

3-6 Chlorine generation and recirculation

a. Make sure holding tank has beenprimed according to paragraph 3-5,

b. Position CU valves as indicated below.

o = open x = closed A = position A B = position B C = position C

CU VALVE NO.	2	2A	3	4	5	6	6A	7	8	9	10
POSITION	o	o	C	A	C	o	o	C	x	x	x

c. Close chlorination unit makeup water and cooling water flowmeter valves (Figure 3-1). Make sure brine pump switch inside control cabinet (Figure 3-) is OFF.

d. Turn alarm switch on control cabinet (Figure 3-5) to OFF.

e. Turn function switch on control cabinet (Figure 3-5) to AUTO.

NOTE

Chlorination system now makes chlorine sol ution of a proper concentration In approximately 4 hours. When DC ammeter (Figure 3-5) Is reading 950 to 1000 amps (0.95 to 1.0 kilo amps), holding tank solution Is at proper level of concentration. Add salt or water to holding tank as necessary.

f. For an alternate method of producing chlorine solution to eliminate initial buildup time, add 10 gallons of commercial hypochlorite solution (Clorox or other liquid chlorine bleach) to holding tank as follows:
   (1) Open cap on Y-connection on top of holding tank.
   (2) Add 1 gallon of commercial hypochlorite solution (bleach) for every 9 gallons of water in holding tank.
   (3) Close cap on Y-connection of holding tank.
   (4) Turn function switch on control cabinet (Figure 3-5) to OFF/RESET to stop recirculation of holding tank solution.

3-7 Chlorination unit descaling. Perform this procedure when an excess of white mineral scale shows on the chlorination unit cells (anodes), when there is a decrease in flow rate to holding tank as shown on makeup flowmeter (Figure 3-1), or when there is an absence of solution at top of the cells. When any of these conditions are observed, excessive scale build-up or low flow is occurring. Flush and descale unit. Flushing procedure uses water from seawater system to flush chlorination unit. Holding tank continues to supply chlorine to product water during descaling and flushing operations.

NOTE

If EMS alarms are activated during descaling procedure, acknowledge alarms according to paragraph 3-4, step p.

3-7.1 Initial flushing with seawater

a. Make sure seawater system is operating and providing seawater to chlorination system through seawater valve SW47 or SW48.
b. Turn alarm ON/OFF switch on control cabinet (Figure 3-5) to OFF.
c. Turn function switch on control cabinet (Figure 3-5) to OFF/RESET.
d. Position chlorination unit valves as indicated below:

o = open x = closed A = position A B = position B C = position C

CU VALVE NO.	2	2A	3	5	6	6A	8	9	12	16
POSITION	x	x	B	A	x	x	x	x	x	o

e. Position valve CU4 halfway between positions A and C to reduce flow through system.
f. Turn brine pump ON/OFF switch inside control cabinet (Figure 3-5) to OFF.
g. Turn cooling water flowmeter, OFF by closing valve at bottom of flowmeter (Figure 3-1).
h. Turn makeup water flowmeter OFF by closing valve at bottom of flowmeter (Figure 3-1).
i. Turn function switch on control cabinet (Figure 3-5) to FLUSH.
j. Allow seawater to flow through chlorination unit for 5 minutes, then turn function switch on control cabineto OFF/RESET.
k. Open chlorination valve CU9 to allow chlorination unit to drain. If sump appears to be overfilling, partially close valve CU9 to reduce drain flow to sump.
l. After chlorination unit has drained, close valves CU8 and CU9 and turn valve CU5 to position C (OFF).
m. Flush unit with acid according to paragraph 3-7.2.

3-7.2 Flushing with acid

3-7.2.1 Acid tank preparation

WARNING

Wear rubber gloves, safety goggles or faceshield, and chemical dust mask when working with acid crystals and acid solution.

a. Remove lid to acid tank and fill with about 25 gallons of drinking water from fill hose attached to bib in void 2 port above holding tank.

WARNING

Always add acid to water. Do not add water to acid. If any acid crystals or solution splash on skin, flush skin with water Immediately. Immediately flush eyes at eyewash station if acid crystals or solution splash in eyes.

b. Add two cans (14 lbs) of sulphamic acid to water in acid tank.

3-7.2.2 Acid flush

a. Turn valve CU3 to position A, ACID.
b. Turn valve CU5 to position B, ACID.
c. Open valve CU17. Make sure valve CU16 is open.
d. Turn function switch on control cabinet (Figure 3-4) to FLUSH.
e. Descale until all visible signs of scale are gone from anodes (cells), approximately 5 minutes, then turn function switch to OFF.

NOTE

Sump tank pump automatically empties sump tank. Level switch In sump tank starts and stops sump pump.

f. Turn valve CU5 to position A, DRAIN, to allow solution to drain to sump tank.
g. Remove lid to acid tank to observe level of solution in tank.
h. Turn function switch on control cabinet (Figure 3-5) to FLUSH. Acid tank is now being emptied by circulating pump.
i. When acid tank is empty, turn function switch to OFF.
j. Close valve CU17.
k. Replace lid on acid tank.

NOTE

After descaling with acid, flush chlorination unit with seawater before returning to normal operation.

l. Turn valve CU3 to position B, WATER, to allow seawater to flush out acid.
m. Turn valve CU5 to position A, DRAIN, to allow flushing seawater to drain to sump tank.
n. Turn function switch to FLUSH.
o. After flushing to remove acid for about 5 minutes, turn function switch on control cabinet (Figure 3-5) to OFF/RESET.
p. Return chlorination system to normal operation (paragraph 3-4).

3-8 Shutdown procedure

NOTE

Shutdown procedure is for normal operation and short downtime. For extended shutdown times, see Chapter 5, Storage.

a. Turn metering pump control MANUAUOFF/AUTO switch to OFF.
b. Stop metering pump by turning MAN/OFF/AUTO switch on metering pump motor controller (Figure 3-2) to OFF.

NOTE

Chlorination unit continues to produce and store chlorine solution for later use. if chlorination unit is to be shut down completely, perform steps c and d.

c. Close valves CU2, CU6, and CU10.

d. Turn function switch on control cabinet (Figure 3-5) to OFF.

3-9 Emergency shutdown

3-9.1 General. The barge has two emergency shutdown modes. One mode shuts down individual systems such as the ventilation system or a diesel high pressure pump, and the other shuts down all barge operating systems.

Both are shut down by pushing a red button protected by a metal guard. During system shutdowns, either fuel or electrical power is shut off to that system only. On total shutdown, all fuel and electrical power is shut off to all operating systems.

Six red shutdown buttons are located on the ROWPU space starboardbulkhead just aft of the personnel door. These system shutdown buttons (Figure 3-10) control shore power, ventilation systems, ROWPU1 diesel high pressure pump, ROWPU2 diesel high pressure pump, ship auxiliary generator, ship service generator 2, and ship service generator 1.

The six red shutdown buttons are located as follows:

a. On ROWPU space starboard bulkhead aft of personnel door, above and forward of row of system shutdown buttons.
b. Outside ROWPU space starboard door on weatherdeck.
c. Outside ROWPU space port door on weatherdeck.
d. Inside ROWPU space port door to weatherdeck.
e. Outside dayroom door to weatherdeck.
f. Inside dayroom door to weatherdeck.

3-9.2 Emergency shutdown procedures

a. In an emergency, push the appropriate red button to shut down either a selected system or all operating systems.
b. When emergency situation is corrected, reset emergency button by turning collar behind button one-quarter turn clockwise. Button pops out and again is in the ready position.
c. When emergency button is reset, restart chlorination system according to Chapter 3, Section III.

Section IV. Operation under extreme conditions

3-10 Operation under extreme conditions. Operation of chlorination system in extreme cold creates a special problem with lubricants. Other problems occur during operation in extreme heat. These conditions are discussed below. Additional information can be found in manufacturers' service manuals/instructions listed in Chapter 6.

3-10.1 Operation In extreme cold. Cold weather lubricants must be used. When not operating, flush chlorination unit with clean, fresh water and drain to prevent damage due to freezing or severe abrasion to the circulating pump impeller due to salt precipitation.

3-10.2 Operation in extreme heat

3-10.2.1 Lubricants. Hot weather lubricants must be used.

3-10.2.2 Motors. Electric motors may have a tendency to run hot, causing internal protective devices to stop motors. When this happens, allow motor to cool and it will automatically restart when it reaches a safe operating temperature.

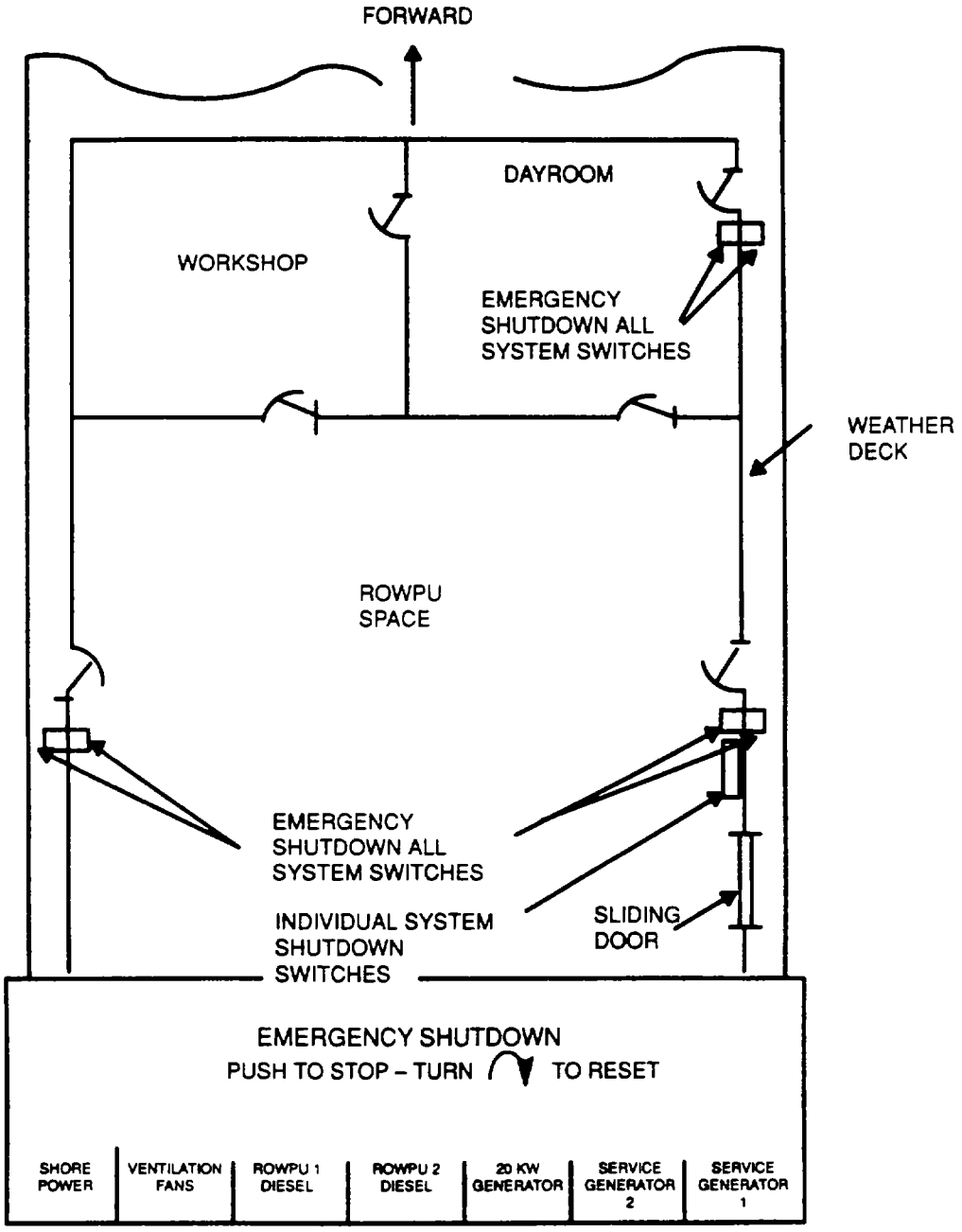


Figure 3-10. Location of Controls for Emergency Shutdown Systems

CHAPTER 4 MAINTENANCE INSTRUCTIONS

Section I. General

4-1 Maintenance concept

4-1.1 Unit level and Intermediate Direct Support and Intermediate General Support (IDS/IGS) maintenance on the chlorination system is performed onboard by barge crew members whenever possible.

4-1.2 Any IDS/IGS maintenance beyond capability of crew members is provided by a shore-based area support maintenance unit. This unit also determines if depot support maintenance is required.

4-1.3 Intermediate support maintenance is accomplished by replacement of components or major end items.

4-1.4 Unless other intermediate support procedures are directed, IDS/IGS maintenance normally is provided by an Army Transportation Corps floating craft intermediate support maintenance unit serving terminal operating area. Components to be disposed of are processed by this unit.

4-1.5 Maintenance Allocation Chart (MAC) is in TM 55-1930-209-14&P-18. For maintenance of other equipment onboard, consult appropriate manual.

4-2 Maintenance procedures. Maintenance instructions are contained in the following sections: Section II, Preventive maintenance checks and services; Section III, Troubleshooting; and Section IV, Maintenance procedures.

Section II. Preventive maintenance checks and services

4-3 See TM 55-1930-209-14&P-4, Appendix C for preventive maintenance checks and services for the chlorination system. See TM 55-1930-209-14&P-19 for complete preventive maintenance checks and services for all ROWPU Barge Systems.

Section III. Troubleshooting

4-4 Major components

4-4.1 Metering pump. Troubleshoot metering pump according to Section 6, page 29, M. Roy Controlled Volume Pump Manual, in Appendix B.

4-4.2 Chlorination unit. Troubleshoot chlorination unit according to Section B, Installation and Operation Instructions Manual, on page 22 in Appendix B.

4-4.3 Metering pump control unit. Troubleshoot control unit according to page 29, Delta Instruction Manual, In Appendix B.

4-5 Chlorination system. Troubleshoot chlorination system according to Table 4-1.

NOTE

For problems not covered In Table 4-1, consult manufacturers' manuals in Appendix B for particular component Involved.

Table 4-1. Chlorination System Troubleshooting

Problem	Probable Cause	Corrective Action
1. Chlorination unit not operating due to recirculation pump failures, power failure, or low salinity	a. Circuit breaker 9P5 on power panel 1 is open	a. Close circuit breaker
	b. Various	b. See Section VIII in Installation and Operation Manual in Appendix B. See also troubleshooting information in component service manuals. Check fuses in control cabinet
	c. Holding tank lid not closed on top of tank	c. Close holding tank lid securely
	d. Port void ventilation fan circuit breaker open	d. Close circuit breaker 8P8 on power panel 2
2. Chlorination unit overheating	a. Seawater discharge pump valve(s) SW47 and/or SW48 closed	a. Open valve(s) SW47 and/or SW48
	b. Seawater pumps not operating	b. Troubleshoot seawater system (TM 55193020914&P2)
3. Chlorine not being injected into drinking water	a. Valve(s) CU14 and/or CU15 closed	a. Open valve(s) CU14 and/or CU15 fully
	b. Valve(s) CU10 and/or CU13 closed	b. Open valve(s) CU10 and/or CU13 fully
	c. Metering pump not operating or malfunctioning	c. Verify power panel 1 circuit breaker 10P5 is closed. Start pump. If pump does not start, troubleshoot (M. Roy manual in Appendix B). Troubleshoot motor controller (paragraph 4-7.1.9). Check thermal unit and fuse
	d. Metering pump control Malfunctioning	d. Troubleshoot (Xertex Corp. Instruction Manual in Appendix B)
	e. Flow switch malfunctioning Troubleshoot flow switch	e. Check fuse in control cabinet
4. Brine pump not supplying brine to chlorination unit	a. Valve CU7 not opened fully	a. Open valve CU7
	b. Brine tank not sufficiently full	b. Add more water and salt to brine tank
	c. Brine pump switch in chlorination unit control cabinet off	c. Turn on brine pump switch
	d. Brine pump malfunctioning	d. Troubleshoot pump (M. Roy Instruction Manual in Appendix B)

Table 4-1. Chlorination System Troubleshooting (Continued)

Problem	Probable Cause	Corrective Action
5 Drinking water not being supplied to chlorination unit	a. Valve CU3 not properly positioned	a. Position valve CU3 to position B for circulating pump
	b. Circulating pump not operating	b. Close power panel 1 circuit breaker 9P5
	c. Valve CU4 closed	c. Open valve CU4 fully
6. Rapid scaling of cells	a. Incoming water too hard	a. Descale (paragraph 3-7)
7. Makeup water not being supplied to brine tank and/or holding tank	a. Stuck solenoid valve	a. Function switch to OFF/RESET, then to AUTO. Repeat if necessary. Replace solenoid if necessary.
	b. Valve CU11 closed	b. Open valve CU11 to tanks
	c. Flowmeter makeup valve not open to tanks	c. Open flowmeter makeup to brine tank
	d. Scale or dirt in flowmeter	d. Clean flowmeter
8. Flowmeter ball fluctuates erratically	a. Air in water supply lines	a. Troubleshoot seawater (TM 55-1930-209-14&P-2) and drinking water system (TM 55-1930-209-1 4&P-5)
	b. Scale or dirt in flowmeters	b. Clean flowmeters
9. Holding tank constantly low	a. Withdrawal rate too high	a. Use constant withdrawal mode instead of bulk withdrawal mode
	b. Stuck solenoid valve	b. Function switch to OFF/RESET, then to AUTO. Repeat if necessary. Replace solenoid if necessary
10. Flow restricted	a. Valves not set properly	a. Open or close valves as necessary
	b. Pipe blockage	b. Clean out piping
11. Leaks in system	a. Loose connections	a. Tighten connection
	b. Damaged seals	b. Replace seals, including valve seals
	c. Valve damaged	c. Repair or replace valve
12. Sump pump malfunctioning or not operating	a. Valve CU16 closed	a. Open valve
	b. Sump pump or sump tank revel switch malfunctioning	b. Troubleshoot pump and level switch
	c. Control cabinet fuse bad	c. Replace fuse

Section IV. Maintenance procedures

4-6 General. Maintenance for this system consists of lubricating, disassembling, and repairing or replacing components using repair parts listed in TM 55-1930-209-14 & P-18. No special tools are required. When performing maintenance, observe safety precautions in this manual, manufacturers' manuals/instructions, and these precautions:

a. Always use new seals and gaskets before reassembling components disassembled for repair. Be sure to use only new seals and gaskets identical to original. Install them carefully so as not to damage seals and gaskets during assembly.

b. When replacing O-rings, make sure all surfaces are clean and free of dirt, grit, or foreign material. Prior to installation, apply a thin coat of silicone grease to O-ring for ease of assembly. Protect rings by applying tape over threads, sharp corners, and edges.

c. When replacing gaskets, make sure mating surfaces are clean and free of old gasket material, adhesive, oil, or grease. These precautions will ensure a leakproof joint.

WARNING

Be sure electrical power is off before performing maintenance on this system. OPEN circuit breakers. Redtag circuit breakers or motor controller with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE." Observe safety precautions listed In front of this volume and those specified in manufacturers' manuals/instructions.

d. Follow these procedures when soldering and crimping connections:

(1) Strip cable insulation equal to depth of terminal well.

(2) Slide insulator, if used, over cable.

(3) Insert cable into terminal well and crimp.

(4) Slide insulator, if used, over crimped end of terminal.

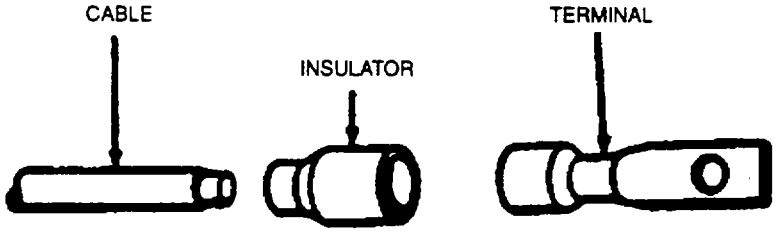


Figure 4-1. Replacement of Crimped Terminals

Check all grounding. Make sure current carrying members are properly insulated to avoid short-circuiting. Check for abrasions and chafing of insulation on wires and cables. Repair with tape or replace as necessary.

e. Replace screws and nuts if threads are damaged. If threads on fittings are only slightly damaged, chase threads with chasing tool. Replace cross-threaded fittings. Inspect tapped holes for damage. if threads are damaged, tap hole for next oversize screw or stud. If retapping weakens part, replace part.

NOTE

Due to this vessel's mission and crew capabilities, maintenance normally assigned to unit level or higher echelons of maintenance may be assigned to the crew.

4-7 Chlorination system. This paragraph describes repair of the chlorination system involving repair parts listed in TM 551930209-14&P-18.

WARNING

Shut down chlorination system before attempting any repairs. Be sure to open (OFF) circuit breakers 9PS and 10P5. Redtag circuit breakers 9P5 and 1OP5 on power panel 1 with: "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

NOTE

CU valve numbers are shown on Figures 1-2,1-3, and 1--.

4-7.1 Repair or replacement of system components

4-7.1.1 Chlorination unit

4-7.1.1.1 Cleaning and inspection

a. Clean exterior of chlorination unit with brush and hot soapy water. Dry with clean cloth.

b. Visually check for evidence of damage or corrosion. Repair damage. Remove corrosion and touch up paint in accordance with TB 43-0144. Inspect electrical cables for chafing, burned insulation, or loose connections. Replace damaged cables or tighten loose connections. Check hoses for damage. Replace damaged hoses. Check mounting hardware hangers, and clamps for tightness. Tighten as necessary.

4-7.1.1.2 Repair. Repair of individual components is given in the following paragraphs:

Component	Paragraph
Brine pump assembly	4-7.1.2
Chlorination pump assembly	4-7.1.3
Control cabinet	4-7.1.4

47.1.2 Chlorination unit brine pump assembly

4-7.1.2.1 Cleaning and Inspection

a. Pump.
   (1) Clean exterior of pump with brush and hot soapy water or with an approved solvent. Rinse and thoroughly dry with filtered compressed air.
   (2) Visually check pump for evidence of cracks, corrosion, or damage. Remove corrosion.

b. Motor.
   (1) Clean motor exterior using filtered compressed air or vacuum. Wipe off using rag moistened with an approved solvent. Clean terminals and wipe wires with lint-free cloth or electrician's brush.
   (2) Visually inspect for burned, bent, loose, corroded, or otherwise damaged terminals. Inspect wiring for breaks, loose connections, or other obvious damage. Tighten loose connections, replace damaged terminals and replace damaged wiring. Touch up paint according to TB 43-0144.

4-7.1.2.2 Repair

a. Removal. Remove brine pump assembly from mounting according to the following procedures:

WARNING

Make sure chlorination unit control cabinet Is electrically dead before starting removal.

(1) Make sure power panel 1 circuit breaker 9P5 is open (OFF). Redtag circuit breakers with: 'WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."
(2) Turn chlorination unit control cabinet function switch to OFF.
(3) Close chlorination system valve CU6, and position valves CU5 and CU7 to C (close).
(4) Tag and disconnect electrical wiring.
(5) Place container under piping and disconnect piping from pump.
(6) Remove mounting bolts and remove brine pump assembly.

b. Disassembly and repair of brine pump. Disassemble and repair brine pump according to page 21, Section 5, in M. Roy Controlled Volume Pump Instruction Manual in Appendix B. Use repair parts listed in TM 55-1930-20914&P-18. Retouch or paint in accordance with TB 43-0144.

c. Test and repair of motor. Repair motor by tightening loose connections, replacing damaged terminals, or replacing damaged wiring. Test motor continuity. Check voltage, resistance, rpm, etc., indicated on label plate.

d. Reinstallation of pump assembly.
(1) Reinstall pump assembly and tighten mounting bolts.
(2) Connect all piping to pump.
(3) Connect electrical wiring as tagged.
(4) Energize chlorination unit control cabinet by closing power panel 1 circuit breaker 9P5. Remove red tags.
(5) Open chlorination valve CU6.
(6) Position chlorination valve CU5 to A.
(7) Position valve CU7 to A.
(8) Prime repaired brine pump (see page 16, paragraph 3.3 of the M. Roy Controlled Volume Pump Instruction Manual in Appendix B).
(9) Energize pump motor by turning function switch on control cabinet to AUTO. Verify that pump operates normally.
(10) Record completion of this repair in maintenance logbook.

4-7.1.2.3 Replacement

a. Removal. Remove brine pump assembly as indicated in step a in paragraph 4-7.1.2.2.

b. Installation. Install brine pump assembly as indicated in step d in paragraph 4-7.1.2.2.

4-7.1.3 Chlorination unit circulation pump assembly

4-7.1.3.1 Cleaning and Inspection

a. Pump.
(1) Clean exterior of pump with brush and hot soapy water or with an approved solvent. Rinse thoroughly and dry with filtered compressed air.

(2) Visually check pump for evidence of cracks, corrosion, or damage. Remove corrosion.

b. Motor.

(1) Clean motor exterior using filtered compressed air or vacuum. Wipe off using rag moistened with an approved solvent. Clean terminals and wipe wires with lint-free cloth or electrician's brush.

4-7.1.3.2 Repair

a. Removal. Remove circulation pump assembly from mounting according to the following procedures:

WARNING

Make sure chlorination unit control cabinet Is electrically dead before starting removal.

(1) Make sure power panel 1 circuit breaker 9P5 is open (OFF). Redtag circuit breaker with 'WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."
(2) Turn chlorination unit control cabinet function switch OFF.
(3) Close chlorination system valves CU2 and CU9. Position valves CU4 and CU3 to C (close).
(4) Tag and disconnect electrical wiring to motor.
(5) Place container under piping and disconnect piping from pump.
(6) Remove mounting bolts and remove pump assembly.

b. Disassembly and repair of circulation pump. Disassembly and repair circulating pump page 17 in Biocidal System Recycle/Accumulating and Operating Instructions Manual in Appendix B. Use repairparts listed in TM 55-193-209-14&P-18. Retouch or paint in accordance with TB 43-0144.

c. Test and repair of motor. Repair motor by tightening loose connections, replacing damaged terminals, or replacing damaged wiring. Test motors for continuity. Check rpm.

d. Reinstallation of pump assembly.
(1) Reinstall pump assembly and tighten mounting bolts.
(2) Connect piping to pump.
(3) Connect electrical wiring to motor as tagged.
(4) Energize chlorination unit control cabinet by closing power panel 1 circuit breaker 9P5. Remove red tag.
(5) Open chlorination valves CU2 and CU9.
(6) Open chlorination valve CU4.
(7) Energize pump motor by turning function switch on chlorination unit control cabinet (Figure 3-4) to AUTO. Verify that pump operates normally.
(8) Record completion of this repair in maintenance logbook.

4-7.1.3.3 Replacement

a. Removal. Remove circulation pump assembly as indicated in step a in paragraph 47.1.3.2.
b. Installation. Install circulation pump assembly as indicated in step d in paragraph 4-7.1.3.2.

4-7.1.4 Chlorination unit control cabinet

WARNING

Make sure chlorination unit control cabinet Is electrically dead before starting repair or removal. Redtag power panel 1 circuit breaker 9P5 with: "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

4-7.1.4.1 Cleaning and Inspection

a. Make sure chlorination unit control cabinet is electrically dead by opening (OFF) power panel 1 circuit breaker 9P5. Redtag circuit breaker with: 'WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."
b. Wipe clean exterior of control cabinet with clean rag. Open control cabinet door and vacuum clean or clean inside with electrician's brush. Avoid using solvents for cleaning inside of control cabinet. Solvents leave a greasy film on components that may reduce electrical continuity.

c. Check fuse. Replace if necessary.

d. Visually inspect for indications of burns, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion from contacts and terminals, tighten loose connections, and replace damaged parts. Clean electrical contacts with silver polish, fine sandpaper, or burnishing tool. DO NOT use emery paper or steel wool. Vacuum to remove residue. Touch up paint according to TB 43-0144. Do not paint threads or labels.

4-7.1.4.2 Fuses

a. Make sure power panel 1 circuit breaker 10P5 is open (OFF). Redtag circuit breaker with 'WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."
b. Turn metering pump motor controller AUTO/OFF/MAN switch to OFF.
c. Open control cabinet door (Figure 3-6) and remove old fuse.
d. Install new fuse and close door.
e. Energize control cabinet by closing power panel 1 circuit breaker 9P5. Remove red tag.
f. Record fuse replacements in maintenance logbook.

4-7.1.4.3 Indicator lights

a. Unscrew lens cap on front of control cabinet.
b. Remove bad bulb and install new bulb.
c. Clean and replace lens cap.

4-7.1.4.4 Replacement

a. Removal.
   (1) Make sure control cabinet is electrically dead before starting repair by opening (OFF) circuit breaker 1 P5 on power panel. Redtag circuit breaker with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."
   (2) Tag and disconnect wiring with connection information.
   (3) Remove attaching hardware and remove motor controller.

b. Installation.

   (1) Install control cabinet using attaching hardware.
   (2) Connect wiring.
   (3) Close (ON) circuit breaker 1 P5 on power panel.
   (4) Check operationally that motor controller operates normally.

4-7.1.5 Sump pump

4-7.1.5.1 Cleaning and Inspection

a. Pump.
   (1) Clean exterior of pump with brush and hot soapy water or with an approved solvent. Rinse thoroughly and dry with filtered compressed air.
   (2) Visually check pump for evidence of cracks, corrosion, or damage. Remove corrosion. Touch up paint according to TB 43-0144.
b. Motor.
   (1) Clean motor exterior using filtered compressed air or vacuum. Wipe off using rag moistened with an approved solvent. Clean terminals and wipe wires free with lint-free cloth or electrician's brush.
   (2) Visually inspect for burned, bent, loose, corroded, or otherwise damaged terminals. Inspect wiring for breaks, loose connections, or other obvious damage. Tighten loose connections, replace damaged terminals, and replace damaged wiring. Touch up paint according to TB 43-0144.

4-7.1.5.2 Repair

a. Removal. Remove sump pump from sump in drip pan according to the following procedure:

WARNING

Make sure chlorination unit control cabinet is electrically dead before starting removal.

(1) Make sure power panel 1 circuit breaker 9P5 is open (OFF). Redtag circuit breaker with 'WARNING -DO NOT ACTIVATE. REPAIRS BEING MADE."

(2) Turn chlorination unit control cabinet function switch OFF.

(3) Position chlorination system valve CU5 to C (CLOSE).

(4) Tag and disconnect electrical wiring to motor.

(5) Disconnect piping from pump.

(6) Remove mounting bolts and remove pump assembly.

b. Repair and test. Repair motor by tightening loose connections, replacing damaged terminals, or replacing wiring. Test motors for continuity. Check rpm.

c. Reinstallation of pump assembly.

(1) Reinstall pump assembly and tighten mounting bolts.

(2) Connect piping to pump.

(3) Connect electrical wiring to motor as tagged.

(4) Energize chlorination unit control cabinet by closing power panel 1 circuit breaker 9P5. Remove red tag.

(5) Position chlorination system valve CU5 to A (OPEN) to fill up sump or fill sump with water.

(6) Energize pump motor by turning function switch on chlorination unit control cabinet (Figure 3-4) to AUTO. Verify that pump empties sump.

(7) Record completion of repair in logbook.

4-7.1.5.3 Replacement

a. Removal. Remove sump pump assembly as indicated in step a in paragraph 4-7.1.5.2.

b. Installation. Install sump pump assembly as indicated in step c in paragraph 4-7.1.5.2.

4-7.1.6 Sump pump switch

4-7.1.6.1 Cleaning and Inspection

a. Wipe clean exterior of sump pump switch located near forward side of control cabinet with clean rag.

b. Visually inspect for indications of bums, corrosion, or loose connections. Tighten loose connections. Replace damaged switch.

4-7.1.6.2 Replacement

a. Removal.

WARNING

Make sure chlorination unit control cabinet Is electrically dead before starting removal.

(1) Make sure power panel 1 circuit breaker 9P5 is open (OFF). Redtag circuit breaker with: WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

(2) Turn chlorination unit control cabinet function switch OFF.

(3) Tag and disconnect leads to switch.

(4) Remove mounting hardware and remove switch.

b. Installation.

(1) Install switch and tighten mounting hardware.

(2) Connect electrical wiring to switch as tagged.

(3) Energize chlorination unit control cabinet by closing power panel 1 circuit breaker 9P5. Remove red tag.

(4) Fill sump with water.

(5) Energize pump motor by turning function switch on chlorination unit control cabinet (Figure 3-4)to AUTO. Verify that pump empties sump.

(6) Record completion of repair in logbook.

4-7.1.7 Drip pan and sump. Maintenance of the drip pan and sump is limited to cleaning and inspection. Visually inspect drip pan and sump pump for excess fluid, corrosion, chipped paint, and damage. Remove liquid by using bilge system foot valve and then wipe clean. Repair damage. Remove corrosion and touch up paint according to TB 43-01 44.

4-7.1.8 Metering pump

4-7.1.8.1 Cleaning and inspection

a. Pump.

(1) Clean exterior of pump with brush and hot soapy water or with an approved solvent. Rinse thoroughly and dry with filtered compressed air.

(2) Visually check pump for evidence of cracks, corrosion, or damage. Remove corrosion. Touch up paint according to TB 43-0144.

b. Motor.

(1) Clean motor exterior using filtered compressed air or vacuum. Wipe off using rag moistened with an approved solvent. Clean terminals and wipe wires free with lint-free cloth or electrician's brush.

(2) Visually inspect for burned, bent, loose connections, or other obvious damage. Tighten loose connections, replace damaged terminals, and replace damaged wiring. Touch up paint according to TB 43-0144.

4-7.1.8.2 Repair

a. Removal. Remove metering from mounting according to the following procedures:

WARNING

Make sure metering pump motor controller is electrically dead before starting repairs.

(1) Make sure power panel 1 circuit breaker 1 OP is open (OFF). Redtag circuit breaker with: -WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

(2) Turn metering pump motor controller AUTO/OFF/MAN to OFF.

(3) Close chlorination system valves CU13 and CU14.

(4) Tag and disconnect electrical wiring.

(5) Place container under piping and disconnect piping from pump.

(6) Remove mounting bolts and remove pump assembly.

b. Disassembly and repair of metering pump. Disassemble and repair metering pump according to page 21, Section 5, in M. Roy Controlled Volume Pump Instruction Manual in Appendix B. Use repair parts listed in TM 55-1930-209-14&P-1 8.

c. Test and repair of motor. Repair motor by tightening loose connections, replacing damaged terminals, or replacing damaged wiring. Test motor continuity, check voltage, resistance, rpm, etc., listed on label plate.

d. Reinstallation of pump assembly.

(1) Install pump assembly and tighten mounting bolts.

(2) Connect piping to pump.

(3) Connect electrical wiring to motor as tagged.

(4) Energize metering pump motor controller by closing power panel 1 circuit breaker 1 OP5. Remove red tag.

(5) Open chlorination valves CU13 and CU14.

(6) Prime repaired metering pump (see page 16, paragraph 3.3, of the M. Roy Controlled Volume Pump Instruction Manual in Appendix B).

(7) Energize pump motor by turning AUTO/OFF/MAN switch to AUTO and pushing START button on metering pump motor controller (Figure 3-2). Verify that pump operates normally.

(8) Record completion of this repair in maintenance logbook.

4-7.1.9 Metering pump motor controller

WARNING

Make sure metering pump motor controller Is electrically dead before starting repair or removal. Redtag power panel 1 circuit breaker 10P5 with: "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

4-7.1.9.1 Cleaning and Inspection

a. Make sure metering pump motor controller is electrically dead by opening (OFF) power panel 1 circuit breaker 10P5. Redtag circuit breaker with: "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

b. Wipe clean exterior of motor controller with clean rag. Open motor controller door and vacuum clean or clean inside with electrician's brush. Avoid using solvents for cleaning inside of motor controller. Solvents leave a greasy film on components that may reduce electrical continuity.

c. Check fuse. Replace if necessary.

d. Visually inspect for indications of burns, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion from contacts and terminals, tighten loose connections, and replace damaged parts. Clean electrical contacts with silver polish, fine sandpaper, or burnishing tool. DO NOT use emery paper or steel wool. Vacuum to remove residue. Touch up paint according to TB 43-0144.

4-7.1.9.2 Replacement

a. Removal

(1) Make sure priming pump motor controller is electrically dead before starting repair by opening (OFF) circuit breaker 1 OP5 on power panel. Redtag circuit breaker with: 'WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

(2) Tag and disconnect wiring with connection information.

(3) Remove attaching hardware and remove motor controller.

b. Installation.

(1) Install motor controller using attaching hardware.

(2) Connect wiring as tagged.

(3) Close (ON) circuit breaker 10P5 on power panel 1.

(4) Check operationally that motor controller operates normally. Troubleshoot if necessary.

4-7.1.10 Metering pump control unit (Analyzer/XMTR)

4-7.1.10.1 Cleaning and Inspection

WARNING

Make sure metering pump control unit is electrically dead by opening (OFF) power panel 1 circuit breaker 10P5. Redtag circuit breaker with: "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

a. Make sure metering pump control unit is electrically dead by opening (OFF) power panel circuit breaker 1 OP5. Redtag circuit breaker with: 'WARNING DO NOT ACTIVATE. REPAIRS BEING MADE.

b. Wipe clean exterior of control unit with clean rag. Open control unit door and vacuum clean or clean inside with electrician's brush. Avoid using solvents for cleaning inside of control cabinet. Solvents leave a greasy film on components and may reduce electrical continuity.

c. Visually inspect for indications of bum, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion from contacts and terminals and tighten loose connections. Touch up paint according to TB 43-0144.

4-7.1.10.2 Test and repair. Test, calibrate, and repair as given in the Xertex Corp. instruction Manual IDS-924 in Appendix B.

4-7.1.10.3 Replacement

a. Removal.

(1) Make sure metering pump control unit is electrically dead by opening (OFF) power panel 1 circuit breaker 10P5. Redtag circuit breaker with: 'WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

(2) Tag and disconnect wiring to control cabinet.

(3) Remove attaching hardware and remove control cabinet.

b. Installation.

(1) Install control cabinet using attaching hardware.

(2) Connect wiring as tagged.

(3) Close (ON) circuit breaker 1 0P5 on power panel 1.

(4) Calibrate control cabinet as given in the Xertex Corp. Instruction Manual IDS-924 in Appendix B.

(5) Check that control cabinet operates normally. Troubleshoot if necessary as given in the Xertex Corp. Instruction Manual.

4-7.1.11 Chlorine sensor

4-7.1.11.1 Inspection and repair. Visually inspect sensor for damage and wire connections. Tighten wire connections or replace damaged wire. Replace screw on membrane cap if tom or ruptured and recalibrate sensor as given on page 24 of the Xertex Corp. Instruction Manual IDS-924 in Appendix B. Check electrolyte level. Add electrolyte as given on page 24 of the Xertex Corp. manual.

4-7.1.11.2 Replacement

a. Removal.

WARNING

Make sure power to chlorine sensor is OFF.

(1) Make sure power panel 1 circuit breaker 1 OP5 is open (OFF). Redtag circuit breaker with: -WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

(2) Tag and disconnect wires to sensor.

(3) Disconnect piping from sensor and remove sensor.

b. Installation.

(1) Install sensor and connect piping.

(2) Connect wires to sensor as tagged.

(3) Energize sensor by closing power panel 1 circuit breaker 10P5. Remove red tag.

(4) Recalibrate sensor as given in Xertex Corp. Instruction Manual in Appendix B.

4-7.1.12 Portable eyewash

4-7.1.12.1 Cleaning and inspection

a. Wipe clean outside with clean cloth moistened in hot water.

b. Visually check for damage. Add fresh water if needed. Change water weekly.

4-7.1.12.2 Replace.

a. Removal. Remove portable eyewash from mounting.

b. Installation.

(1) Install portable eyewash on bulkhead mounting.

(2) Fill with drinking water.

(3) Check operation.

4-7.1.13 Flow switch

4-7.1.13.1 Cleaning and inspection

a. Wipe clean with clean cloth moistened in hot soapy water.

b. Visually inspect for leaks, loose wire connections, or damage. Tighten connections. Replace damaged switch. Remove paddle and check for buildup or deterioration. Clean or replace paddle if necessary.

4-7.1.13.2 Repair. The only repair required is replacement of the flow switch paddle.

WARNING

Make sure metering pump motor controller is electrically dead before starting removal.

a. Make sure power panel 1 circuit breaker 1 OP5 is open (OFF). Redtag circuit breaker with: 'WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."

b. Turn metering pump motor controller AUTO/OFF/MAN to OFF.

c. Unscrew flow switch.

d. Remove flow switch.

e. Remove paddle and install new paddle.

f. Reinstall flow switch.

g. Energize metering pump motor controller by closing power panel 1 circuit breaker 1 0P5. Remove red tag.

h. When product water from ROWPU is flowing to drinking water tanks, make sure flow switchstarts and stops metering pump when metering pump motor controller AUTO/OFF/MAN switch is in AUTO.

i. Record completion of this repair in maintenance logbook.

4-7.1.13.3 Replacement

a. Removal.

(1) Close chlorination system valve CU14 and ROWPU System valve RO15.

(2) Tag and disconnect wiring to flow switch.

(3) Disconnect piping and remove flow switch.

b. Installation.

(1) Install flow switch and connect piping.

(2) Connect wiring as tagged.

(3) Open chlorination system valve CU14 and ROWPU system valve R015.

(4) Check for normal operation when ROWPU and chlorination system are operating.

4-7.1.14 Chlorination unit holding tank air escape valve

4-7.1.14.1 Repair

a. On face of valve located on top of deckhouse, remove three cap screws holding cap in place.

b. Carefully remove cap, protective mesh, space ring, and flame screen from valve body.

c. Clean all of these components with soap and water using a stiff brush if necessary.

d. Visually inspect parts for damage and replace damaged parts.

e. Install parts in air escape body in reverse order of removal. Tighten three cap screws holding cap in place.

4-7.1.14.2 Replacement

a. Removal. Burn off escape valve.

b. Installation. Weld on new escape valve.

4-7.1.15 Piping and valves. Replace piping or valves, or repack worn or damaged valves according to procedures in TM 55-503.

4-7.1.16 Electrical wiring and cables

4-7.1.16.1 Inspection. Inspect wiring and harnesses for chafed or burned Insulation. Look for causes of chafing or bums. Inspect terminal connectors for corrosion, loose connections, and broken parts. Clean corrosion and replace damaged connector pins or wires, replace damaged connectors or replace harness assembly. Check mounting hardware, hangers and receptacles for tightness. Tighten If necessary.

4-7.1.16.2 Repair. When replacing wires or repairing wire harnesses, lay wires alongside wire or harness and cut new wires at least 1 1/2 Inches longer than wire being replaced.

4-7.1.17 Hoses

4-7.1.17.1 Cleaning and inspection

a. Wipe hoses clean with cloth moistened in hot soapy water.

b. Inspect hose for breaks, leaks, kinks, and damage. Check fitting for damage. if fittings are damaged, replace entire hose. Save fittings not damaged or corroded for use on new hoses.

CHAPTER 5 STORAGE
Section I. Short-term storage

5-1 Short-term storage. If barge is taken out of service for more than 7 days, but less than 30 days, open power panel 1 circuit breakers 9P5 and 10P5. Periodically inspect system for corrosion, damage, and pilferage.

Section II. Administrative storage

5-2 Administrative storage. If barge is taken out of service for more than 30 days, but less than 6 months, barge remains a unit responsibility and shall be maintained by unit personnel.

5-2.1 Administrative storage procedures. To place chlorination system in administrative storage, perform the following:

NOTE
Valve numbers referred to are the same as shown In Figure 1-2 (Barge 1) and Figure 1-3 (Barge 2 and 3) for chlorination system.

a. Flush chlorination system according to paragraph 3-7.1. Use drinking water instead of seawater.

b. When authorized by bargemaster, flush system with acid according to paragraph 3-7.2.

c. Turn chlorine metering pump motor controller AUTO/OFF/MAN switch (Figure 3-2) to OFF.

d. Close chlorination valves CU12 and CU15.

e. Position chlorination valve CU11 to C (CLOSE).

f. Position chlorination valve CU3 to B (WATER), CU5 to A (DRAIN), CU4 to A (To CELLS), and CU7 to B (DRAIN).

NOTE
There are two valves CU14 on Barge 1. Ensure that both are opened.

g. Open chlorination valve CU2, CU2A, CU6, CU6A, CU8, CU9, CU10, CU13, CU14 and CU16 and drain chlorination system.

h. Break open pipes at lowest point to drain. Drain and clean holding tank, brine tank, and sump tank. Clean catchment.

i. Clean glass cells, flowmeters, gauges, and indicators with a clean, lint-free cloth.

j. Clean grease coated surfaces with clean, lint-f4ree cloth moistened with cleaning solvent. Scrub off hard deposits with a bristle brush that has been dipped in solvent. Dry surfaces with a clean, lint-tree cloth.

k. Thoroughly clean all other external surfaces to remove any corrosion or other foreign matter. Clean all surfaces except electrical parts with soapy water and a stiff bristle brush. Then flush with clean water. Clean motor controllers and remote START/STOP switches by wiping with a clean cloth moistened with silicone spray lubricant. Remove corrosion by wire brushing or sanding. Clean other electrical components as given in TM 55-1930-20914&P-9.

l. Touch up paint, as necessary, to match surrounding areas in accordance with TB 43-0144. Do NOT paint threads or labels.

5-2.2 Administrative storage Inspection. Chlorination system, if not in use during storage, will be inspected at least once every 30 days. Check for corrosion, damage, or pilferage. Correct as necessary.

Section III. Long-term storage

5-3 Long-term storage. If barge is to be taken out of service for 6 months or more, turn it in to depot for preparation and placement into long-term storage. If barge is in administrative storage and is to be taken out of service and place in depot long-term storage (6 months or more), process chlorination system for normal operations as specified below before releasing to depot.

a. Perform before operation checks in Appendix C.

b. Operate chlorination system as given in Appendix C.

c. Perform during operation checks in Appendix C.

d. Perform after operation checks in Appendix C upon completion of normal operation.

e. Upon successful completion of operation and inspection, release barge to depot for processing into long-term storage.

CHAPTER 6 MANUFACTURER'S SERVICE MANUALS/INSTRUCTIONS

6-1 General Manufacturers' operation and maintenance manuals listed below provide additional information on chlorination system components. A copy of each manual/set of instructions is contained in Appendix B. It may be necessary to refer to both these manuals/instructions and drawings listed in Appendix A while performing procedures in this TM.

Component	Document title	Manufacturer
Chlorination unit mode 49R/A	Installation and Operating Instruction Biocidal System Recycle/Accumulating, Model No. 49R/A	Scienco, Inc. 3240 N. Broadway St. Louis, MO 63147 (314) 621-2536
Metering pump and brine pump	Instruction Manual, M. Roy Controlled Volume Pump, 102-9856-999A	M. Roy Co. Flow Control Division 201 Inland Road Ivyland, PA 18974 (215) 441-0800
Metering pump control unit model 924	Delta Instruction Manual IDS-924, Model 924 Chlorine FAC/TFC Analyzer/Transmitter	Xertex Corp. Delta Analytical 250 Marcus Blvd. Hauppage, NY 11787 (516) 273-6600 Telex: 14-4545
Flow switch FS-550	Flow Switches Paddle Type, FS-550, FS-600 Series Installation and Maintenance	Transamerica DeLaval, Inc. Gems Sensors Division Cowles Road Plainville, CT 06062 (203) 677-1311 Telex: 99-306
Air escape valve type 1600W	Tank Air Escape Valves Model 1600	Robert H. Wager Co., Inc. Passaic Avenue Chatham, NJ 07928 (201)635-9200
Metering pump motor control	See TM 55-1930-209-14&P-9 Electrical Power Systems	

CHAPTER 7 MANUFACTURERS' WARRANTIES/GUARANTEES

7-1 General. Information on the warranty for chlorination system components is given below.

Component	Manufacturer	Duration	Coverage
Chlorination unit model 49R/A	Scienco, Inc. 3240 N. Broadway St. Louis, MO 61347 (314) 621-2536	1 year after shipment or 90 days after install-ation, whichever comes first	Material and workmanship
Electrolytic cells in Scienco unit	Scienco, Inc. 3240 N. Broadway St. Louis, MO 63147 (314) 621-2536	3 years from date of shipment	Electrolytic cells repair or replacement -
Metering pump	M. Roy Co. Flow Control Division 201 Ivyland Road Ivyland, PA 18974 (215) 441-0800	1 year	Material and workmanship
Metering pump control unit model 924	Xertex Corp. Delta Analytical 250 Marcus Blvd. Hauppage, NY 11787 (516) 273-6600	18 months after shipment or 1 year after installation, whichever comes first	Material and workmanship
Flow switch FS-550	Transamerica DeLaval, Inc. Gems Sensors Division Cowles Road Plainville, CT 06062 (203) 677-1311	1 year from date of purchase	Material and workmanship
Air escape valve 1600W	Robert H. Wager Co., Inc., Passaic Avenue Chatham, NJ 07928 (201) 6359200	1 year from date of purchase	Material and workmanship
Metering pump motor controller	See TM 55-1930-209-14&P-9, Electrical Power Systems		

APPENDIX A
REFERENCES

A-1 Drawings

US Army Belvoir Research, Development and Engineering Center (97403)

13226E1892	ROWPU/Barge Arrangement
13226E1893	List of Label Plates
13226E1896	Drinking Water System
13226E1897	Drinking Water System Operational Instruction Placard
13226E1903	Voids Ventilation
13226E1923	Chlorination System
13226E1928	Alarm/Casualty Monitoring System
13226E1932	Electrical Power Schematic Diagram
13226E1933	Communication System
13226E1934	Load, Cables and Circuit Breakers Data
13226E1935	Electrical Power System Layout
13226E1939	Motor Controllers Schematic and Wring Diagram
13226E1941	Chlorination System Operational Instruction Placard
13226E1943	Battery Box

A-2 Painting

TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use

A-3 Cleaning

Fed Spec P-D-680	Metal Cleaning Solvent for Army Use

A-4 Maintenance

DA PAM 738-750	The Army Maintenance Management System (TAMMS)
TM 55-503	Marine Salvage and Hull Repair
TM 5-6630-215-12	Operator and Organizational Maintenance, Water Quality Analyses/Sets
TB 43-0144	Painting of Vessels

APPENDIX B
MANUFACTURERS' SERVICE MANUALS/INSTRUCTIONS

Component	Document title	Manufacturer
Chlorination unit mode 49R/A	Installation and Operating Instruction Biocidal System Recycle/Accumulating, Model No. 49R/A	Scienco, Inc. 3240 N. Broadway St. Louis, MO 63147 (314) 621-2536
Metering pump and brine pump	Instruction Manual, M. Roy Controlled Volume Pump, 15.11	M. Roy Co. Flow Control Division 201 Inland Road Ivyland, PA 18974 (215) 441 -0800
Metering pump control unit model 924	Delta Instruction Manual IDS-924, Model 924 Chlorine FACITFC Analyzer/Transmitter	Xertex Corp. Delta Analytical 250 Marcus Blvd. Hauppage, NY 11787 (516) 273-6600 Telex: 14-4545
Flow switch FS-550	Flow Switches Paddle Type, FS-550, FS-600 Series Installation and Maintenance	Transamerica, DeLaval, Inc. Gems Sensors Division Cowles Road Plainville, CT 06062 (203) 677-1311 Telex: 99-306
Air escape valve type 1600W	Tank Air Escape Valves Model 1600	Robert H. Wager Co., Inc. Passaic Avenue Chatham, NJ 07928 (201) 635-9200

APPENDIX C

Preventive maintenance checks and services (PMCS) for the Chlorination System

C.1 Introduction to PMCS

NOTE

TM 55-1930-209-14P-19 contains PMCS for all systems on the ROWPU Barge. This appendix contains only PMCS for the Chlorination System

a. General.

(1) Systematic (B) before, (D) during, (A) after, and scheduled periodic PMCS are essential to ensure that the Reverse Osmosis Water Purification Barge is in operational readiness at all times. The purpose of the PMCS program is to discover and correct deficiencies and malfunctions before they cause serious damage or failure of the barges and their support systems. An effective PMCS program requires that operators report all unusual conditions noticed before, during and after operation as well as while performing periodic PMCS. All deficiencies and malfunctions discovered during maintenance inspections must be recorded, together with the corrective action taken, on DA Form 2404 (Equipment Inspection and Maintenance Worksheet).

(2) A schedule for preventive maintenance inspections and service should be established and adhered to. When operating under unusual conditions, such as extreme heat or cold, it may be necessary to perform PMCS more frequently.

(3) The PMCS items have been arranged and numbered in a logical sequence to provide for greater efficiency and the least amount of downtime required for maintenance.

b. PMCS columnar entries.

(1) Item Number Column. Checks and services are numbered in chronological order regardless of interval. This column is used as a source of item numbers for the "Item Number" column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.

(2) Interval Column. The interval columns tell you when to do a certain check or service: before, during, or after operation. Sometimes a dot may be placed in more than one interval column which would mean you should do the check or service at each of those intervals.

(3) Item to Be Inspected Column. This column lists the common name of the item to be inspected such as 'Air Filters."

(4) Procedures Column. This column tells you how to do the required checks and services. Carefully follow these instructions.

(5) Equipment is Not Ready/Available if Column. This column tells you when and why your equipment cannot be used.

NOTE

The terms "Ready/Available" and "Mission Capable" refer to the same status: equipment is on hand and Is able to perform its combat missions. (See DA PAM 738-750).

(6) Increased Inspections. Perform weekly as well as Before Operations PMCS if:

(c) You are the assigned operator and have not operated the item since the last weekly PMCS.

(d) You are operating the item for the first time.

(7) Leakage definitions. In checking for fluid leaks, the following leakage definitions apply to all ROWPU barges and barge equipment, product water, and seawater leakage by class type.

(a) Class I - Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.

(b) Class II - Leakage of fluid great enough to form drops, butnot enough to cause drops to drip from the item being checked/inspected.

(c) Class III - Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

CAUTION

Equipment operation is allowable with minor leakages (Class I or II). However, the fluid level or operating pressure of the item being checked/inspected must be considered. When in doubt, notify the shift leader or bargemaster. When operating with Class I or Class II leaks, continue to check fluid levels as required by PMCS and operating Instructions.

(8) The following fuel and hazardous material leakage procedures apply for any fuel, chemical, or bilge system.

WARNING

Class 1, 11 or III leaks or seepage occurring In a fuel, chemical, or bilge container, tank, line, piping, or valve can cause fire or health hazards.

(a) If any leaks or see page from a fuel, chemical, or bilge container, tank, or fluid line is detected, it must be immediately reported to the shift leader or bargemaster for corrective action.

(b) To prevent combustible or toxic fumes from collecting or contaminated material from spilling, exercise extreme caution after detecting leaks or seepage of flammable or hazardous material.

c. Continuous operation. When equipment must be kept in continuous operation for extended periods of time, check and service only those items that can be checked and serviced without disturbing operations. Perform complete checks and services when the equipment can be shut down.

d. Maintenance log. Always record thetime and date of PMCS, any deficiencies noted, and corrective action taken in the PMCS log book.

C-2 Major components. The chlorination system consists of a priming brine tank and holding tank, chlorine generation and recirculation unit, metering pump control unit, acid tank, various pumps, flowmeters, pressure gauges, and valves. In addition, there are associated indicator lights, LED displays, fluid lines, piping, sensors, switches, and electrical circuitry. Major components of the chlorination system, their basic functions, and their location on the barge are listed in Chapter 1.

C-3 Chlorination system description. The chlorination system generates a strong solution of sodium hypochlorite (commonly called chlorine) for treating water produced by the Reverse Osmosis Water Purification Units (ROWPU's). Adding this solution to the water makes it safe for human consumption. A metering pump adds this solution, upon demand, to water processed by the ROWPU system just before the water enters the four drinking water storage tanks. The system generates and maintains a 5000 to 6000 parts per million (ppm) solution of chlorine and then meters this solution into product water from the ROWPU system to obtain a chlorine concentration of 5 to 7 ppm in the drinking water.

Table C-1. Preventive Maintenance Checks and Services for Chlorination System

B - Before
D - During
A - After

D - Daily
W - Weekly
M - Monthly

Q - Quarterly
S - Semiannually
A - Annually

ITEM NO.	INTERVAL									ITEM TO BE INSPECTED	PROCEDURES CHECK FOR AND HAVE REPAIRED OR ADJUSTED AS NECESSARY	EQUIPMENT IS NOT READY/ AVAILABLE IF
	B	D	A	D	W	M	Q	S	A			
										CHLORINATION SYSTEM	**WARNING** **Be sure electrical power is off before performing any maintenance on electrical systems. Redtag appropriate switches and circuit breakers with: "WARNING – DO NOT ACTIVATE. REPAIRS BEING MADE." Observe all safety precautions at the beginning of this manual. Hazardous chemical materials are used with this equipment. Always use approved breathing devices when working with chemicals. Avoid chemical contact with eyes, skin and clothing. Always wear safety glasses, gloves, and rubber aprons when handling chemicals.**	
1										All Components	**NOTE** **When performing BEFORE and AFTER PMCS, make sure all circuit breakers are open (OFF):** **1. Circuit breakers P5 and P8 are open (OFF) to panels 1 and 2.** **2. Power panel circuit breaker 9P5 is open (OFF) to chlorinate unit control panel.** **3. Power panel 1 circuit breaker 10P5 is open (OFF) to metering pump controller motor.** **4. Power panel 2 circuit breaker 8P8 in open (OFF) to vent for 8 controller motor.**	
	•		•	•							a. Wipe all components clean, especially flowmeters, indicators, control panels and electrolytic cell (Void 2 port).	
	•		•	•							b. Check for leaks paying special attention to joints, valves, fittings and piping. Report leaks to shift leaders or bargemaster for corrective action.	Class III leaks.

Table 4-2. Preventive Maintenance Checks and Services for Chlorination System (Continued)

B - Before
D - During
A - After

D - Daily
W - Weekly
M - Monthly

Q - Quarterly
S - Semiannually
A - Annually

ITEM NO.	INTERVAL									ITEM TO BE INSPECTED	PROCEDURES CHECK FOR AND HAVE REPAIRED OR ADJUSTED AS NECESSARY	EQUIPMENT IS NOT READY/ AVAILABLE IF
	B	D	A	D	W	M	Q	S	A			
	•		•	•							c. Check for damage, especially to flowmeters, indicators, control panels, and electrolytic cell. Repairs as necessary.	Flowmeter inoperable.
	•		•	•							d. Check for loose or missing securements and fasteners. Tighten or replace as necessary.	
	•		•	•							e. Remove rust and corrosion and touch up paint in accordance with TB43–0144 as necessary. Do not paint threads or labels.	
2	•		•	•						Wiring	a. Check wiring for loose or missing connections and frayed cables. Tighten or replace as necessary, using insulated tools.	Cables damaged.
		•									b. Visually check wiring for loose connections. If sparks are seen, report to shift leader or bargemaster so corrective action can be taken. Shut off power. Use insulated tools while performing inspection.	Sparks are seen.
3	•		•							Seawater Filter	Make sure seawater filter (filter 3) in line to chlorination system is clear and seawater pressure regulator is set to 10 psi.	
4	•									Circulating Pump	Check oil level on chlorinations unit circulating pump (Void port 2) to make sure oil is up to mark. Add oil as necessary.	
5		•								Chlorination Unit Panel, Meters and Gauges	a. Monitor the following: 1) Makeup water flowmeter to assure 36 gph. 2) Cooling water flowmeter to assure 80 gph. 3) Cooling water pressure gauge to assure 20–40 psi. 4) Heat exchanger pressure gauge to assure 30–60 psi.	

Table 4-2. Preventive Maintenance Checks and Services for Chlorination System (Continued)

B - Before **D - Daily** **Q - Quarterly**
D - During **W - Weekly** **S - Semiannually**
A - After **M - Monthly** **A - Annually**

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item To Be Inspected	Procedures Check For And Have Repaired Or Adjusted As Necessary	Equipment Is Not Ready/ Available If
	•			•							b Check cooling and makeup water flowmeters to assure they are not clogged with mineral deposits or rust. Remove and clean when necessary as follows: 1) Turn the black valve knob counter-clockwise until the threads are disengaged. Then withdraw the stem from the valve by gently pulling on the knob. 2) Remove the two large mounting bracket screws which secure the flowmeter to the system. 3) Unscrew the four recessed screws located on the back side of the flowmeter, then gently pull the body from the rear plate. Keep the body parallel with the back plate to prevent undue strain on the body. 4) Remove the slip cap with a push on a screwdriver, then remove the plug ball stop using a 1/2 in Allen wrench. 5) Remove the ball float by inverting the body and allowing the ball to fall into your hand. (Cover the discharge port to avoid losing the float thru that opening.) 6) Clean the flow tube and flowmeter body with ordinary soap and water. Do not use liquid soaps or detergents which may contain chlorinated solvents. 7) Reassemble the unit by reversing the procedure outlined; then place the flowmeter in service.	Flowmeters are clogged.
								•			c. Adjust makeup water flowmeter flow rate for higher flow rate during summer months and lower flow rate during winter months. Local climatic conditions determine final flow rate.	

Table 4-2. Preventive Maintenance Checks and Services for Chlorination System (Continued)

B - Before **D - During** **A - After**
D - Daily **W - Weekly** **M - Monthly**
Q - Quarterly **S - Semiannually** **A - Annually**

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item To Be Inspected	Procedures Check For And Have Repaired Or Adjusted As Necessary	Equipment Is Not Ready/ Available If
6		• • •								Brine Tank	a. Check brine tank salt level and add salt as necessary. b. Check cooling water and makeup water flowmeter and ammeter readings. Adjust water and brine feed control. c. Check condition of cells for scale buildup. Descale when necessary as follows: 1) Rush with seawater. (a) Check that seawater system is operating and providing sea-water to chlorination system thru seawater SW47 or SW48. (b) Turn alarm ON/OFF switch on control cabinet to OFF. (c) Turn function switch on control cabinet to OFF/RESET. (d) Position chlorination unit (CU) valves as indicated below: O - open X = closed A = position A B - position B C. = position C CU Valve No. — Valve Position 2 — x 2A — X 3 — B 5 — A 6 — x 6A — X 8 — x 9 — x 12 — x 16 — O (e) Position valve CU4 halfway between position A and C to reduce flow thru system. (f) Turn brine pump ON/OFF switch inside control cabinet to OFF.	

Table 4-2. Preventive Maintenance Checks and Services for Chlorination System (Continued)

B - Before **D - During** **A - After**
D - Daily **W - Weekly** **M - Monthly**
Q - Quarterly **S - Semiannually** **A - Annually**

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item To Be Inspected	Procedures Check For And Have Repaired Or Adjusted As Necessary	Equipment Is Not Ready/ Available If
		•									(g) Turn cooling water flowmeter OFF by closing valve at bottom of flowmeter. (h) Turn makeup water flowmeter OFF by closing valve at bottom of flowmeter. (i) Turn function switch on control cabinet to FLUSH. (j) Allow seawater to flow thru chlorination unit for about 5 minutes, then turn function switch on control cabinet to OFF/RESET. (k) Open chlorination valve CU9 to allow chlorination unit to drain. If sump appears to be overfilling, partially close valve CU9 to reduce drain flow to sump. (l) After chlorination unit has drained, close valves CU8 and CU9 to position C (OFF).	
									•		d. Drain and clean sludge buildup from brine tank and holding tank.	
7				•						Acid Tank	**WARNINGS** **Wear rubber gloves, safety goggles or faceshield, and chemical dust mask when working with add crystals and acid solution.** **Always add acid to water. Do not add water to acid. If any acid crystals or solution splash on skin, flush skin with water immediately. Immediately flush eye at eyewash station If acid crystals or solution splash In eyes.** a. Flush acid tank with sulphuric acid as follows:	

Table 4-2. Preventive Maintenance Checks and Services for Chlorination System (Continued)

B - Before **D - During** **A - After**
D - Daily **W - Weekly** **M - Monthly**
Q - Quarterly **S - Semiannually** **A - Annually**

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item To Be Inspected	Procedures Check For And Have Repaired Or Adjusted As Necessary	Equipment Is Not Ready/ Available If
				•							1) Remove tank lid and fill with 25 gal of drinking water from fill hose attached to bib in void 2 port above holding tank. 2) Add two cans (14 lbs) of sulphuric acid to water in tank for acid flush. 3) Turn valve CU3 to position A, ACID. Turn valve CU5 to position B, ACID. Open valve CU17. Make sure valve CU16 is open. 4) Turn function switch on control cabinet to FLUSH. 5) Descale until all visible signs of scale are gone from anodes (cells), approximately 5 minutes, then turn function switch to OFF/REST. **NOTE** **Sump tank pump automatically empties sump tank. Level switch In sump tank starts and stops sump pump.** 6) Turn valve CU5 to position A, DRAIN, to allow solution to drain to sump tank. 7) Remove acid tank lid to observe level of solution in tank. 8) Turn function switch on control cabinet to FLUSH. Acid tank should be emptied by circulating pump. 9) When acid tank is empty, turn function switch to OFF/RESET. 10) Close valve CU17 and CU3 to B. 11) Replace lid on acid tank.	

Table 4-2. Preventive Maintenance Checks and Services for Chlorination System (Continued)

B - Before **D - During** **A - After**
D - Daily **W - Weekly** **M - Monthly**
Q - Quarterly **S - Semiannually** **A - Annually**

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item To Be Inspected	Procedures Check For And Have Repaired Or Adjusted As Necessary	Equipment Is Not Ready/ Available If
				•							12) Rush chlorination unit with seawater before returning to normal operation as follows: (a) Turn valve CU3 to position B, WATER, to allow seawater to flush out acid. (b) Turn valve CU5 to position A, DRAIN, to allow flushing seawater- to drain to sump tank. (c) Turn function switch to FLUSH. (d) Flush to remove acid for 5 minutes Turn function switch on control cabinet to OFF/RESET. (e) Return system to normal operation	
8	·			•						Brine Feed Pump	Check that oil level in chlorination unit brine feed pump is above indicated mark in air bleeder filler reservoir. Add oil as necessary.	
9	•									Metering Pump	Check sight on metering pump to ensure oil level is at mark. Add oil as necessary.	
10		•								Metering Pump Control	Monitor metering pump control unit to Unit assure chlorine status on LED display.	
11		•							·	Chlorination Unit Control Cabinet	a. Monitor ammeter to assure reading is between 950-1000A (0.95-1,0kA). b. Monitor voltmeter to assure reading is between 6.0-6.5 Vdc.	
12		•								Equipment Monitoring System	a. Monitor CHLORINE STATUS display page for chlorine content and pump position. b. Monitor SYSTEM STATUS display page to assure: 1) CHLORINE OPERATING OFF is normal.	

Table 4-2. Preventive Maintenance Checks and Services for Chlorination System (Continued)

B - Before **D - Daily** **Q - Quarterly**
D - During **W - Weekly** **S - Semiannually**
A - After **M - Monthly** **A - Annually**

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item To Be Inspected	Procedures Check For And Have Repaired Or Adjusted As Necessary	Equipment Is Not Ready/ Available If
											2) CHLORINATOR PWR SUPPLY is normal. 3) BRINE RCIR PMP OPERATING OFF is normal.	
13							•			Voltage Connection on Cells	Check for cracked or frayed connections. Notify shift leader or bargemaster for corrective action.	Connections are frayed or cracked.
14						•				Ball Valves	Check that ball valves turn freely. Notify shift leader or bargemaster for corrective action.	Ball valves do not turn freely.

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MANUAL

SCIENCO INC.

TABLE OF CONTENTS

GENERAL INFORMATION.

The Science Biocidal Recycling/Accumulating System is designed to produce a relatively low pH sodium hypochlorite solution which does not contain caustic stabilizers or chlorine in gaseous form. Only the highest quality material and workmanship has been used in the manufacture of this equipment.

When installed, used and maintained in accordance with the information contained herein, many years of service can be expected from the equipment. It is highly recommended that one individual in the Maintenance Engineering Department become thoroughly familiar with the contents of this manual and be responsible for the system's maintenance.

I. INTRODUCTION AND THEORY OF OPERATION

A. General

The BIOCIDAL Sodium Hypochlorite Generating System is a safe and relatively inexpensive method of generating a highly effective disinfecting solution for Food Plant sanitation and for the treatment of potable and process water. The system can also be used for waste water and sewage treatment applications where the daily usage is within the capacity of the various models available.

The system generates and automatically maintains a hypochlorite strength of 5000 6000 ppm maximum (0.5 0.6%) expressed as total available chlorine equivalent. This is accomplished by constantly recirculating a weak brine solution (3 4% NaCl) through a single or series of proprietary electrolytic cells for a predetermined period of time.

Several reactions occur simultaneously within the cell to produce Sodium Hypochlorite solution. In addition, a small amount of hydrogen is generated which escapes to atmosphere through the internal venting system. THE EXACT AMOUNT OF HYPOCHLORITE GENERATED IS DETERMINED BY THE AMOUNT OF ELECTRICAL POWER APPLIED, PLUS THE SALINITY AND TEMPERATURE OF THE SOLUTION IN THE RECIRCULATING TANK. Any imbalance of these parameters will result in either under-powering or over-driving the system, resulting in insufficient chlorine strength (under powering) or excessive heat build-up in the power supplies and cells (over driving) in which case, the power supply starter will trip.

B. System Activation:

The entire operational cycle is triggered by a single two level sensor which is located in the holding tank cover.

As Hypochlorite solution is withdrawn from the holding tank, the low level sensor is triggered which immediately operates the main power relay which supplies voltage to the brine pump, circulating pump, cold water solenoid valve and to each cell. Chlorine is generated and will continue to be generated until the tank is filled and the high level sensor shuts down the system. The system will remain off until the low level is once again reached at which time the cycle repeats itself.

This cycling and recycling will continue as long as Sodium Hypochlorite (chlorine) is withdrawn.

C. Modes of Operation:

Two modes of operation are possible with the R/A System, i.e., a constant withdrawal mode or a bulk withdrawal mode.
A constant withdrawal mode requires that the number of gallons of Hypochlorite withdrawn during any period does not exceed the make-up rate for the particular model (see general specifications on page 3,

In the bulk withdrawal mode a large quantity of Hypochlorite can be withdrawn at one time providing the total quantity withdrawn does not lower the level below the low level mark (see total drawdown volumes in the general specification table (page 3.) If this mode is selected, sufficient time must be allowed for the system to replenish the chlorine used. This can be ideally accomplished during periods of low demand or after normal working hours.

II. RECYCLINC/ACCUMULATING SYSTEMS GENERAL SPECIFICATIONS

MODEL	PARTS CHLORINE PRODUCED PER HOUR	PROD. RATE G.P.H.	CAPACITY POUNDS OF CHLORINE DAY	BRINE CONSUMPTION GAL./DAY 100 SAL.	HOLDING TANK CAPACITY	HOLDING TANK	APPROX. INITIAL BUILD-UP TIME FULL TANK	SYSTEM DRAWDOWN CAPACITY
49 R/A	243,000	40.5	48	97.2	One 310 Gal.	42x54	4 Hrs.	206 Gal.
65 R/A	324,000	54	64	129.6	One 310 Gal.	42x54	3 Hrs.	206 Gal.
100 R/A	486,000	81	96	194.4	One 540 Gal.	48x72	4 Hrs.	360 Gal.

III. INSTALLATION INSTRUCTIONS

A. Uncrating and Shipping Damage

Uncrate the unit carefully and check the contents of the various boxes against the packing list enclosed. Look for visible SIGNS of damage and REPORT ANY DAMAGE TO THE CARRIER IMMEDIATELY. Check all electrical terminals and connections for tightness (paying particular attention to the large rubber covered cables in the low voltage D.C. circuits going from the power supply to the cells). Check all plug-in relays, etc., for full contact with socket.

B. Utilities Required.:

Check to assure that the proper electrical power is available for the systems (220/440 50/60 Hz 3 phase).* Note: This is a very important factor as the production of Hypochlorite and salt usage is directly related to the applied electrical current. A separate service line should be installed.

C. Water Supply.:

The brine tank and holding tank must be supplied with soft filteredwater at 20-60 psi. The upper limit permissible hardness is 5 grains. Water containing an excess of hardness minerals will cause a rapid build-up of scale deposits within the cells and associated Hypochlorite handling components.
The heat exchanger can operate with either soft or hard water.

D. Salt Selection.: Only food grade evaporated salt without additives should be used in the brine system.

* Required Electrical Service: Voltage/Amperage

49 R/A - 220V./30 Amp. - 440V./15 Amp.
65 R/A - 220V./42 Amp. - 440V./21 Amp.
100 R/A - 220V./60 Amp. - 440V./30 Amp.

E. Location of Equipment:

Locate the equipment as close as possible to the source of use, but avoid locating in close proximity to sources of excessive heat, cold or water overspray. For outdoor installation, use a simple frame storage shed, vented and containing a hydrogen monitoring device. Allow sufficient clearance around the floor mounted tanks and cabinets to facilitate routine maintenance. Locate the chlorine holding tank so that the semi-rigid interconnecting tubing follows the shortest and most direct path (Fig. No. 1). All fluid handling lines are color coded or numerically identified for ease of assembly. Simply connect like numbers on the tubing to matching numbers on the tanks and valves. In the event a number tag is missing, consult the single line plumbing diagram on Fig. #2 to determine the proper location.

CAUTION

Using the vent kit supplied, vent the holding tank to outside atmosphere. Seal the corrugated vent tube with the RTV rubber supplied. Also GROUND the HOLDING TANK to the POWER SUPPLY using the green ground wire supplied and continue the ground from the cabinet back to a RELIABLE ELECTRICAL OR WATER SYSTEM GROUND.

IV. INITIAL START-UP PROCEDURE.

A. Priming System:

Once all electrical and plumbing connections are completed, the system is ready for the initial prime as follows:

1. Brine Tank: Fill the brine tank approximately 1/2 full with cold water then add approximately 700 lbs. ofsalt.

2. Fill the holding tank to the "low" level mark with cold water. Add approximately 4-5 ounces of salt for each gallon of water. For example: If the 310 gallon holding tank on the Model 49 R/A is filled to the low level mark (90 gallon), use 90 x 5 450 or 28 lbs. of salt for the initial prime. Stir the contents of the tank until all the salt is in solution. Do not run unit during this time.
Place lid on top of tank so unit will operate.

B. Priming of Brine Pump: (See Addendum #1.)

V. CONTROL AND VALVE SETTINGS

A. Once the system is properly primed check to see that the various controls are set as follows:

1. Pump Starters "ON" (Inside Control Cabinet)

2. Function switch in "AUTO".

3. Flowmeters "OFF") During

) Build-up Period

4. Brine Pump "OFF" (Remove fuse).) Only.

(Or turn off switch inside Control Cabinet.)

With the control set as above, the solution in the holding tank can be brought to the required strength by recirculating for the hours indicated in the General Specifications (Page 3) (IF THE DC AMMETER IS NOT READING 950 TO 1000, INCREASE THE SALT LEVEL. IF THE DC AMMETER IS PEGGING TO THE FAR RIGHT, DILUTE AS NECESSARY.) An alternate approach to the above is to add a predetermined amount of Commercial hypochlorite to the tank in addition to the salt. This will eliminate the initial build-up time. For example: 20 gal. of a 5 1/4% Commercial Hypochlorite (bleach) added to 180gal. of 12 salometer brine will provide initial stock solution containing 6000 ppm C12.

B. Heat Exchanger:

Optimum operating conditions exist when the holding tank solution temperature is in the 75 95° F. range. This can be accomplished by proper adjustment of the heat exchanger.
To place the exchanger in operation proceed as follows:

Connect a suitable length of tubing to the fitting marked "Drain", on the right side of unit near center of heat exchanger flange. Place other end down into the closest drain. Adjust flowmeter so that approximately 80 gph water @ 10 PSI is flowing through the cooling chamber; however, local climatic conditions will determine the final flowrate. For example, a seasonal rise of thirty or more degrees Fahrenheit is not uncommon in locations where the Plant water is from a river source. THEREFORE, TO STABILIZE THE SOLUTION TEMPERATURE, A BI-YEARLY ADJUSTMENT SHOULD BE MADE, I.E., A HIGHER FLOWRATE IN THE SUMMER, LOWER IN THE WINTER.

VI. PLACING SYSTEM ON-STREAM

A. Once the internal piping and wiring has been connected and the unit is in the build-up period, consideration can be given to connecting the system to the various points to be chlorinated.

Make sure that arrangements have been made to secure the proper piping and plumbing fittings beforehand. NO METAL FITTINGS of any kind should be used in the chlorine feed piping. Use only Schedule 80 P.V.C. or polyethylene semi-rigid tubing. As a general rule 1/2" PVC or 3/8" polyethylene tubing is satisfactory for most installations. Schedule 40 PVC, although chemically suitable for the job, is not rugged enough and should be avoided unless no other type is readily available. An output manifold should be constructed from schedule 80 P.V.C. fittings and attached to the valve which is part of the Chlorine output assembly supplied with the unit. The manifold should then be installed in the Chlorine output fitting which is located approximately one third up from the bottom of the holding tank. Under no circumstances should any other fitting be used for Hypochlorite withdrawal. (THIS ESPECIALLY APPLIES TO THE DRAIN FITTING WHICH IS LOCATED AT THE TANK BOTTOM.)

All chlorine withdrawal from the systems should be taken from the chlorine output fitting except when injectors are being used. When this is the case, the injector suction tubing should be inserted through holes in the side of the tank using the schedule 80 P.V.C. insertion tubes supplied..

These tubes control the depth to which the tank can be drained thereby assuring that the circulating pump is always operating in a flooded suction condition. Failure to use these tubes could result in damage to the pump.

Once all the necessary pumps and fittings have been installed, check to make sure that the total chlorine being withdrawn does not exceed the make-up rate of the system. Bear in mind that in situations where little or no chlorination has been accomplished in the past, the build-up of organic matter in the water lines being treated can create a large temporary chlorine demand which will result in over dosing the system initially. It is a desirable practice to check the chlorine residuals after several days of chlorination and reduce the feed rate if the chlorine residual has risen to a higher than desired level.

B. Fail-Safe Circuitry:

Several "Fail-Safe" circuits are included in the system to protect the system in the event of accidental overload or pump failure. These are:

1. Pump Pressure Failure Circuit consists of a diaphragm type pressure switch and pressure gauge. This circuit immediately removes the D.C. power to the cells in case of pump failure. Once the malfunction has been corrected, the system can only be activated by placing the function switch to "OFF/RESET" then to "AUTO."

2. Pump and Power Supply Overload Circuits: The D.C. power supply and the pump motors are protected in the event of electrical overload by individual starters. THE FAIL SAFE CIRCUITRY SETTINGS ARE FACTORY SET AND ARE NOT TO BE CHANGED. CHANGING MAY PRECLUDE SAFE OPERATION OF UNIT.

C. Typical Operating Parameters:

Some variances in operating parameters can occur depending on local water and electrical condition; however, typical operating parameters for the various models are tabulated below. IT IS WORTHWHILE TO REITERATE THAT ANY SIGNIFICANT VARIANCE IN ANY OF THESE FACTORS WILL HAVE SOME EFFECT ON THE FINAL CONCENTRATION DEVELOPED IN THE HOLDING TANK. Individual system components have built-in tolerances which can also result in slight operational variances. The equipment is designed to easily withstand the ten percent tolerance which can occur from this source. IT IS THE COMBINATION OF ELECTRICAL POWER, SALT AND SOLUTION TEMPERATURE WHICH DETERMINES THE HYPOCHLORITE PRODUCTION. As a result, several options are available which permits some leeway in setting the internal controls. For example: If a chronic voltage drop exists which lowers the cell voltage, a compromise can be effected by increasing the brine feed to the holding tank and increasing the temperature of the solution in the tank. This will result in an increase of conductivity (also a decrease in resistance) which will offset the voltage drop and increase the current thereby increasing chlorine production.

Note:

If the amount of salt increase is greatly in excess of the amount shown below, it may be advisable to install a voltage set-up transformer between the electrical source and the unit. Prior to doing this, try changing the taps on the main transformer as shown in the wiring diagram.

TYPICAL CONTROL SETTINGS

MODEL NO.	VOLTAGE AT CELL	MAKE-UP WATER	COOLING WATER APPROX.	BRINE FEED APPROX.	WATER PRESSURE	HOLDING TANK TEMP.	**HOLDING TANK SALINITY
49 R/A	6.0-6.5 vdc	36 gph	80 gph	100%	5-10 psi	75-95°F	12-15° sal.
65 R/A	6.0-6.5 vdc	48 gph Total	160 gph	100%	5-10 psi	75-95°F	12-15° sal.
100 R/A	6.0-6.5 vdc	72 gph Total	160 gph	100%	5-10 psi	75-95°F	12-15° sal.

** Salometer readings may vary from one to five percentage points (saturation) due to individual variances between salometers plus the added specific gravity of the hypochlorite.

VII. SYSTEM MAINTENANCE

A. Routine:

Routine maintenance is relatively simple and consists of the following:

1. Daily, or as experience indicates, check the brine tank salt level. Add pure evaporated granulated salt as needed.

2. Check the flowmeters (Rotameter), indicators and the DC Ammeter reading, Adjust water and brine feed control if required. If the DC Ammeter reading is not in the full output range, consult the trouble-shooting section of the manual.

B. Weekly:

1. Observe the condition within the cells, if an excess of white mineral scale is noted on the electrodes, check the flowrate to the holding tank. If a decrease is noted, the cells require immediate flushing. Another indication is the absence of solution at the top of the cells. If this is observed, excessive scale build-up or low flow is occurring. The procedure outlined on Page No. 18 should be followed to remove this scale deposit. If naturally soft or artifically softened water is used, this scale build-up will be very slow and flushing should only be required about once or twice a year. Under no circumstances should hard water be used in the system as very rapid and excessive scaling will occur, which could severely damage the electrodes within the cells

C. Monthly:

1. Check oil level in Brine Feed Pumps.

D. Every Three Months:

1. Check low voltage connection at cells. If any evidence of oxidation or corrosion is observed, clean thoroughly with a suitable wire brush. Be sure to observe the proper polarity when replacing the cables. Failure to do so will result in rapid destruction of the electrodes. If the special silicone bronze terminal bolts are lost, do not substitute wits any other except copper or brass. If any other type is used, excessive heating of the terminals could result.

PAGES 13 THROUGH 16 NOT APPLICABLE.

SEE ADDENDUM #1 FOR BRINE PUMP

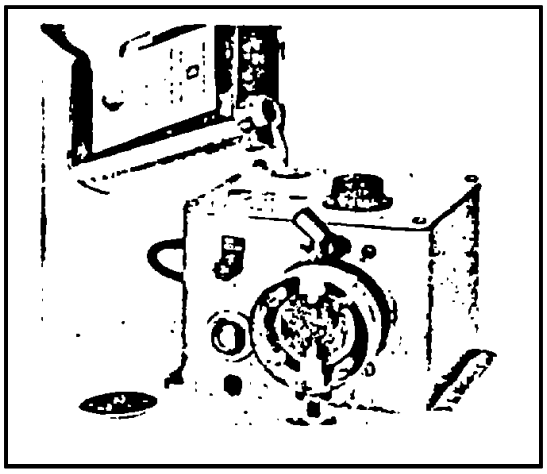
D. Brine Pump & Recirculating Pump Maintenance: (AMF)

Note: 'For Helwig Pump See attached Addendum #1)

BRINE PUMP:

1. Running Temperature:
   When running constantly, the unit will heat up to nearly 700F above room temperature. IT WILL BE VERY HOT TO TOUCH. This hot running temperature is normal.
2. Changing Lubricating Oil:

   The oil should be changed every six months or every 2000 operating hours.



   a. To lubricate the pump remove Lubrication the 224 oil cover plate located on top of the pump.
   b. The oil may be drained by removing the 1/4" NPT Drain Plug, Part No. 909 located at the front of pump.
   c. The pump requires one quart of lubricating oil, Precision Part No. 205. Substitutes are Shell Tellus 21 or Mobile Velocite No. 10.

3. Changing the Diaton (Diaphragm):

   a. Switch pump OFF. Release pressure in pumping line. Disconnect suction and discharge tubing from cartridge valve.

   b. Unscrew the four head screws and remove head and cartridge valve assembly.

3. Changing the Diaton (Continued)

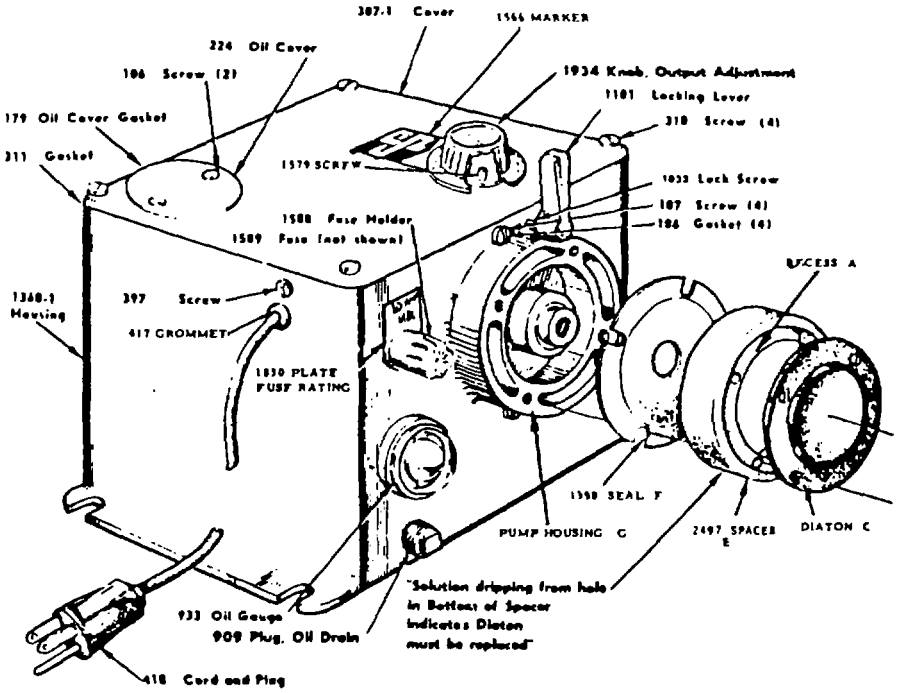
c. With the pump running, set output adjustment knob at 50 (i.e. 50%) and remove old Diaton by turning it counter clockwise.
d. With pump running be sure output adjustment knob is locked at 50% setting.
e. Install the spacer (E) with the drain hole facing down and with the 1388 seal (F) between the spacer and the boss of the pump housing. (G). Make certain that the slots of the 1388 seal (F) are aligned with holes in the spacer (E) and the tapped holes in the boss of the pump housing (G).
f. Turn on the pump and screw in the new Diaton (C) until the back side of the Diaton just touches the recess (A) of the spacer (E).,
g. Unscrew the Diaton counterclockwise 1/4 to 1/2 full turn until the four holes in the Diaton (C) are aligned with the four holes in the spacer OEP.
This place the Diaton in an optimum position for long life and best accuracy.
h. Re-install pump head and cartridge valve assembly, tightening the four head mounting screws in a criss-cross pattern.
i. Retighten these four head mounting screws after two days to take care of Diaton Set.

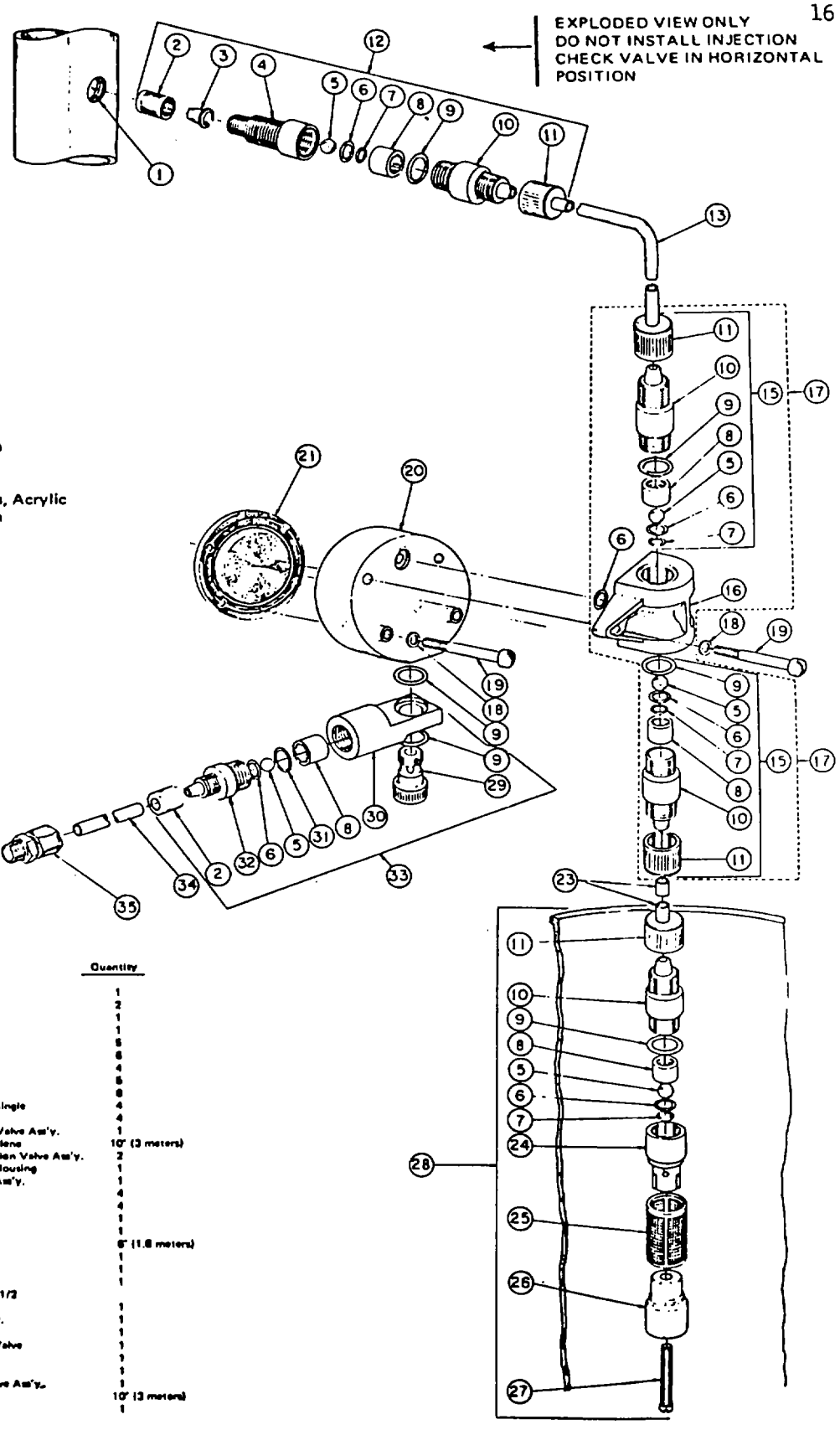
4. Pump Components:

a. External components can be identified from below.
b. To protect against electric shocks or excess current, the unit is equipped with a 1.0 ampere MDL Slo-blo fuse for 115 VAC and 0.5 ampere MDL Slo-blo fuse for 230 VAC. Only a 1.0 ampere (115 VAC) or 0.5 (230 VAC) type MDL: 1.0 ampere (115 VAC) or 0.5 ampere (230 VAC) type 3 AG Slo-blo fuse should be used.
c. If a fuse continually blows: (1) Pump is stalled because of plugged discharge line.

(2) Discharge pressure is too high.
(3) Voltage supply is too high.
(4) Excessive line transients are present.

e. Internal Drive Mechanism
It is recommended that repairing of the drive mechanism be done by authorized factory service station only.





Code 73
Liquid Handling Connections

Material:

Fittings	PVC
Valve Seat O-Rings	Hypalon
Seal Rings	Viton
Balls	Ceramic
Head	Plexiglas, Acrylic
Diaton	Hypalon

For Spare Parts Use Kit No. 500-73

Key No.	Part No.	Description	Quantity
1		¾" Pipe Thread	1
2	2398	Coupling Nut	2
3	3329 *	Flapper	1
4	535.844.P	Injector Fitting	1
5	1058*	Valve Ball	5
6	1061*	O-Ring	6
7	1060*	O-Ring	4
8	3177.P	O-Ring Seat	5
9	3368*	O-Ring	8
10	832 882.P	Housing, Valve, Single	4
11	211.P	Coupling Nut	4
12	290.250.P	Injection Check Valve Ass'y.	1
13	242	Tubing, Polyethylene	10' (3 meters)
15	292 711.P	Discharge & Suction Valve Ass'y.	2
16	3312.P	Cartridge Valve Housing	1
17	300 467.P	Cartridge Valve Ass'y.	1
18	118	Washer	4
19	1836	Screw	4
20	882 762	Head	1
21	2A	Diaton	1
23	241	Tubing, Vinyl	6' (1.8 meters)
24	2471-2P	Valve Seat	1
25	2472	Screen, Filter	1
26	2473	Retainer, Screen	1
27	2474*	Screw 12-24 x 1-1/2 Polypropylene	1
28	287 729-P	Foot Valve Ass'y.	1
29	838 118	Flush Plug	1
30	837 987	Housing, Flush Valve	1
31	1364*	O-Ring	1
32	2368	Valve Seat	1
33	300 629	Flush Check Valve Ass'y.	1
34	2630	Tubing	10' (3 meters)
35	3086	Connector	1

*Parts included in Spare Parts Kit 500-73

RECIRCULATING PUMP

1. Pump Disassembly:

   To disassemble the pump simply remove the six Housing Screws. The entire assembly up to the Motor and Drive Magnet Assembly will now slide apart. The Impeller-Magnet Assembly will slide off the Spindle. The Spindle is a light press fit into the Pump Housing and can be pulled out by hand. Clean all parts as necessary and replace any worn or damaged parts before re-assembling.

2. Electrical Connections and Dry Running:

   The only moving parts inside the pump volute is the Impeller-Magnet Assembly and the Carbon Bushing which rotates on the Porcelain Spindle. If the pump is run with no liquid inside the pump volute, there is danger of damaging the Carbon Bushing. The electrical wiring diagram is located inside the cover of the motor conduit box. The Impeller must rotate in a clock-wise direction when viewed through the inlet of the pump. The totally enclosed motor is 3/4 H.P., 115/208 or 230/460 volts, 60 cycle, three phase, rated for continuous duty, capacitor start, No. 56 "C" Nema Frame with rigid base. Standard Nema motor mounting on 11/32 wide slots on 3 inch centerlines. Pump inlet is 1-1/2" F.P.T. and outlet is 1" M.P.T.

E. Yearly:

1. Once a year drain and clean out the brine and holding tanks. A certain amount of sludge will be observed in the bottom, which is quite normal. This sludge results from slight impurities in the salt, combined with chemical reactions which occur when Hypochlorite is generated from local water supplies which contain minerals in solution.

End of Season Service: When the equipment is being used in a highly seasonal industry (such as Seafood and Canning Plants), it must be completely drained and flushed with clean water. The water should then be drained from the cells, pumps and associated fittings by removing the plugs in the pipe below the water inlet connections. Failure to do so may result in damage to the plastic components due to freezing or severe abrasion of the circulating pump impeller due to salt precipitation.

F. Scale Flushing Procedure:

To remove mineral scale deposits, proceed as follows:

1. Add approximately 20 gallons of water to the acid tank. Carefully add 5 gallons of muriatic acid to the water. CAUTION: Always addacid to water not the reverse.
2. Function Switch in "OFF" position.
3. Close V-4 Recirculating Pump Valve 50% to reduce the flowthrough the system.
4. Close V-2 & V-6.
5. Brine pump: Remove fuse, or turn off brine pump switch, 6. Close Flowmeter Valves.
7. Open V-3 to WATER and V-5 to drain. Arrow designates direction of flow.

F. Scale Flushing Procedure (Continued):

8. Turn Function Switch to "FLUSH". This will allow fresh water to flush out the residual Hypochlorite and will act as a buffer between the acid and chlorine. Circulate the water until all the chlorine has been purged from the cells and heat exchanger (5 min.) and turn Function Switch "OFF." 9. Open V-5 to drain, V-8 to vent and V-9 to drain to allow system to drain.

10. Close V-5 to OFF, V-8 and V-9 to OFF.

11. Open V-3 and V-5 to acid.

12. Open acid tank valve.

13. Function Switch to "FLUSH" position. Circulate acid until all visible signs of the scale is removed from cell electrodes.

14. Function Switch "OFF." 15. Close acid tank valve.

16. Open V-3 to water and V-5 to drain.

17. Turn Function Switch to "FLUSH" approximately 5 minutes, until all traces of acid are removed.

18. Turn Function Switch "OFF."

19. Close V-3 and V-5 to "OFF."

20. Open V-2, V-4, and V-6, replace fuse in brine pump or turn on Brine Pump Switch. Turn "Function Switch" to AUTOMATIC and reset flowmeters as previously set.

The system is now ready for normal operation.

G. Flowmeter (Rotameter) Maintenance:

Occasionally the flowmeter will become partially clogged with mineral or rust deposits from the incoming water supply. When this occurs, the obstruction can be removed and the flowmeter cleaned by following the instructions below:

1. Turn the black valve knob counter-clockwise until the threads are disengaged. Then withdraw the stem from the valve by gently pulling on the knob.
2. Remove the two large mounting bracket screws which secure the flowmeter to the system.
3. Unscrew the four recessed screws located on the side of the flowmeter, then gently pull the body from the rear plate. Keep the body parallel with the back plate to prevent undue strain on the body.
4. Remove the slip cap with a push on a screwdriver as shown in Fig. No. 7 then remove the plug ball stop as shown in Fig. No. 8 using a 1/2" allen wrench.
5. Remove the ball float by inverting the body and allowing the ball to fall into your hand as shown in Fig. 9. (Cover the discharge port to avoid losing the float through that opening.)

G. Flowmeter (Rotameter) Maintenance (Continued):

6. Clean the flow tube and flowmeter body with ordinary soap and water. Do not use liquid soaps or detergents which may contain chlorinated solvents.
7. Reassemble the unit by reversing the procedure outlined then place the flowmeter in service.

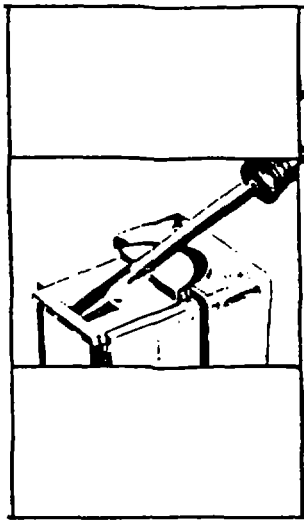


Figure 7

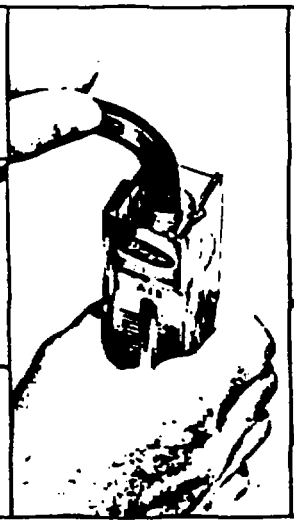


Figure 8

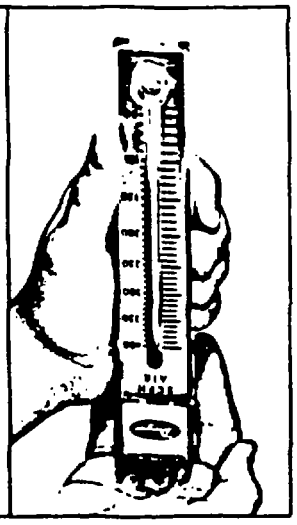


Figure 9

VIII. SYSTEM TROUBLE SHOOTING

A. The Trouble-Shooting Chart and associated electrical and plumbing schematics will enable plant engineers to diagnose and trouble-shoot most system malfunctions. Several additional factors may also help.

1. If the main water supply to the unit must be temporarily disconnected, make sure to TURN OFF the Main Disconnect Switch to the unit.

2. If the salt or water feed rate has been radically changed, then contents of the holding tank must also be adjusted, i.e., if the water rate has been set too low or the salt feed set too high, then the contents of the tank must be diluted. The opposite is true if the reverse has occurred.

3. If less than 230/460 VAC 3 Phase 50/60 HZ is supplied to the unit, the voltage to the cells will be low by approximately 0.5 volt D.C. As the optimum operating voltage is 6.0 to 6.5 volts D.C. a decrease in cell current will be evidenced by a drop in the D. C. Ammeter. If the system is generating sufficient Hypochlorite in this condition no adjustment is required. If the unit is required to operate at maximum capacity, however, change the taps on the transformers as shown in BI-652-D Wiring Diagram, or increase the salt feed.

4. The Cell D.C. Voltage consists of full wave rectified D.C. If it is necessary to check the cell voltage, use a D.C. Voltmeter with a 1 to 10 or 1 to 15 volt D.C. scale.

RECYCLING/ACCUMULATING SYSTEM
TROUBLE-SHOOTING CHART

SYMPTOM	POSSIBLE CAUSES																							
	HOLDING TANK LID NOT ON TOP OF TANK	V-7 INCORRECT POSITION	SCALE OR DIRT IN FLOWMETERS	AIR IN WATER SUPPLY	BRINE INJECTION VALVES STUCK	OPEN POWER DIODES	SHORTED POWER DIODES	FLOW METER SETTING INCORRECT	BRINE PUMP SETTING TOO HIGH	CIRCULATION PUMP MALFUNCTION	STICK SOLENOID VALVE	3 WAY VALVE V-3 UNIONS LOOSE	INCOMING WATER TOO HARD	COOLING WATER MISADJUSTED	STUD TERMINAL CONNECTORS LOOSE	INSUFFICIENT BRINE MAKE-UP	WITHDRAWAL RATE TOO HIGH	FAULTY FLOAT SWITCH OR RELAY	BRINE PUMP VALVE STUCK
CHLORINE METERS READ LOW		X				X	X								X	X			X
RAPID SCALING OF CELLS													X						
MAIN CIRCUIT BREAKERS TRIP REPEATEDLY								X	X	X				X					
MAKE-UP WATER DOES NOT SHUT OFF OR COME ON											X								
UNIT WILL NOT SWITCH ON OR SHUT OFF	X																	X	
WATER LEAKING INTO CHLORINE LINES												X							
CHLORINE IN WATER LINES												X							
WATER FILLS UP ACID BOTTLES												X							
CHLORINE IN BRINE TANK					X														
FLOWMETER BALL FLUCTUATES ERRATICALLY			X	X															
HOLDING TANK CONSTANTLY LOW											X						X		

Figure 6
FIG. #6

ADDENDUM #3

RECYCLE TANK SPECIAL NOTES:

1. Chlorine tank inlet fittings should remain at an angle of 450 as set by the factory to maximize solution mixing.
2. Water inlet ell should be left at the vertical angle to eliminate the possibility of the tank siphoning when the solution is at its maximum level.

SCIENCO INC.
3240 N. Broadway St. Louis, Missouri 63147 (314) 621-2536
Telex No. 44-2449 SCIENCO STL

ADDENDUM #4
SCIENCO R/A ON-SITE SODIUM HYPOCHLORITE GENERATOR

WITH

VOLTAGE MONITOR

This equipment has an integral Voltage Monitor to control the operation of the brine pump.

The Scienco Recycle Accumulating On-Site Sodium Hypochlorite Generators have an integral Voltage Monitor built into the electronic controls to provide ON-OFF switching of the brine pump. This special monitor will either be contained in a blue box or will be part of the printed circuit board and located within the electrical control cabinet.

This Voltage Monitor senses a voltage increase or decrease across the percent output ineter electrical shunt as the conductivity in the recycle tank changes as the salt content is converted to sodium hypochlorite or the conductivity is raised due to salt injection to the tank via the brine pump. When the conductivity is below the design parameters the Voltage Monitor switches the brine pump "ON", injecting concentrated salt brine into the recycle tank until the conductivity is increased to the proper level at which time the pump is switched off.

The Voltage Monitor is preset at the factory and under normal circumstances should not be touched. During the initial start-up, salt and water are added to the holding tank manually and only enough salt should be added to bring the percent output meter up to the 85% mark with the brine pump in the "ON" position. If the meter is reading below 100% output, the

WARRANTY

SCIENCO INC. Warrants each new product, (exclusive of the Electrolytic Cell), manufactured by it to be free from defects in material, workmanship, and parts, under normal use and service, such obligations under this Warranty being limited to making good at the SCIENCO Factory, any parts which shall, within 12 MONTHS after shipping date to the original purchaser, be returned to SCIENCO INC. with transportation charges prepaid and which SCIENCO INC.'s examination shall disclose to its satisfaction to have been defective. All other material and parts, (exclusive of the Electrolytic Cell), are warranted for 90 days after installation by the original owner, if examination by SCIENCO INC. discloses that failure was caused by a defect in workmanship or material under normal use and service.

Seller's Liability hereunder insofar as the Electrolytic Cells in the SCIENCO Biocidal System are concerned, shall be limited to the repair, or replacement, for a pro-rated charge based upon the then-current selling price of such Electrolytic Cells and the expired portion of the original Three-Year Cell Warranty period, provided, however, that in the case of replacement purchases, shall, at SCIENCO INC.'s request, return such Electrolytic Cells F.O.B. SCIENCO INC.'s Plant.

PRO RATED CHARGE:
Current Selling Price X $\frac{\text{Expired Warranty Period in Months}}{\text{Total Warranty Period in Months}}$

THIS WARRANTY BEING EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMIPLIED, AND OF ALL OTHER OBLIGATIONS AND LIABILITIES ON THE PART OF SCIENCO INC. AND SCIENCO INC. NEITHER ASSUMES OR AUTHORIZES ANY PERSON TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF ITS PRODUCTS.

"WHAT THIS WARRANTY DOES NOT INCLUDE"

This Warranty does not include any Field Labor charges for replacement of parts, adjustments, repairs or any other work done on SCIENCO INC.'s products. This Warranty does not apply _o any product which shall have been modified or altered in any way outside of SCIENCO INC.'s Factory or authorized service agency in any way so as, in SCIENCO INC.'s judgment, to affect its stability, nor which has been subject to misues, negligence, accident, improper installation, improper operation, nor the free replacement of parts inoperative because of wear occasioned by use.

NOTES:
No merchandise will be accepted for Warranty Service or return to the Factory without prior written authorization from the Company.

CHANGES:

The Company reserves the right to modify or change the equipment in whole or part, at any time prior to delivery thereof, in order to include therein, electric or mechanical refinements deemed appropriate by the company; but without incurring any liability to modify or change any equipment previously delivered, or supply new equipment in accordance with earlier specifications.

OPERATION & MAINTENANCE
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OPERATION & MAINTENANCE

MANUAL

SCIENCO INC.

Milton Roy
Metering pumps

Instruction Manual

mRoy® A & B
Electric Capacity Controls

15.11

Supersedes 102-9792-999A

CONTENTS

LIST OF ILLUSTRATIONS

MILTON ROY WARRANTY

The Milton Roy Company warrants its products against defects in workmanship or materials for one year under normal use from the date of shipment. An exception to this one year warranty is that Milroyal A, B, and C pump drive mechanisms are warranted for two years from date of shipment. All other pump components are warranted for one year, except that warranties on equipment and accessories furnished with the pump but manufactured by others are limited to the warranties offered by the manufacturers for their respective products.

All obligations and liabilities under this warranty are limited to repairing or replacing (at our option), f.o.b. our plant, such allegedly defective units as are returned to our plant, carrier charges prepaid. Repairs or replacements are made subject to factory inspection of returned items.

This warranty does not extend to damage by corrosion or erosion. The materials of construction offered are recommendations subject in all cases to verification and acceptance by the customer. These recommendations, based on previous Company experience and best available information, do not constitute guarantees against wear or chemical action.

Expressly excluded from this warranty are defects caused by misuse, abuse, or improper application, employment, or operation of the unit. Expendable items and damage resulting from unauthorized repair are not covered by this warranty. No liability for consequential damages or reinstallation labor is accepted. Milton Roy Company will not assume responsibility for contingent liability for alleged failure of its products.

This warranty is in lieu of all other warranties expressed or implied.

SECTION 1

INTRODUCTION

Electric capacity controls for mRoy metering pumps consist of a family of controls to adjust the flow rate of the pumps in accordance with manual or electronic input signals.

This control is achieved by use of two distinct, separate devices: the actuator and the controller. The actuator mounts on the pump body and contains a reversible motor to drive the pump capacity adjustment. The controller, which can be mounted remotely, contains electronic circuitry to accept an input signal and commands the actuator to drive to a corresponding position.

Two actuators are described in this manual, one for the mRoy A and one for the larger mRoy B. Five types of controllers are described, any one of which will control either actuator.

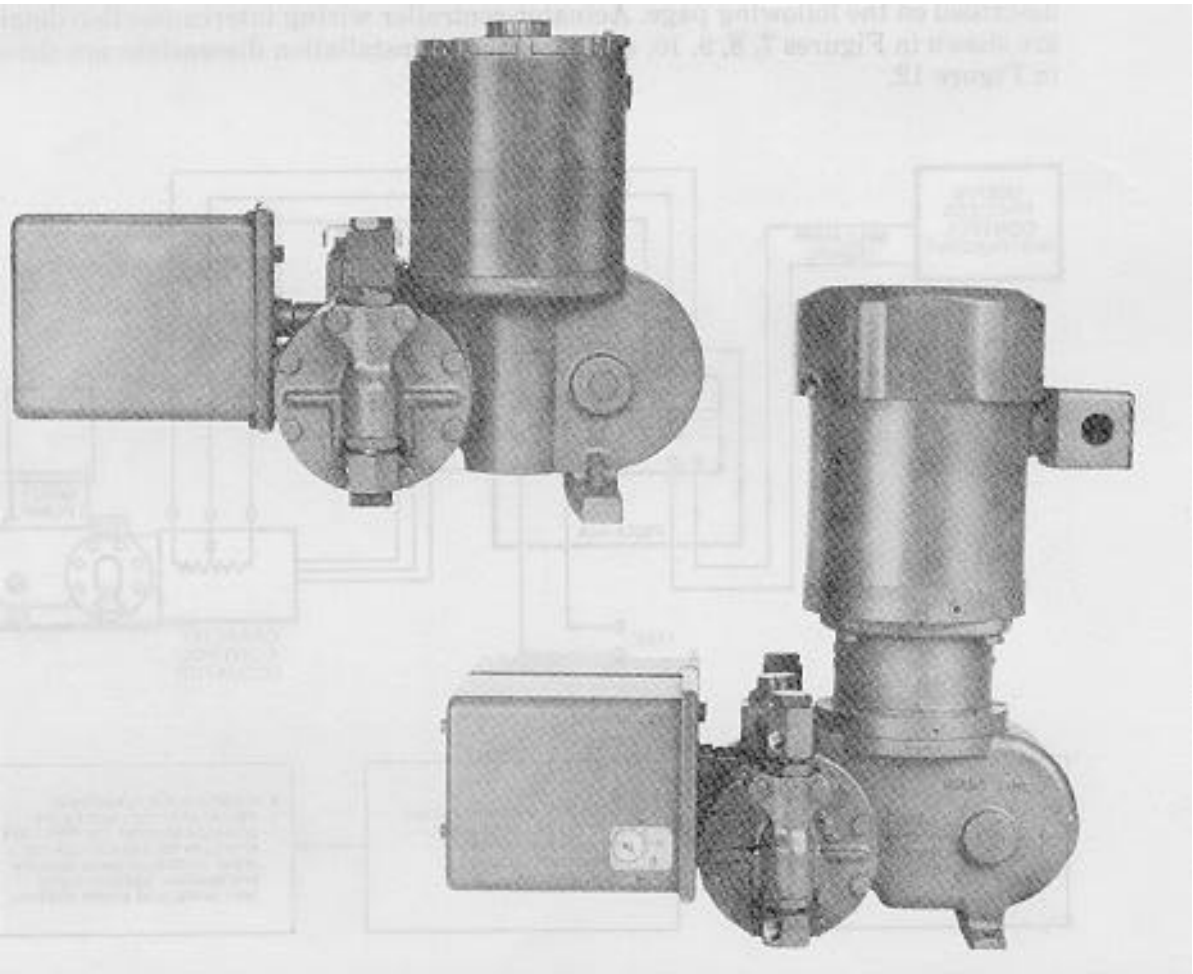


Figure 1. mRoy A Simplex and Duplex Pumps with Electric Capacity Control Actuator Assemblies

SECTION 2

DESCRIPTION

ACTUATOR

The electric capacity control actuator is an accessory that is available on simplex and duplex mRoy A and B pumps. For both models, the actuator mounts directly to the pump drive housing in place of the conventional micrometer capacity adjusting knob. Figure 1 shows actuator assemblies mounted on the pumps. The actuator is attached to (and positions) the pump capacity control spool. Although both assemblies are the same size, spool coupling hardware and the pulley ratio for positioning the feedback potentiometer differ (see Figures 3 and 4). Details are noted in Figure 6.

The actuator adjusts and maintains pump delivery by responding to a forward, off, or reverse signal received from a controlling instrument. The components are connected as shown in the functional block diagram (Figure 2). Milton Roy offers five standard controllers with a variety of manual and automatic control options, as described on the following page. Actuator-controller wiring interconnection details are shown in Figures 7, 8, 9, 10. and 11; actuator installation dimensions are shown in Figure 12.

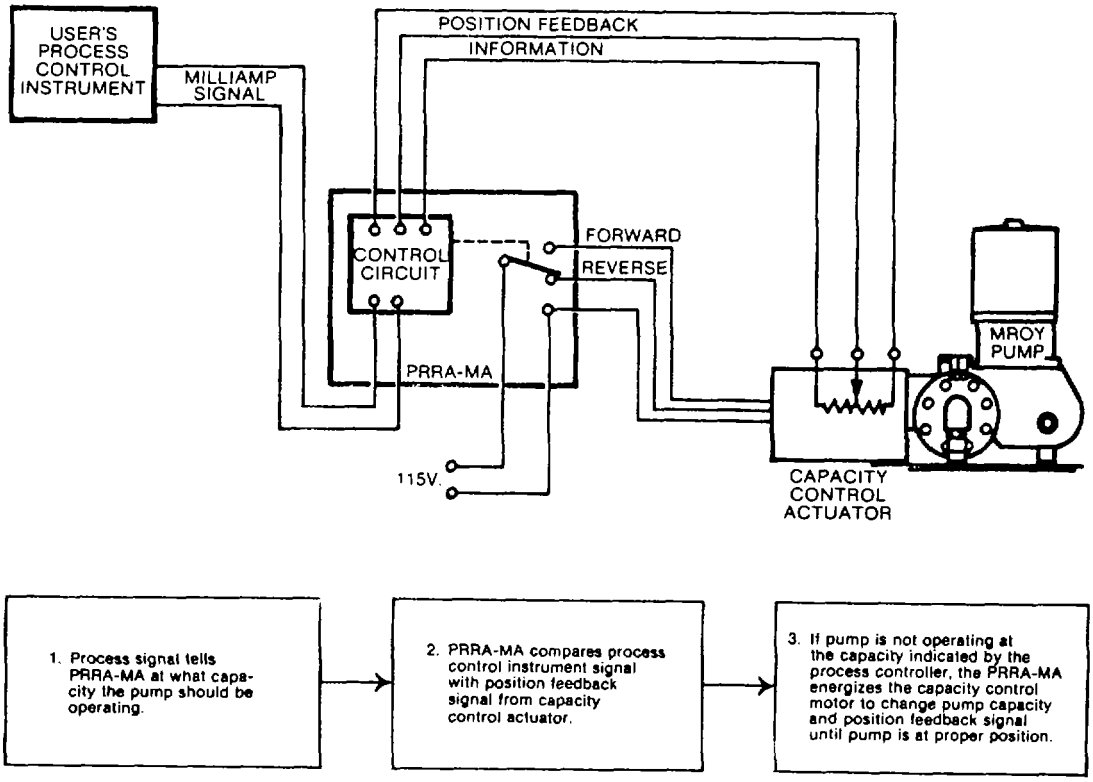


Figure 2. Operating Principle Block Diagram

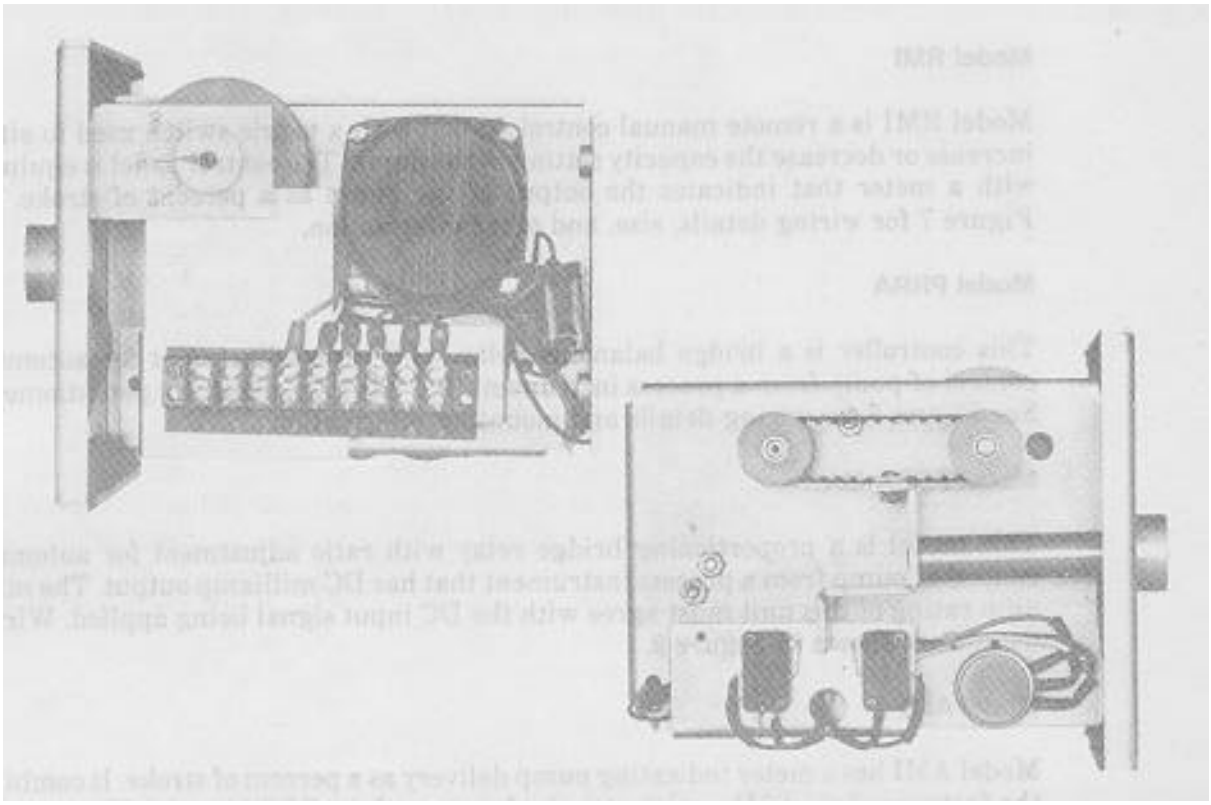


Figure 3. mRoy A Unit (Interior Views)

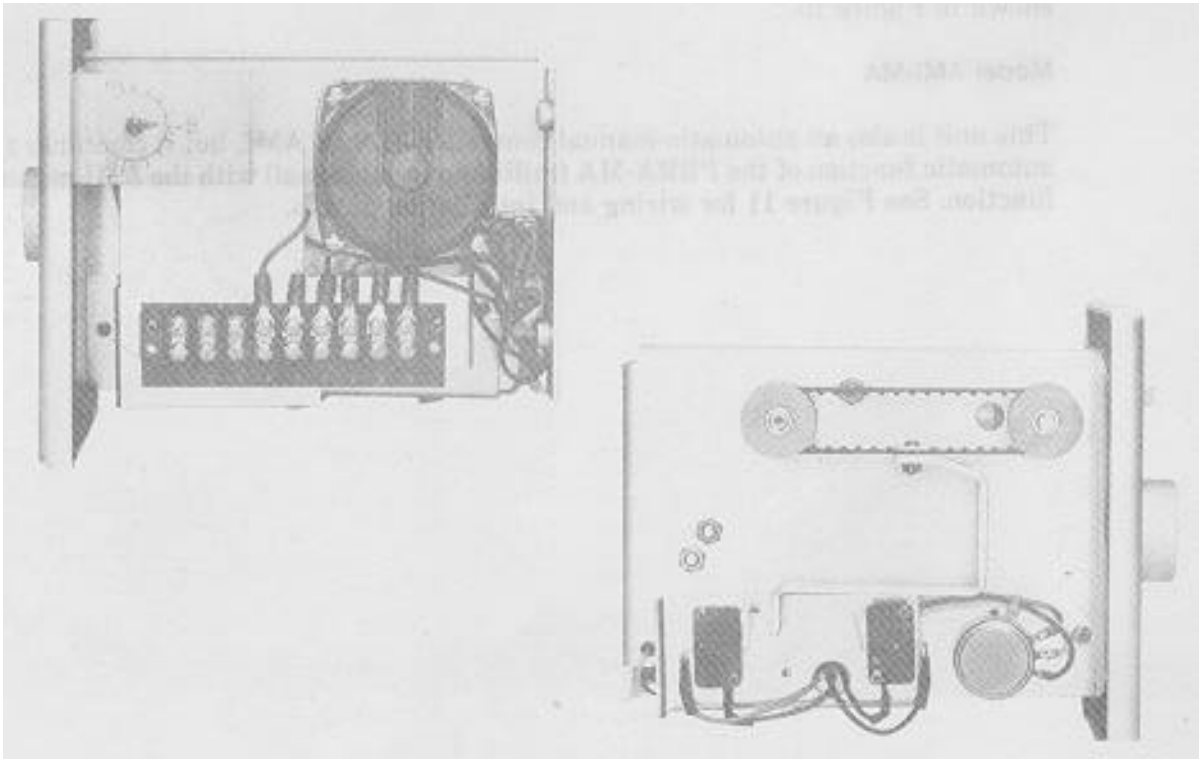


Figure 4. mRoy B Unit (Interior Views)

CONTROLLERS

Model RMI

Model RMI is a remote manual-control station with a toggle switch used to either increase or decrease the capacity setting of the pump. The control panel is equipped with a meter that indicates the output of the pump as a percent of stroke. See Figure 7 for wiring details, size, and other information.

Model PRRA

This controller is a bridge balancing relay with ratio adjustment for automatic control of pump from a process instrument that has a transmitting potentiometer. See Figure 8 for wiring details and mounting information.

Model PRRA-MA

This model is a proportioning bridge relay with ratio adjustment for automatic control of pump from a process instrument that has DC milliamp output. The milliamp rating of this unit must agree with the DC input signal being applied. Wiring details are shown in Figure 9.

Model AMI

Model A MI has a meter indicating pump delivery as a percent of stroke. It combines the features of the RMI model with the features of the PRRA model. The manual-off-auto switch allows either manual or automatic operation. The wiring diagram is shown in Figure 10.

Model AMI-MA

This unit is also an automatic-manual controller like the AMI, but it combines the automatic function of the PRRA-MA (milliamp input signal) with the RMI manual function. See Figure 11 for wiring and installation details.

SECTION 3

OPERATION

ACTUATOR UNIT

The electric capacity control actuator unit operates on 115v., 60-Hz, single-phase electrical service. Power is supplied to the actuator through an interconnecting control cable (not furnished). The actuator is driven by a gearmotor at 0.8 rpm. A system of toothed pulleys and belts converts rotary motion into linear motion that actuates the pump capacity control spool. Complete travel from zero to 100 percent capacity is accomplished in less than one minute.

Normally, the actuator is direct acting (pump capacity increases with increasing input signal to controller). To convert the actuator to reverse acting (pump capacity decreases with increasing input signal to controller), reverse interconnecting leads to the actuator terminal strip only (leads 8 & 9, 4 & 6, and, if applicable, 1 & 3).

A 250-ohm potentiometer (pot) driven by the pulley system provides the resistance signal to feed back the actuator position to any one of the control units. Limit switches, which prevent overtravel of the actuator beyond 100 or 0 percent capacity adjustments, are located at fixed distances and actuated by an extension of the rigid mechanical link between the pulley system and the pump control spool.

The location of the limit s-witch mounting plate is set with respect to the actuator mechanism. This correlates the calibration-settings between the limit switches and the pump capacity control mechanism positions. These adjustments have been properly set at the factory and will require no attention in normal service.

CONTROLLERS

Model RMI Controller (Figure 7)is provided with a single-pole, double-throw switch that, when operated manually, energizes the actuator motor in either the forward or reverse direction. This adjusts the capacity setting, which is indicated as a percentage of stroke on the meter on the face of the control box. A 250-ohm potentiometer furnished with the actuator provides the resistance signal feedback that controls the indicating meter on the control station. The meter, calibrated by factory adjustment, is connected to a trim pot that is accessible for field recalibration if necessary.

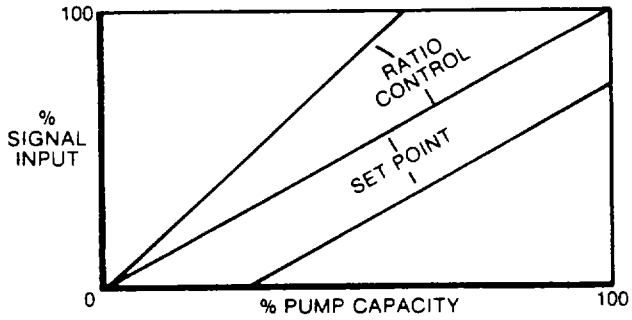
Model PRRA Controller (Figure 8) is a bridge balancing relay utilizing a fully transistorized amplifier. Maximum power consumption is 3.5 watts. This unit can be controlled by a process controller having a transmitting potentiometer with a value between 135 and 1000 ohms. The sensitivity adjustment controls dead band of the instrument. Factory adjustment will be made for nominal sensitivity.

Model PRRA-MA Controller (Figure 9) is a solid-state, electronic-proportioning relay. Power consumption is approximately 6.5 watts. This unit can be controlled from an electronic instrument with 1-5, 4-20, or 10-50 ma DC output ranges. Since the milliamp rating must agree with the DC input signal being applied, the rating on the control should be checked before wiring the circuit. The various ranges are attained by using different values of resistors R1 and R2.

This controller is normally used in closed loop process control applications where an error signal is provided by a set point type process control instrument. Potentiometer adjustments are provided for zero adjust (set point), ratio control (proportional band), and dead band. All three adjustments are located behind the control box cover (see Figure 5).

Model AMI and AMI-MA Control Units (Figures 10 and 11) are combination automatic-manual controllers; both have the RMI circuitry for remote manual control and percent capacity meter indication. The model AMI incorporates the PRRA automatic control circuitry (slide wire input), and the model AMI-MA has the PRRA-MA circuitry (DC milliamp input). These units use a toggle switch for selection of automatic or manual mode. The actuator unit furnished with these controllers has a dual potentiometer arrangement. One potentiometer provides the position feedback signal to the controller, and the potentiometer is used for the percent capacity meter on the panel.

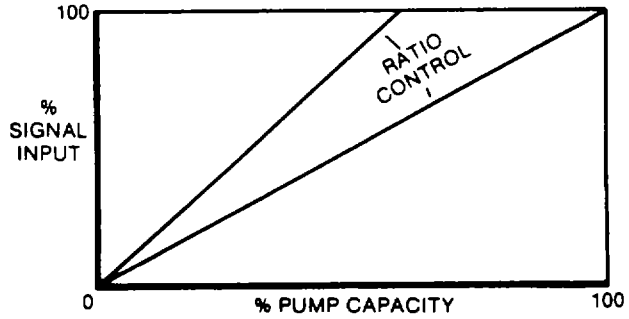
PRRA-MA AND AMI-MA



Adjusting ratio control changes slope of line about the zero point.

Adjusting set point causes parallel displacement of line.

PRRA AND AMI



Adjusting ratio control changes slope of line about the zero point.

Figure 5. Signal Input vs. Pump Capacity

SECTION 4

MAINTENANCE

GENERAL

The electric capacity control actuator is a relatively simple mechanism with few moving parts; it therefore should provide reliable operation for long periods with a minimum of maintenance. The signal-conditioning controllers incorporate complicated solid-state circuitry and should not be serviced in the field. Factory service is recommended for any inoperative controller.

Refer to Figure 6 to identify component locations and part numbers noted in the following paragraphs.

RECOMMENDED SPARE PARTS

Unscheduled parts replacement in the actuator unit due to failure or malfunction is unusual. When the pump is installed in a process where maintenance downtime must be kept to a minimum, however, the following spare parts should be on hand:

PART NO.	QUANTITY	DESCRIPTION
40-49983-154	3	E-Ring (B Unit)
45-60030-008	1	Limit Switch
45-60431-010		250-Ohm Single Potentiometer or
45-60431-027	1	1K Single Potentiometer
45-60431-026		250-Ohm Dual Potentiometer or
45-60431-028		1K Dual Potentiometer
410-0156-000	1	Toothed Drive Belt, A Unit or
410-0156-010		Toothed Drive Belt, B Unit

PERIODIC CHECKS

Inspection of the actuator is recommended at three-month intervals. Remove the screws in the rear of the housing cover (281-A) and slide the cover forward and off.

Visually inspect the mechanism for signs of wear, parts misalignment, loose-fitting components, or other problems. Maintain as necessary.

ACTUATOR REMOVAL

NOTE

Most service can be performed without removal of actuator from pump as long as the unit is accessible. Refer to the Service Procedures section before removing the actuator.

Removal of actuator from pump (see Figure 6):

1. Remove the two screws (405-C) and the actuator housing cover (281-A).

2. The pump end of the actuator coupling device should be accessible. If not, energize the actuator toward zero percent capacity until the E-ring (404) on B-frame units or setscrew (256) on A-frame units is accessible. Pry the E-ring from the control spool (268-B) groove or back out the setscrew as required to permit removal of the pump control spool from the actuator coupling.

3. Remove the actuator mounting nut located on the lower front plate of the actuator. The actuator can now be removed from the pump. Save the special sealing washer (408-A); do not remove the upper sealing washer and bolt (this is a hole seal only).

CAUTION

Do not move the control spool during disassembly or assembly, as additional motion past zero percent can damage the internal-pump seals.

ACTUATOR INSTALLATION

To reassemble actuator onto pump, follow the previously outlined steps in reverse order. Make sure drive belt and potentiometer are both at zero position during reinstallation (see Potentiometer Replacement for details).

SECTION 5

SERVICE PROCEDURES

Complete actuator disassembly is not required when performing the following service procedures.

POTENTIOMETER REPLACEMENT

1. Run actuator to zero percent.
2. Remove actuator from pump only if necessary for access (see Actuator Removal).
3. Loosen potentiometer pulley setscrews.
4. Loosen potentiometer nut.
5. Slide out potentiometer.
6. Unsolder wiring from potentiometer, noting orientation (refer to Figure 13). Solder new wires to new potentiometer in correct orientation using a rosin core solder and minimum heat.
7. Install new potentiometer in reverse sequence. At zero percent, resistance across terminals 4 and 5 should be less than 10 ohms for a 250-ohm pot; less than 40 ohms for a 1000-ohm pot. When dual potentiometers are used, the same resistance should be set across terminals 1 and 2. To set resistance, loosen indicator pulley (410-D) setscrews and manually turn the potentiometer.
8. Tighten indicator pulley setscrews. Run the actuator toward 100 percent. Resistance should be 235 ohms or more for a 250-ohm pot; 940 ohms or more for a 1000-ohm pot.

DRIVE BELT/PULLEY/MOTOR REPLACEMENT

1. Run actuator to zero percent.
2. Remove actuator from pump only if necessary for access (see Actuator Removal).
3. Remove belt clamp (280-A).
4. Loosen pulley setscrews and remove pulleys as necessary. Replace pulleys in the same orientation to facilitate tightening of setscrews.
5. If motor is being replaced, remove two motor mounting nuts, lockwashers, and motor. Mark and unclip capacitor leads and cut motor wires.
6. Install new part, and follow previously outlined steps in reverse order.

LIMIT SWITCH REPLACEMENT

1. Run actuator to zero percent.

2. Remove actuator from pump only if necessary for access (see Actuator Removal).

3. Mark the position of limit switch plate (284-A) on the frame of the unit; Reassembly in the same position is critical. Remove limit switch plate.

4. Loosen two screws (405-A) to detach each limit switch and lift off plate. Replace one switch at a time to ensure proper wiring. Unsolder wires, noting proper location for subsequent assembly (see Figure 13). Resolder with rosin solder and minimum heat. Do not allow solder or flux to flow into switch.

5. Install new limit switch and replace plate assembly in original position. Replace actuator and run from zero to 100 percent to verify proper limit switch operation.

INDICATOR ADJUSTMENT

1. Run actuator to 100 percent position; remove actuator cover (281-A).

2. Loosen disc screw and rotate pointer to 100 percent.

3. Tighten disc screw.

TRANSFER SHAFT/BUSHING REPLACEMENT

1. Run actuator to zero percent.

2. Remove actuator from pump only if necessary for access (see Actuator Removal).

3. Remove drive belt (410-C) and transfer pulley (410-D) after loosening both transfer pulley setscrews.

4. Loosen indicator pulley (410-A) setscrews. Tap out transfer shaft (268-A).

5. To remove bushings, pry out the retaining rings and push out the bearings.

6. Reassemble in reverse order. Set potentiometer resistance at less than 10 ohms before tightening indicator pulley setscrews. Before replacing actuator, check resistance across terminals 4 and 5. Resistance should be less than 10 ohms for a 250-ohm pot; less than 40 ohms for a 1000-ohm pot. When dual potentiometers are used, the same resistance should be set across terminals 1 and 2. To set resistance, loosen indicator pulley setscrews (410-D) and manually turn the potentiometer shaft. Tighten indicator pulley setscrews.

ACTUATOR DISASSEMBLY

NOTE

Complete actuator disassembly is seldom required. Refer to the Troubleshooting Chart and Service Procedures first.

Disassemble actuator as follows (see Figure 6):

1. Disconnect electrical power to controller.
2. Remove actuator from pump as previously explained.
3. Factory calibration has established relative position of limit switch plate (284-A) and potentiometer shaft (406-A).

CAUTION

Be sure to make legible alignment marks for the limit switch plate to permit reassembly in the same relative position. Limit switches should be removed without disturbing plate positions if possible.

4. Loosen all pulley setscrewsto facilitate access.
5. Pull motor pulley (410-A), remove motor mounting nuts, remove motor (411-A), remove transfer pulley (410-A), pull transfer shaft (268-A), remove potentiometer pulley (410-A), and remove potentiometer (406-A) by loosening the 1/2" panel nut.
6. Mark and remove capacitor leads and the sheet metal bracket (204-A) that isolates the terminal block (456-B & C) from the mainframe.
7. Transfer shaft bushings are removed by prying off the retaining rings and pushing out the bearings. This procedure is not normally required.

ACTUATOR REASSEMBLY

Follow the disassembly procedure in reverse order to reassemble the actuator mechanism. Use the alignment marks to ensure correct positioning of the limit switch mounting plates and potentiometer shaft.

Before tightening pulley setscrews, attach the mechanical coupling to the control spool and move the control spool out until the zero percent limit switch actuates. Tighten all pulley setscrews except the indicator pulley setscrews. Set potentiometer resistance across terminals 4 and 5 to less than 10 ohms by manually turning the potentiometer shaft, then lock the indicator pulley setscrew.

Re-adjust the indicator (298-A & 253-B) by loosening the locking screw (405-E) and rotating the pointer in the proper direction.

TROUBLESHOOTING CHART

SYMPTOM	CAUSE AND REMEDY
Actuator does not respond to signal. Motor feels warm but drive pulley does not rotate. Coupling nut is not at end of travel.	Blown fuse in line. Check for short circuit or overload. Faulty capacitor. Replace capacitor. Setscrew on motor shaft is loose. Be sure setscrew is centered on shaft flat side and tightened. Drive motor is stalled. Realign binding drive parts-make sure there is freedom of movement and pump control shaft moves freely in both directions. Faulty limit switch. Replace switch (see Limit Switch Replacement). Open circuit. Repair or replace faulty connections, broken wires, etc. Broken drive belt. Replace drive belt (see Drive Belt/Pulley/Motor Replacement).
Actuator does not respond to signal. Motor case feels cold but coupling nut is not at either end of travel.	Blown fuse in line. Check for short circuit or overload. Faulty or improperly positioned limit switch. Readjust or replace limit switch (see Limit Switch Replacement). Open circuit. Repair or replace faulty connections, broken wires, etc. Controller not functioning. If controller is inoperative, send for factory repairman.
Actuator goes to end of travel and stops-no further response.	Signal controller not properly calibrated to pump. Adjust controller to match range of actuator. Improper signal to controller. Check input signal to controller and compare with controller data sheet specifications. Faulty limit switch. Replace switch (see Limit Switch Replacement).

SECTION 6

FIELD INSTALLATION

Conversion of an existing mRoy A or B pump from micrometer knob capacity adjustment to electric capacity control requires removal of certain parts from the pump and actuator as well as calibration adjustments. No machining is necessary.

1. Remove the end plug (402-B) and replace with the new mounting stud furnished separately with the actuator. This plug must be tightened flush or slightly below the machined surface with the special tool provided.

NOTE

Do not use Teflon tape on mounting stud threads as Teflon debris may enter the hydraulic system of the pump. An oil-resistant pipe compound should be used instead.

2. Rotate the micrometer control knob (255) to the zero capacity setting.

3. Pry the E-ring (404) from the control spool (268-B) groove located against the face of the control knob.

4. Unscrew the control knob.

CAUTION

Be careful to maintain the control spool location.

5. Remove the small screw (256) that enters through the threaded sleeve (243). Using pliers, rotate the sleeve to break the Loctite bond, then remove the sleeve.

6. Remove all Loctite residue from the extension to assure a proper moisture seal by the actuator housing O-ring.

7. Remove the two screws (405-C) holding the cover on the electric capacity control actuator and remove the cover. Remove the 1/4-20 screw from the microswitch mounting plate (284-A) and let the plate hang free.

8. Assemble the actuator over the pilot extension on the pump housing, carefully guiding it over the control spool extension. The actuator must slide over the pilot far enough to allow the mounting faces to meet without changing the zero position of the control spool. Assemble the seal washer (408-A) and nut over the mounting stud with rubber side of washer toward pump. Tighten securely.

9. Attach the spool coupler assembly (294-A & B) to the spool using washer (404-D) and E-ring (404) on mRoy B units or setscrew (256) on mRoy A units. The A unit setscrews must engage the spool groove. Be careful not to change the position of the control spool. Tighten motor and transfer pulley setscrews.

10. Loosen indicator pulley setscrews (410-D). Move the potentiometer with the pulley and belt until the resistance across terminals 4 and 5 is 10 ohms or less at the zero position for 250-ohm pot; 40 ohms or less for 1000-ohm pot. Tighten indicator pulley setscrews.

11. Carefully replace the limit switch plate without disturbing the zero spool position (hold the spool). Adjust the plate position until the zero limit switch is just actuated by the spool coupler and tighten the mounting screw securely.

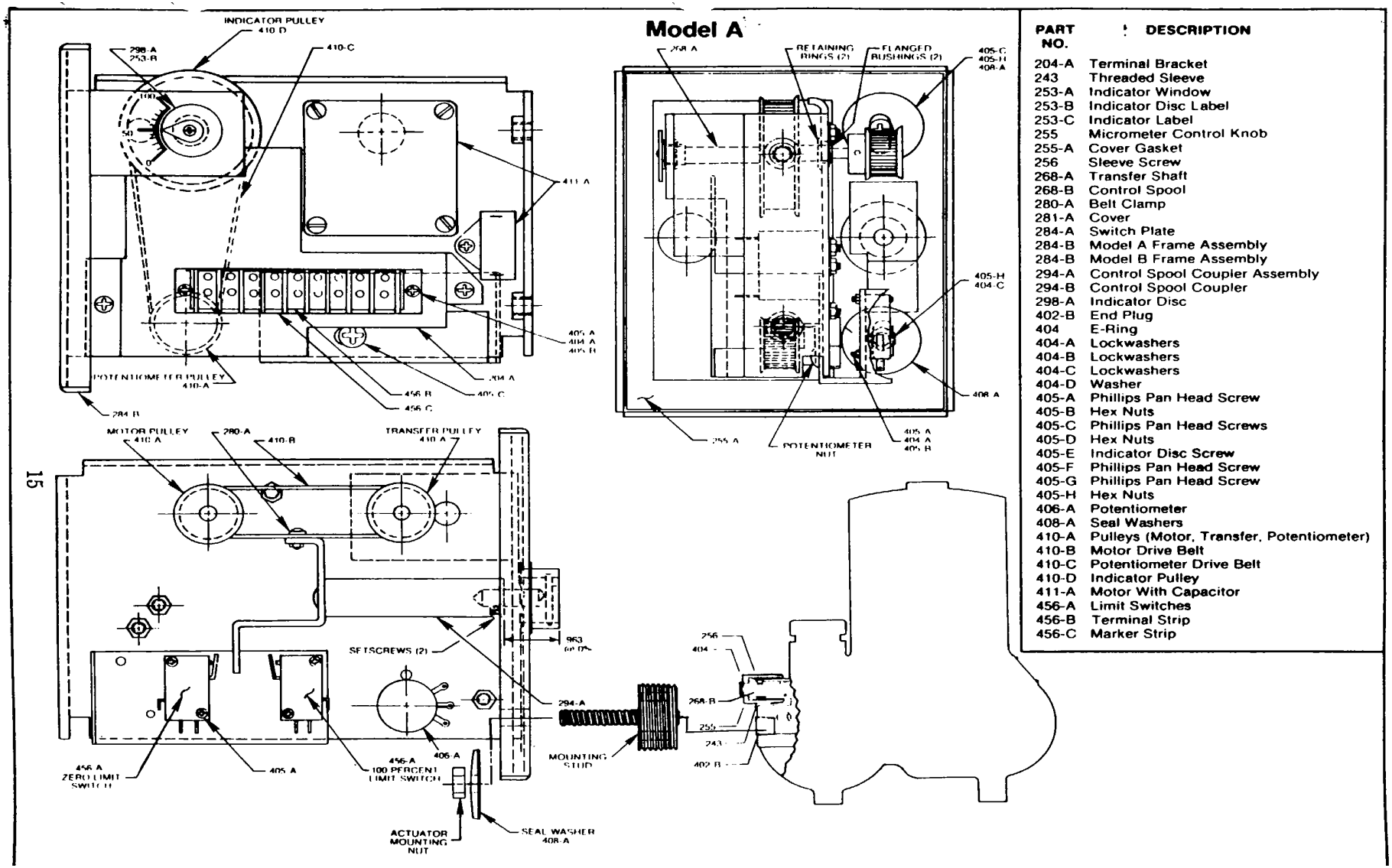
12. Run the actuator toward 100 percent until it contacts the limit switch and shuts off. Resistance across terminals 4 and 5 should be 235 ohms or more for 250-ohm pot; 940 ohms or more for 1000-ohm pot. Run the actuator back to zero percent. Re-check resistance as per step 10, and adjust if necessary via the indicator pulley.

13. Apply 115v. AC to terminals 7 and 9 to drive the unit toward the 100 percent limit switch. Verify that the potentiometer is not driven against its internal stop and that the limit switch operates. The unit will function properly provided the zero position of the control spool was maintained during assembly.

14. At the 100 percent position, set the indicator (298-A & 253-B) to 100 percent by loosening the locking screw (405-E) and rotating the pointer in the required direction. Retighten screw.

15. Attach control wiring and feed through the conduit. Beyond the conduit, isolate alternating current wires from wires carrying electric signals.

16. Seat the actuator cover (281-A) in the gasket groove with the large sealing washers (408-A) under the cover screws (rubber side against housing). Tighten the cover screws securely.



PART NO.	DESCRIPTION
204-A	Terminal Bracket
243	Threaded Sleeve
253-A	Indicator Window
253-B	Indicator Disc Label
253-C	Indicator Label
255	Micrometer Control Knob
255-A	Cover Gasket
256	Sleeve Screw
268-A	Transfer Shaft
268-B	Control Spool
280-A	Belt Clamp
281-A	Cover
284-A	Switch Plate
284-B	Model A Frame Assembly
284-B	Model B Frame Assembly
294-A	Control Spool Coupler Assembly
294-B	Control Spool Coupler
298-A	Indicator Disc
402-B	End Plug
404	E-Ring
404-A	Lockwashers
404-B	Lockwashers
404-C	Lockwashers
404-D	Washer
405-A	Phillips Pan Head Screw
405-B	Hex Nuts
405-C	Phillips Pan Head Screws
405-D	Hex Nuts
405-E	Indicator Disc Screw
405-F	Phillips Pan Head Screw
405-G	Phillips Pan Head Screw
405-H	Hex Nuts
406-A	Potentiometer
408-A	Seal Washers
410-A	Pulleys (Motor, Transfer, Potentiometer)
410-B	Motor Drive Belt
410-C	Potentiometer Drive Belt
410-D	Indicator Pulley
411-A	Motor With Capacitor
456-A	Limit Switches
456-B	Terminal Strip
456-C	Marker Strip

Figure 6. Electric Capacity Control Actuator

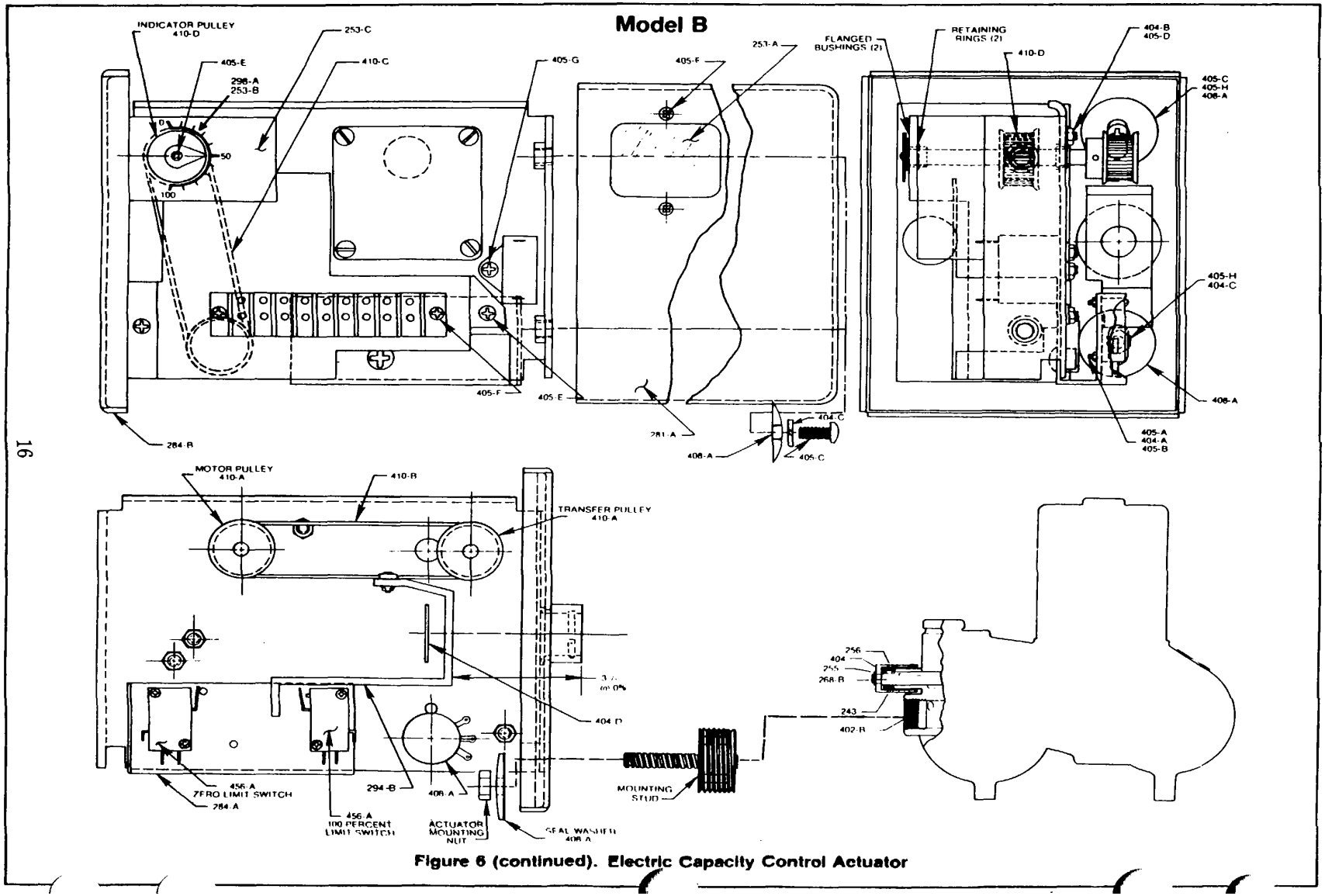


Figure 6 (continued). Electric Capacity Control Actuator

16

Figure. 6 (continued). Electric Capacity Control Actuator

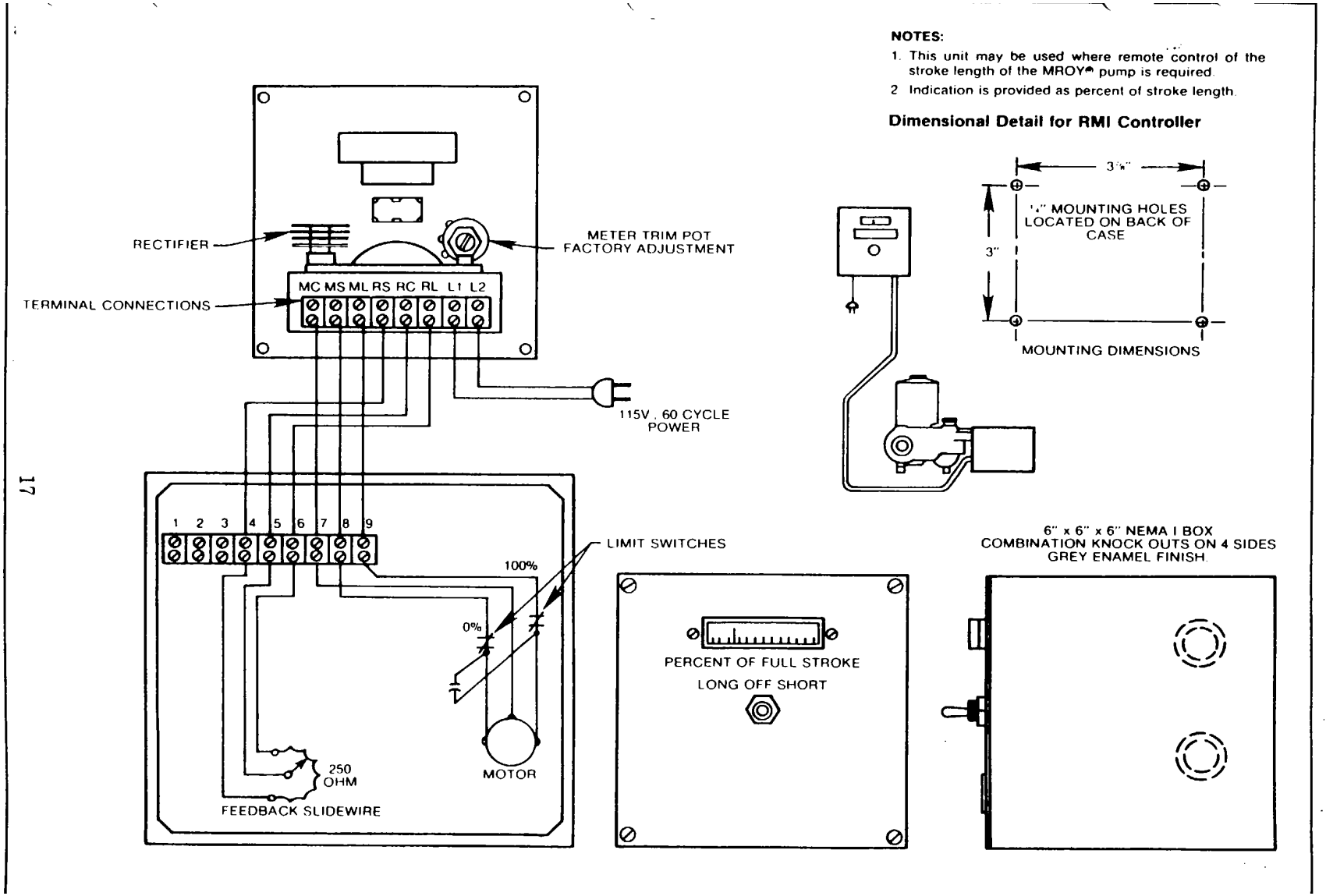
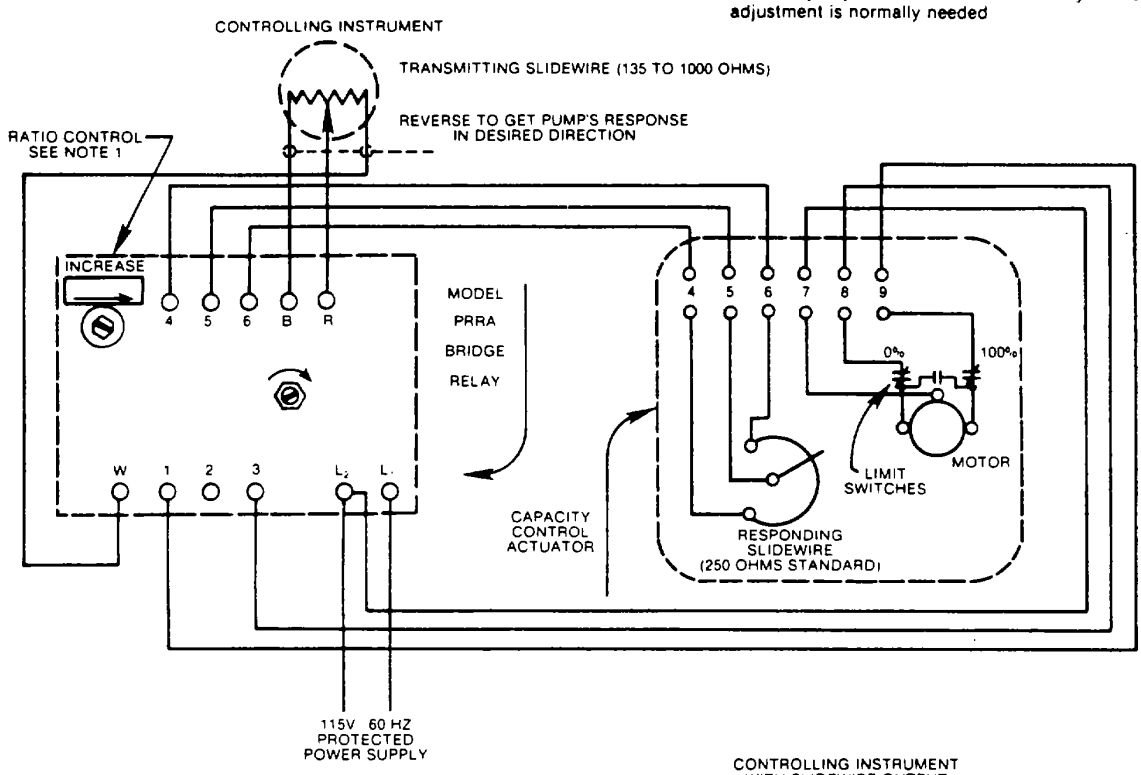


Figure 7. Model RMI Controller-to-Actuator Wiring Diagram

NOTES:

1. Ratio control is used to change the amount of response of pump output for any given change in instrument signal.
2. Sensitivity adjustment is set at the factory. No further adjustment is normally needed



Dimensional Detail for PRRA Controller

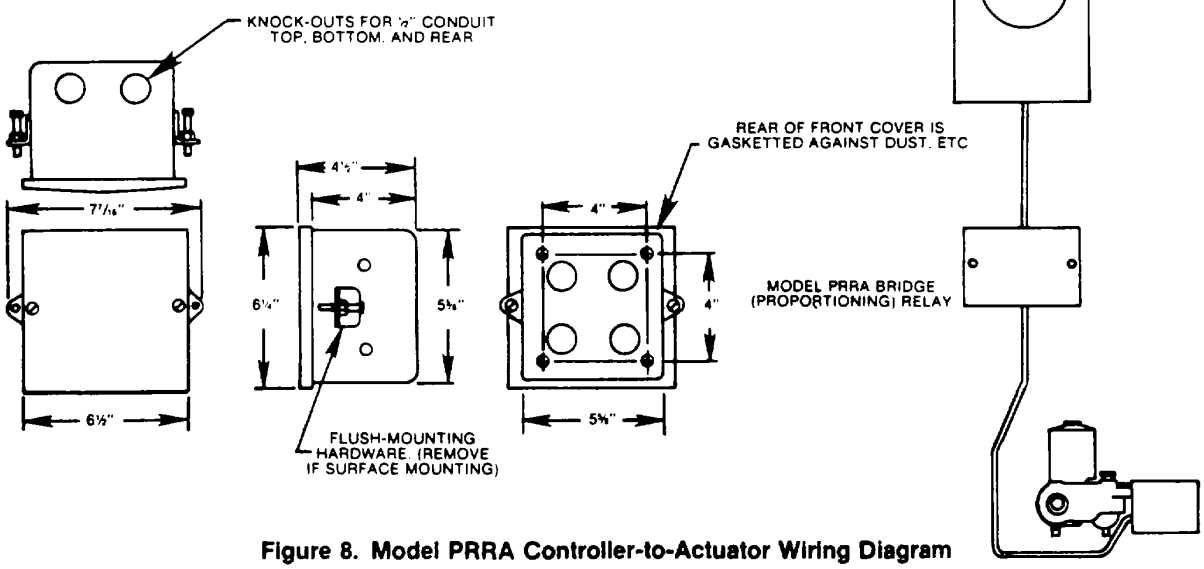
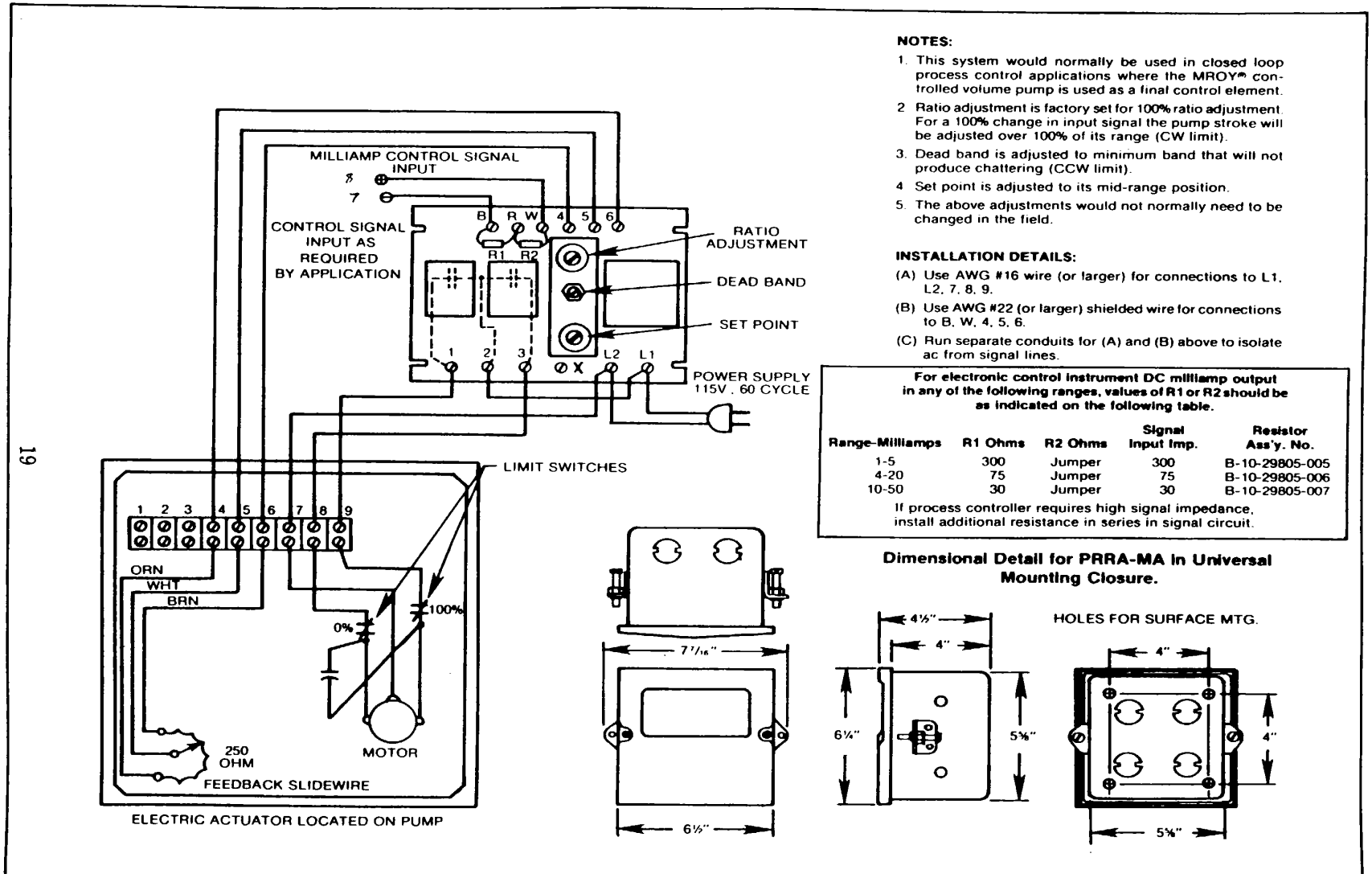


Figure 8. Model PRRA Controller-to-Actuator Wiring Diagram

Figure 8. Model PRRA Controller-to-Actuator Wiring Diagram



NOTES:

1. This system would normally be used in closed loop process control applications where the MROY® controlled volume pump is used as a final control element.
2. Ratio adjustment is factory set for 100% ratio adjustment. For a 100% change in input signal the pump stroke will be adjusted over 100% of its range (CW limit).
3. Dead band is adjusted to minimum band that will not produce chattering (CCW limit).
4. Set point is adjusted to its mid-range position.
5. The above adjustments would not normally need to be changed in the field.

INSTALLATION DETAILS:

(A) Use AWG #16 wire (or larger) for connections to L1, L2, 7, 8, 9.

(B) Use AWG #22 (or larger) shielded wire for connections to B, W, 4, 5, 6.

(C) Run separate conduits for (A) and (B) above to isolate ac from signal lines.

For electronic control instrument DC milliamp output in any of the following ranges, values of R1 or R2 should be as indicated on the following table.

Range-Milliamps	R1 Ohms	R2 Ohms	Signal Input Imp.	Resistor Ass'y. No.
1-5	300	Jumper	300	B-10-29805-005
4-20	75	Jumper	75	B-10-29805-006
10-50	30	Jumper	30	B-10-29805-007

If process controller requires high signal impedance, install additional resistance in series in signal circuit.

Dimensional Detail for PRRA-MA in Universal Mounting Closure.

Figure 9. Model PRRA-MA Controller-to-Actuator Wiring Diagram

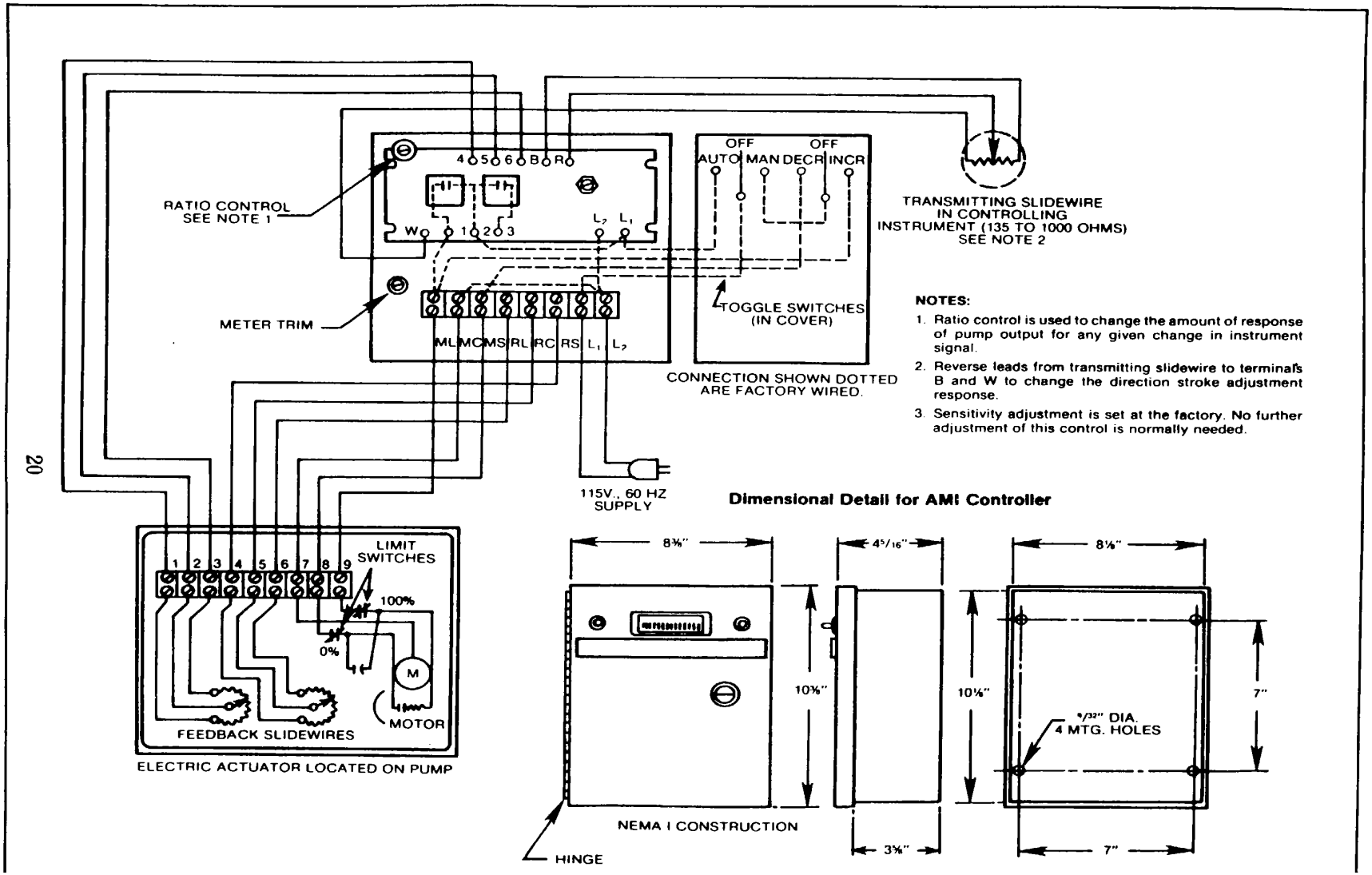
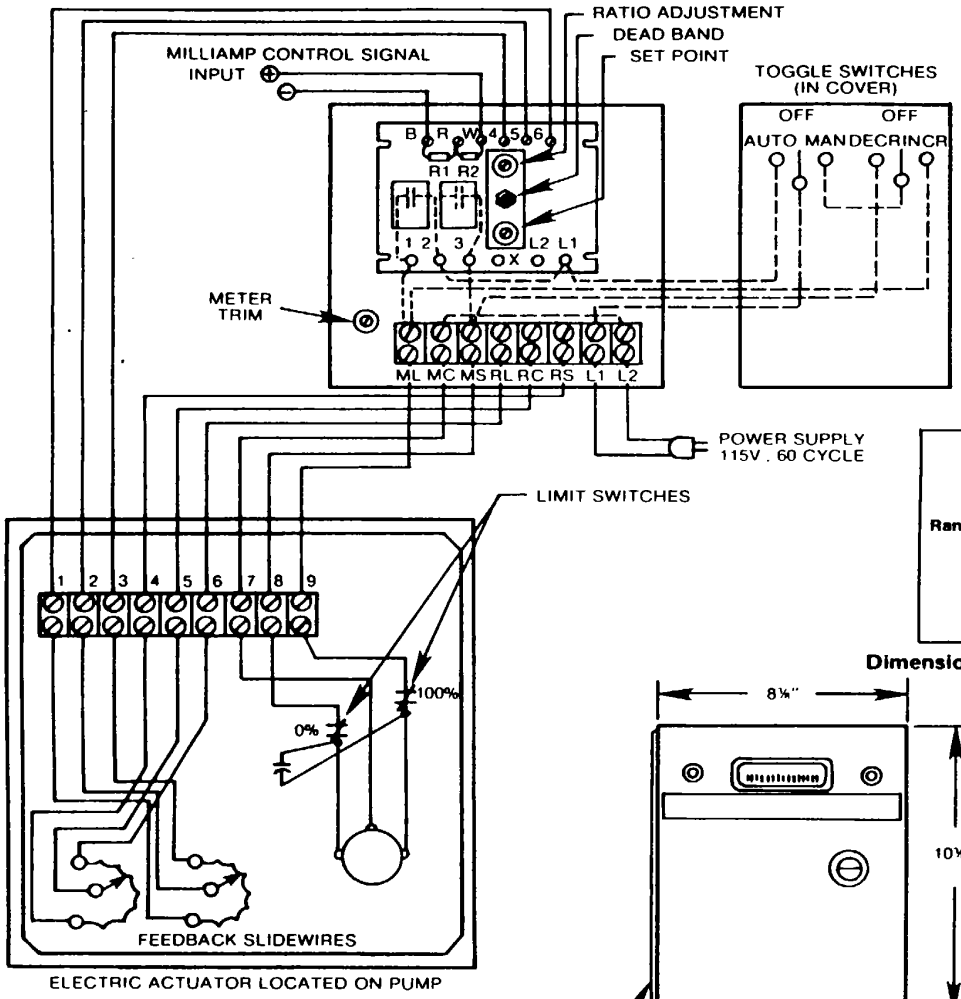


Figure 10. Model AMI Controller-to-Actuator Wiring Diagram



NOTES:

1. This system would normally be used in closed loop process control applications where the MROY® controlled volume pump is used as a final control element, and where remote manual operation is desired in addition to automatic control.
2. Ratio adjustment is factory set for 100% ratio adjustment. For a 100% change in input signal the pump stroke will be adjusted over 100% of its range (CW limit). (CW limit).
3. Dead band is adjusted to minimum band that will not produce chattering.
4. Set point is adjusted to its mid-range position.
5. The above adjustments would not normally need to be changed in the field.

INSTALLATION DETAILS

(A) Use AWG #16 wire (or larger) for connections to L1, L2, ML, MC, MS.

(B) Use AWG #22 (or larger) shielded wire for connections to B, W, 4, 5, 6, RL, RC, RS.

(C) Run separate conduits for (A) and (B) above to isolate AC from signal lines.

For electronic control instrument DC milliamp output in any of the following ranges, values of R1 and R2 should be as indicated on the following table.

Range-Milliamps	R1 Ohms	R2 Ohms	Signal Input Imp.	Resistor Ass'y. No.
1-5	300	Jumper	300	B-10-29805-005
4-20	75	Jumper	75	B-10-29805-006
10-50	30	Jumper	30	B-10-29805-007

If process controller requires higher signal impedance, install additional resistance in series in signal circuit.

Dimensional Detail for AMI Controller

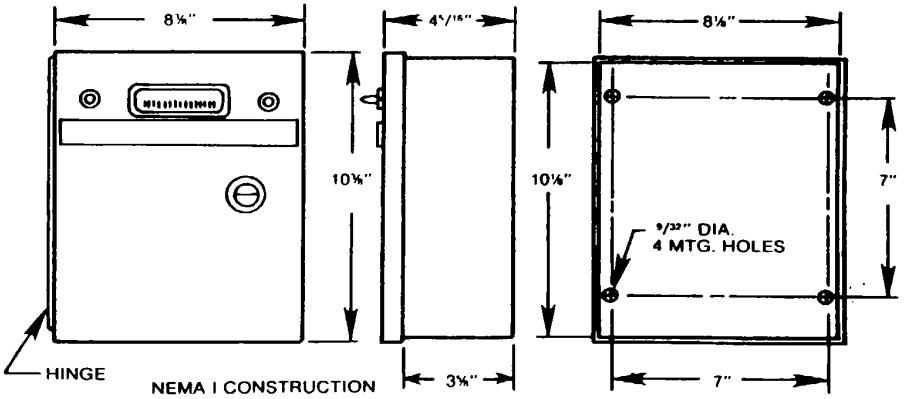
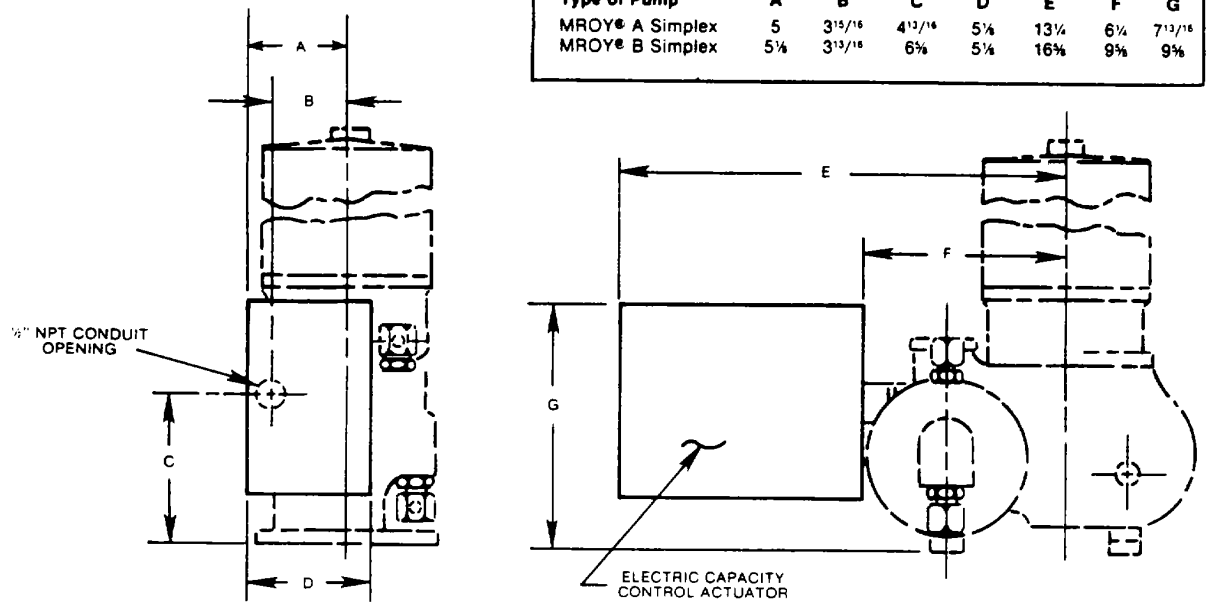


Figure 11. Model AMI-MA Controller-to-Actuator Wiring Diagram

MROY® A- and B-Frame Simplex

Type of Pump	Dimensions (in.) A	B	C	D	E	F	G
MROY® A Simplex	5	3 15/16	4 13/16	5 1/8	13 1/4	6 1/4	7 13/16
MROY® B Simplex	5 1/8	3 13/16	6 5/8	5 1/8	16 5/8	9 5/8	9 5/8



MROY® A- and B-Frame Duplex

Type of Pump	Dimensions (in.) A	B	C	D	E	F	G
MROY® A Duplex	5	3 15/16	4 13/16	5 1/8	13 1/4	6 1/4	7 13/16
MROY® B Duplex	5	4 1/4	6 5/8	5 1/8	16 5/8	9 5/8	9 5/8

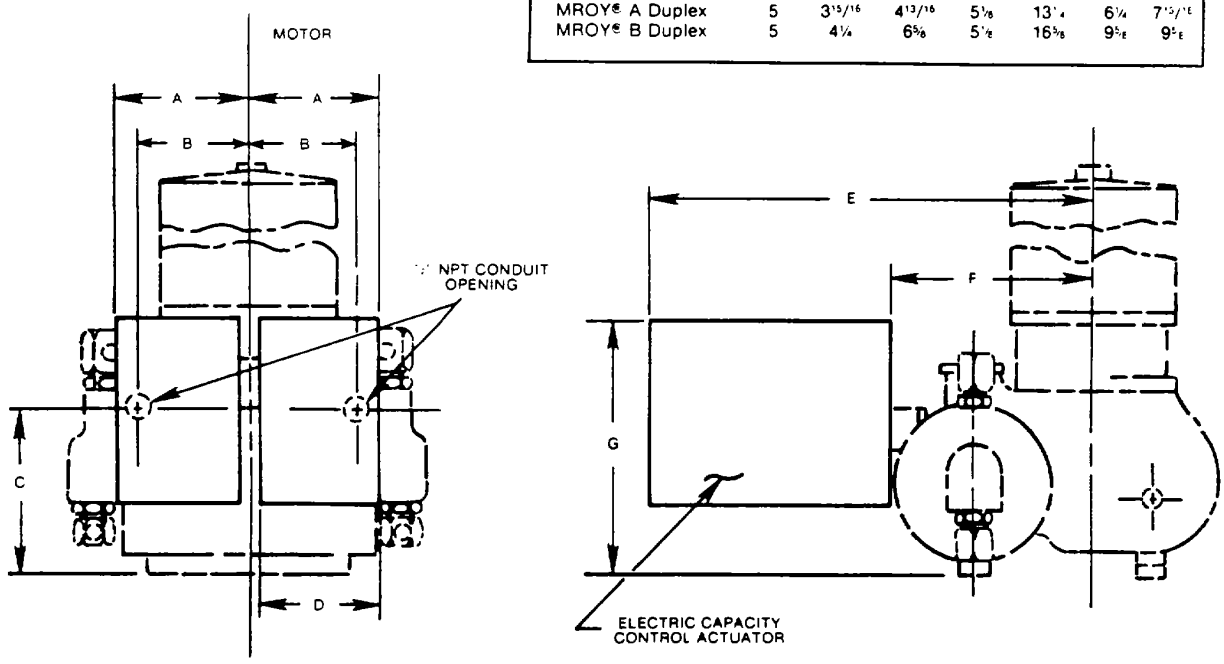


Figure 12. Actuator Installation and Dimensions

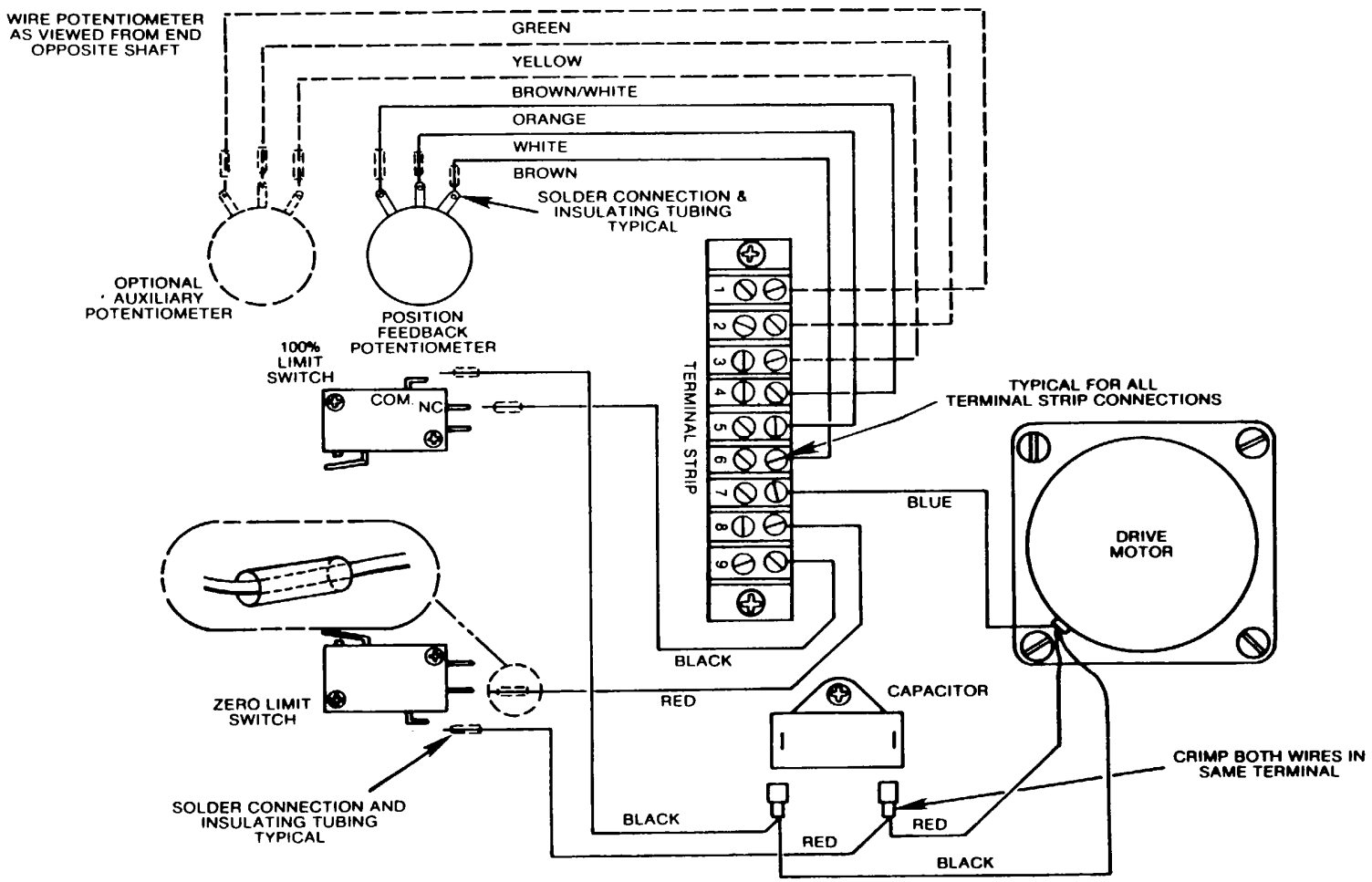


Figure 13. Electric Capacity Control Wiring Diagram

TABLE OF EQUIVALENTS

1 atmosphere	equals	1.0333 kilograms/square centimeter 101.33 kilopascals 1.0135 bars
1 Btu/hour	equals	2928 Watts
Degrees Fahrenheit	equals	1.8° Celsius + 32
1 Engler Degree	equals	7.45 square millimeters/second
1 foot	equals	30.48 centimeters 12 inches
1 Ford Cup #4	equals	3.76 square millimeters/second
1 gallon (U.S.)	equals	1337 cubic feet .8333 Imperial gallons 3.785 liters 4 quarts
1 gallon/hour (U.S.)	equals	003785 cubic meters/hour .002228 cubic feet/minute
1 horsepower	equals	745.7 Watts
1 inch	equals	2.540 centimeters
1 inch of mercury	equals	03442 kilograms/square centimeter 3376.5 Pascals .4897 pounds/square inch
1 pint (liquid)	equals	4732 liters 16 ounces
1 pound/square inch	equals	06804 atmosphere .06897 bars .07029 kiograms/square cer.timeter 6894.8 Pascals
1 Redwood Admiralty	equals	2.340 square millimeters/second
1 Redwood Standard	equals	237 square millimeters/second
1 Saybolt Furol	equals	2.16 square millimeters/second
1 Saybolt Second Universal	equals	216 square millimeters/second

Milton Roy
Flow Control Division
201 Ivyland Road
Ivyland, PA.USA 18974
(215) 441-0800
Telex USA 083-4348

MODEL 924
CHLORINE FAC/TFC
ANALYZER/TRANSMITTER

XERTEX CORP., 250 Marcus Boulevard, Hauppauge, N.Y. 11787
(516) 273-6600 **Telex 14-4545**

GENERAL DESCRIPTION

INTRODUCTION

The Delta Analytical Model 924 Chlorine Measurement System provides accurate, sensitive, reliable, and troube-free operation using amperometric sensor techniques. A multiple use instrument, the 924 measures (1) HOCL; (2) HOCL + OCL (TFC/total free chlorine) manually if pH is known and controlled; and (3) TFC automatically if equipped with a pH sensor. There are no sample pumps, reagents, or dilution systems required, making this system superior to amperometric wet chemistry analyzers.

The sensor is protected from direct contact with the stream by a chlorine-permeable membrane. When chlorine permeates the membrane, it reacts electrochemically with the cathode and causes a linear current, proportional to the chlorine concentration, to flow between a voltage-based gold cathode and silver anode. This current is then processed in the microprocessor-based analyzer transmitter and displayed on the 3 1/2 LCD digital display.

SYSTEM DESCRIPTION

The Chlorine Analyzer/Transmitter System consists of two separate units: an Analyzer/Transmitter and an amperometric sensor. The Analyzer/Transmitter is housed in rugged NEMA 4X enclosure which is suitable for either surface or handrail mounting. The system utilizes microprocessor based electronics to ensure stable readings over a wide range of operating conditions.

The sensor is available with two different mounting systems to meet varying installation requirements. The Model 921243 sensor may be mounted directly in the sample using Delta Analytical's exclusive "sweep-ell" handrail mounting system or may be mounted in a flow-thru "tee" for in-line sample measurements. The same sensor can be used for either application.

SENSOR DESCRIPTION

The Model 921243-XXX Amperometric Sensor is composed of a PVC body, gas permeable membrane, a gold cathode, a silver anode. The sensor also has a precision thermistor built into it, for temperature compensation of Chlorine readings and for temperature readout over the range of 0 to 50° C. The sensor is provided with a screw-on type membrane cap for easy maintenance.

THEORY OF OPERATION

The Delta Analytical Model 924 instruments are supplied with an amperometric sensor which can be located in any part of a stream or water flow. The sensor has a gold cathode at its tip, and an internal silver anode. The body of the sensor is filled with No. R-448 Electrolyte. Unique channels in the body bring electrolyte solution from the reservoir to the gold cathode under a special permeable membrane. In use, water being analyzed is made to flow past the tip of the sensor. As hypochlorous acid molecules diffuse through the membrane, an elec-

trical current is automatically produced in proportion to the chlorine content of the sample. The membrane is part of the membrane cap which screws on and off, for easy replacement in cases where it becomes torn or punctured.

The microprocessor based electronics provide the capability for processing input signals, displaying data, and providing multiple outputs. Mathematical computations on multiple variables are performed for accurate determination of measured parameters which are related to other variables even in non-linear relationships such as sensor temperature compensation.

The results are displayed on the 3 1/2 digit LCD Display on the front panel or are available on the input/output connector board either as isolated current or voltage outputs. (Fig. 1)

An internal switch (S4-1) puts the microprocessor into a built-in simulator mode (mode 0) when used in conjunction with front panel switches (S1, S3) and display, and R35 pot input parameters are simulated to verify proper internal functioning of the A/D converter processing and outputs. This procedure is convenient for setting up alarms, recorders, printers or computer outputs.

When the Model 924 analyzer is in operation, the microprocessor continuously monitors all the operational and equipment functions. In this self diagnostic mode whenever a malfunction occurs an error message will be present on the LCD display, messages being of 'two types: operational or equipment. Operational malfunctions include questionable calculation results, insufficient data, excessive input noise, input measurement or calculated results out of range. Examples of equipment problems that will generate a malfunction display which include ROM fail check sum, RAM problems, identification error, card in wrong position, switch failure, wrong or no input card. (For further details see Troubleshooting section.)

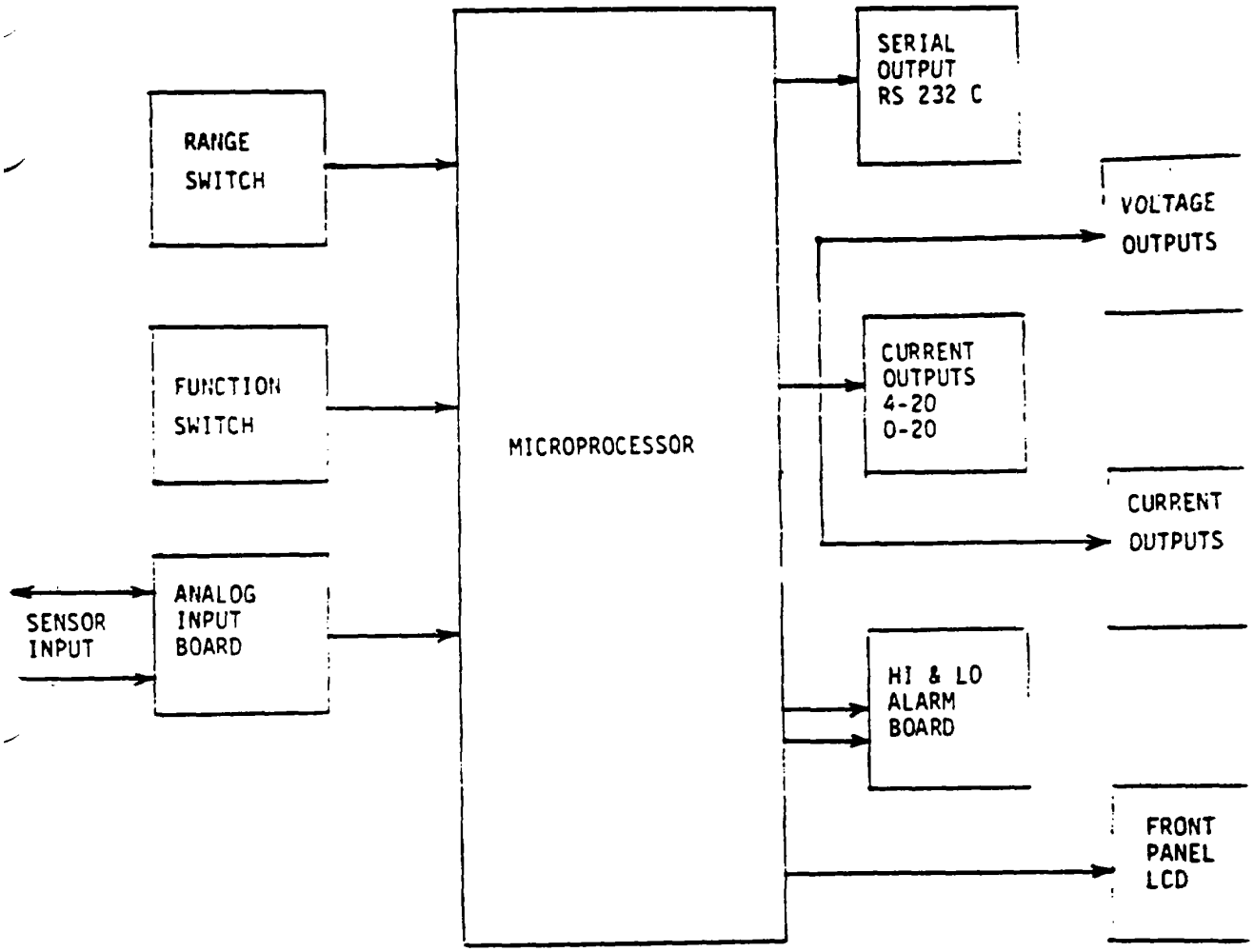


FIG. 1 - Basic Microprocessor Input/Output Block Diagram

The sensor is a "passive" type. It operates with a constant voltage applied to it by the instrument. If this source of power is removed from it, for example, if the sensor cable is disconnected from the instrument, the sensor must be "stabilized" for at least 30 minutes before it is calibrated or used. This is done simply by connecting the sensor for 30 minutes with the instrument powered on.

Initial "stabilization," described above, will be necessary when the sensor is reconnected after storage. If the analyzer module suffers a power failure, an internal battery will keep the sensor polarized for 50 hours.

The design of the sensor eliminates the need for frequent changing of the membrane and re-calibration. The membrane should be replaced only if accidentally damaged. The buffered potassium chloride solution may be replenished when necessary, without the need to replace the membrane. See later sections for servicing the sensor.

A temperature measuring thermistor is built into the sensor. It automatically measures the temperature while the sensor is immersed in the sample water. When measuring chlorine, there is no need to make any setting on the instrument for temperature since it is automatically' compensated for in the electronic system. In addition, temperature can be directly indicated on the display when the DISPLAY switch is placed in the TEMPERATURE position.

All Chlorine sensors require a flow of fresh sample at the sensor tip. The molecules of Chlorine next to the membrane diffuse through it, and are consumed in the electrochemical reaction. These Chlorine molecule must be replaced by new ones in the sample flow. The flow must be a least 1 foot per second.

A Refill-Membrane Kit No. 824240 is supplied with the instrument. It consists of a 4 oz. bottle of R-448 Electrolyte with dropper cap and three screw-on membrane caps with the membranes pre-stretched across one end, ready for use.

SPECIFICATIONS	
ANALYZER/TRANSMITTER	
Measuring Ranges	0-1, 0-5, 0-10 ppm Chlorine 0°-50°C Temperature
Repeatability	± 0.01 ppm Chlorine, 0.1°C Temp.
Stability	± 0.02 ppm Chlorine, 0.2°C Temp.
Ambient Temperature Range	-5° to + 50°C
System Accuracy	± 1% of Full Scale
Ambient Relative Humidity	0-90% RH non-condensing
ANALOG OUTPUTS	
Output, Chlorine, pH	0-20 mA or 4-20 mA DC isolated (optional) 0-10 VDC, 0-1- m VDC, non isolated
Output, Temperature	0-10 VDC non-isolated 0-10 m VDC non-isolated 0-20 or 4-20mADC isolated (optional)
Alarm	Dual alarm, selectable Lo-Hi, Hi-Hi, Lo-Lo NO and NC contacts 10 A, 24 VDC/250 VAC
CASE	NEMA 4X, Thermoplastic
Mounting	Surface
Electrical Power Requirements	105 to 130 VAC, or 210 to 260 VAC with 50/60 Hz, 15 watts.
Dimensions (Outside)	11 3/4" W x 13" H x 7 1/2" D (300 x 330 x 190 mm)
Weight	13 lbs (5.9 Kg), Sh. Weight 16 lbs.
Sensor Connections	Screw Clamp Modular Terminal Block
AMPEROMETRIC SENSOR	
Sensor Material	Grey PVC body, gold cathode, silver anode, gas permeable membrane.
Dimensions	6 1/2" x 1 29/32" (16.5 cm x 4.84 cm)

AMPEROMETRIC SENSOR (Continued)	
Weight	Net 3 lbs. (1.36 Kg)
Cable Length	25 ft. (8.0 m) standard
Mounting	Pipe or handrail for direct submergence. In line "tee" flow- thru applications.
Range	0-20 ppm
Minimum Sample Flow	1 ft. per sec. (30 cm/sec); optional Cleaner/Agitator available
Response	90% in 20 seconds
Accuracy	± 1% Full Scale
Stability	± 1% F.S. at given temperature for 24 hours.
Ambient Temperature	+32° to +122°F (0° to +50°C)
Pressure Compensation	150 ft. (46 m) submergence or 125 psig (862 kPa)
Electrolyte Capacity	60 ml of R-448 Electrolyte
Electrolyte Life	Approximately 6-9 months.

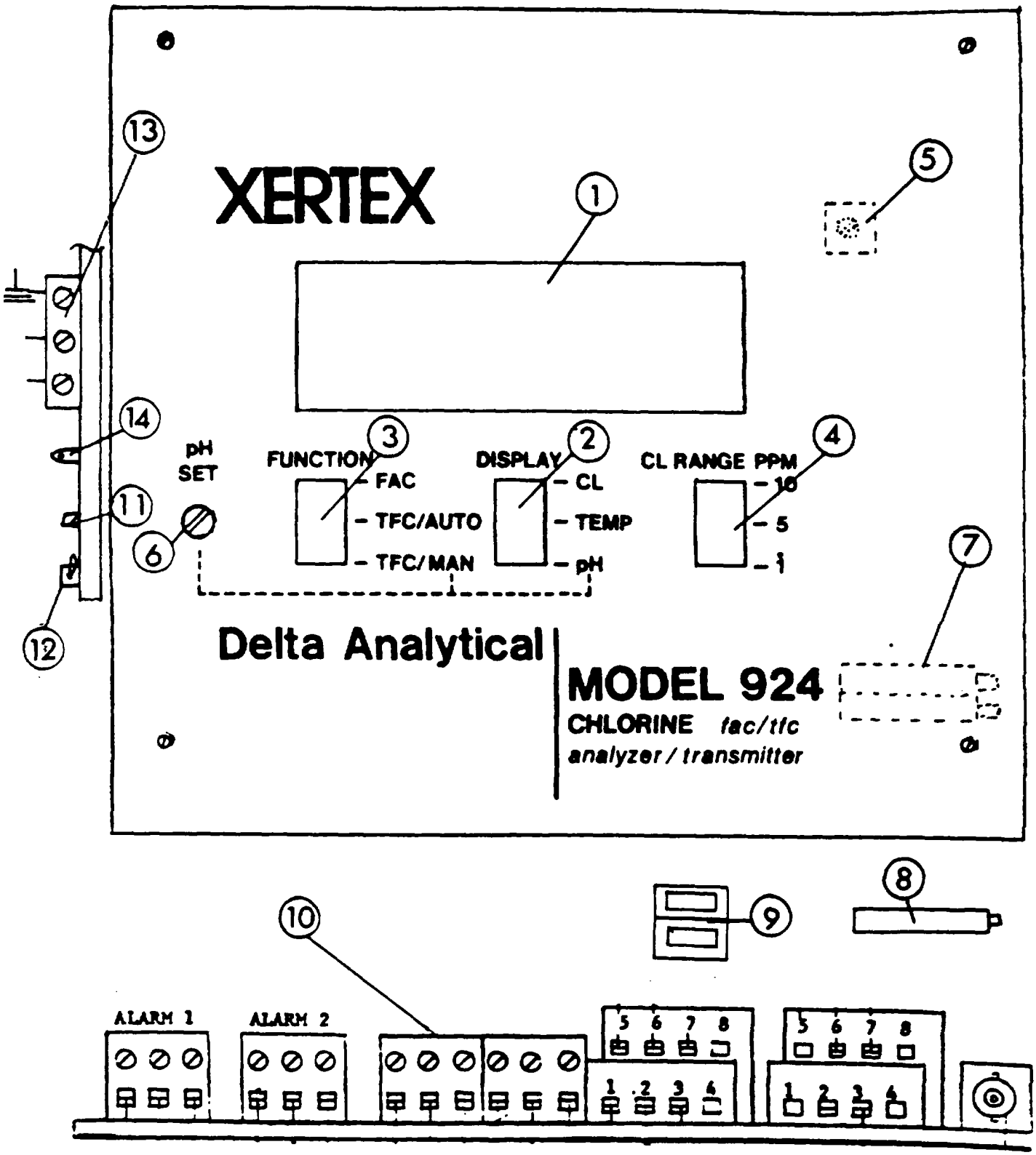


FIG. 2 -924 Controls and Indicators

TABLE 1

INDEX NO	NAME	FUNCTION
1	LCD Display	Displays Chlorine concentration in PPM or mg/l. May be set to read 0-1, 0-5 or 0-10 and temperature from 0 to 50°C. Also displays messages from microprocessor.
2	Display Control Switch Switch (S1)	Selects displays between chlorine, pH, temp.
3	Function Switch (S3)	Selects between FAC, TFC/Auto, TFC/Man modes.
4	Range Switch (S2)	Used to select 0-1, 0-5 or 0-10 ppm range.
5	R5 Trim	Used to trim 2.5 volt reference (should not require adjustment unless D/A converter or V reference is changed.)
6	pH Set	pH adjustment pot for setting pH level on TFC/Man mode.
7	R24, R25 Trim	Used to trim analog outputs 1 and 2
8	R35 Trim	Used for setting alarm setpoints and also for simulating inputs to 4-20 mADC P.C.B. (simulated 0-10VDC)
9	S4-1 Test Mode Switch	Used to switch microprocessor into mode 0 for built-in simulator.
10	Input/Output Connector Board	Terminal block connections for sensor, alarm contacts, 4-20 mADC outputs, voltage outputs.
11	Fuse	1 AMP SLO-BLO line fuse
12	On/Off Switch	Applies power to unit.
13		Terminal block for AC power connections.
14	Ground Connection	For grounding the system to line the ground. Also for signal groun

INSTALLATION

INTRODUCTION

Installation of the 924 Analyzer Transmitter System will vary with the application. In most cases the user has determined which type of sensor mounting is required. Prior to installing the system, the following determination should be made:

1. What is the measurement required?

2. What are the sample handling requirements for proper sensor mounting?

3. Environmental conditions.

4. Physical installation considerations.

Once installed, the system should be calibrated with the sample it will be monitoring. The following paragraphs provide procedures to install and calibrate the system.

UNPACKING AND INITIAL INSPECTION

Both the sensor and transmitter are packed in the same carton. Upon receipt of the units, inspect the shipping carton as well as the units themselves for obvious damages, such as dislodged components. The sensor should also be checked for any physical damage.

When shipped, the sensor's membrane cap is covered by a protective cap which serves not only to prevent damage to the membrane but also has a foam pad which is wetted with electrolyte solution.

CAUTION

Do not subject sensor to freezing or sub-freezing temperatures since doing so may damage the unit.

INSTALLATION OF THE ANALYZER/TRANSMITTER

The 924 Analyzer/Transmitter is contained in a NEMA 4X thermoplastic, weatherproof case and may be mounted on a wall or handrail (see Fig.8). Mounting in an area where excessive vibrations exists should be avoided. To provide power to the analyzer and to connect sensor refer to Fig. 3 and proceed as follows:

1. Before connecting 120 VAC/220 VAC power to terminal GRN, N, L, Fig. 3 verify that power supply transformer is appropriately connected for that voltage.

2. Connect sensor to terminals 3, 5, 6 & 7, Fig. 3.

2a. The pH sensor is connected to the BNC connector and the two lead wires from the pH sensor thermistor should be taped and left disconnected.

3. Complete external wiring connections using Fig 3.

4. Connect solution ground to 14 (Fig. 3).

CAUTION

Current to the relay terminal connections should never exceed 10 amps for 115V or 5 amps for 220V. This includes inductive or capacitive surges associated with motors and other devices. Adequate current protection MUST be insured by means of a fuse in any external circuit. The use of "slo-blo" or delayed action fuses is not recommended. Higher currents can be handled by a separate external power relay if required.

SENSOR INSTALLATION

Sensors must be installed in a vertical position to insure proper operation.

SUBMERSIBLE TYPE SENSOR INSTALLATION

The 921243 sensor is equipped with a 3/4" NPT male fitting (See Fig. 4) so it can be attached to a pipe coupling or pipe and may be installed directly into the sample. The sensor may also be mounted on Delta's exclusive "Sweep-Ell" handrail mounting system (See Fig. 7). The "Sweep-E11" system is provided with instructions and all required hardware.

FLOW-THRU CELL INSTALLATION

The 921243 sensor is equipped with 1 1/2" NPT thread for installation into a suitable pipe "Tee" or Delta's Model 915240 Flow-Thru Tee assembly (See Fig. 5). The 915240 assembly has two 3/4" NPT female fittings for connection to the sample pipe. The "Tee" should mounted in a horizontal position with the sensor installed vertically in the Tee with the membrane facing down. A Minimum flow rate of 3 GPM is required.

PRE-CALIBRATION CHECKS

The paragraphs that follow describe the calibration procedures for FAC TFC/Auto TFC/Manual. For location and identification of indicators and controls refer to Fig.2 and Table 1.

Calibration of analyzer for FAC, TFC, preliminary steps prior to use:

1. After performing installation procedure (pg. 9 of this manual), turn the instrument on. At this time the display operation is verified. (During the memory check the display contains four dashes.) The following sequence is displayed for visual verification at approximately half-second intervals:

0000
1111
2222
3333
4444
5555
6666
7777
8888
9999

EEEE
HHHH
LLLL
PPPP
(BLANK)

(If unable to obtain this message on display, please refer to section on troubleshooting.)

2. Remove the protective cap from the sensor's membrane cap.
3. Check level of electrolyte.* Hold the sensor vertically with the membrane cap facing up. View electrolyte level through pressure port window.
4. Ensure that the sensor is securely mounted.
5. Ensure that the sensor leads are connected to the analyzer at the proper terminals and that power is connected to the unit.
6. Stabilize the system by turning on the power and turning the range/function switch to 0-1 ppm. The sensor will stabilize in sample in about 30 minutes.
7. Always allow the sensor to reach temperature of the sample before calibrating or taking readings. If a large temperature difference exist, allow at least 10 to 15 minutes for the sensor to reach equilibrium.
8. The sensor will remain polarized as long as it is connected to the analyzer.

Check the calibration of the instrument: The instrument has been calibrated at the factory before shipment. It is a good idea, however, to check the calibration since rough handling or prolonged storage may have changed the original calibration. See Calibration Section, for detailed instructions.

As mentioned in an earlier section, Chlorine sensors require a flow of fresh sample past the tip for accurate operation. This may be accomplished by one of two methods: (1) the use of a No. 812A-111 Agitator OR (2) a naturally-fast moving body of water.

*Unless otherwise specified the sensors are filled with electrolyte at the factory and are ready for use.

Agitator: The optional agitator is a device which screws on to the sensor and causes water to flow past the tip at the proper rate. It stays with the sensor to continuously ensure accurate results. The unit is pressure-proofed for operation to 150 ft. depths.

Fast moving water: When analyzing fast moving water from rivers, streams, pipes, or conduits the water flow may be sufficient for accurate reading. Face the membrane tip of the sensor directly into the flow. Make sure that at least one inch of the sensor tip is completely and continually submerged. The flow should be at least 1 ft. per second. Water flow is sufficient if swishing the sensor rapidly in the water does not cause the readings to move upscale further.

CALIBRATION

Prior to sensor and electronic circuit adjustment, please take time to read this brief circuit description.

The Model 924 analyzer electronic circuitry consists of: (See Block Diagram Fig. 1)

MOTHERBOARD Fig. 9

The Motherboard provides interconnections between the input connector board, the power supply board, the several option boards, and the processor/display board. In drawing 30998 the various input and output signals are identified by number.

POWER SUPPLY BOARD Fig. 10

The power supply employs linear regulators to provide plus and minus 15 volts and a switching regulator to supply up to one ampere at five volts. The transformer has a dual primary which may be jumpered for 110 or 220 volt ac lines. The transformer secondary used to supply ac to the minus 15-volt regulator also supplies 18 VAC to the current output board.

PROCESSOR/DISPLAY BOARD Fig. 11

The processor/display board is mounted on hinged stand-offs to allow access to the other circuit boards. When the instrument is turned on, it initiates a series of self-checks.

1) The ROM is summed and the result compared to a stored checksum. If this comparison fails, it means the ROM contents have changed and the ROM is unusable. In case of checksum failure the error message H001 is displayed, and the program is restarted.

2) All locations of RAM are given a read/write check to insure that all locations may be written and read, and that writing affects only the location being written. Failure means the instrument is inoperable. In case of RAM failure the error message H003 is displayed, and the program is restarted.

3) Display operation is verified. (During memory check the display contains four dashes.) The following sequence is displayed for visual verification at approximately half-second intervals:

0000
1111
2222
3333
4444
5555
6666
7777
8888
9999

EEEE
HHHH
PPPP
(BLANK)

4) Each option slot and the input conditioner slot is checked frequently during a program cycle to verify that no board has been inserted in a wrong slot. Failure of this check causes H004 to be displayed and restarts the program.

5) If reading the display switch results in an unpermitted code, the message H005 is displayed, and the program is restarted.

6) During every program cycle the input conditioner board identification code is read. If the ROM does not contain the program corresponding to the identification, H006 is displayed. If the code differs from that which was read during initialization, H003 is displayed. In both cases the program is restarted.

INPUT CONDITIONER BOARD Fig. 12
The input conditioner board accepts the analog signals from the Chlorine sensor and temperature compensator and pH sensor and maintains the sensor polarization voltage during a power failure, by incorporating a rechargeable battery.

DUAL ALARM BOARD (Optional) Fig. 13
This board provides two independent alarm setpoints, each with an isolated form C relay contact rated at 10 Amps/250 VAC/24 VDC. If it is required to switch more than 3 Amps it is recommended that a power relay be interposed. Connection to these contacts is made by means of terminal blocks on the input connector board.

ISOLATED CURRENT OUTPUT BOARD (Optional) Fig. 14
The isolated current output board provides a 0-20 mADC or 4-20 mADC current signal to drive loads up to 1000 ohms such as recorders, controllers, etc.

SERIAL INPUT/OUTPUT BOARD (Optional)
Consult factory.

CALIBRATION METHODS

The Chlorine Analyzer/Transmitter must be calibrated using a solution with a known concentration of chlorine. This solution may be either synthetically produced or be the process water to be measured. To arrive at the known concentration, any of the following methods may be used:

1. "Standard Methods", 15th Edition, 1980-Method 408D.

2. "EPA Methods for Chemical Analysis of Water and Wastes", EPA 600/4-79-020, March 1979-Method 330-4.

3. Delta Analytical Model 4024 Portable Chlorine Analyzer.

4. Delta Analytical DPD-50 Chlorine Analysis Kit.

It is recommended that the Delta Analytical DPD-50 Chlorine Analysis Kit be used as it is simple to use and will provide excellent results. The DPD-50 test procedure follows the calibration procedure.

CALIBRATION PROCEDURE I - FAC MODE (Refer also to Input Conditioner board Adjustments) (krig. 12)

1. Turn the analyzer on and prepare it for use in accordance with preliminary instructions.

2. Place the sensor and solution ground (connected to #14 Fig. 2) in a beaker with about 600 to 800 ml. of Chlorine demand free water on a magnetic stirrer. Do not run stirrer so fast as to create air bubbles in the solution. Add 1 ml. of pH5 buffer. Allow the sensor to stabilize for about 1 minute.

3. Set Function Switch to FAC.

4. Set Display Switch to CL.

5. Set the RANGE SWITCH to its lowest value (0-1) and adjust the CL ZERO TRIMPOT (R 828) (PROBE ZERO) until the display reads zero.

6. Set the SPAN POT (R820) to about mid-range. Now add a dilute hypochlorite solution drop-wise until a reading of between 25 to 50% of range is obtained. Allow the solution to stabilize for about 2 to 3 minutes. (Note: to prepare dilute hypochlorite solution, add 10cc of 5Z bleach, such as chlorox, to 100cc of water).

7. Withdraw sample of solution and check for concentration of chlorine using DPD-50 test kit, or other test method.

8. Adjust the CL SPAN TRIMPOT (R820) to the value obtained with the test kit or other test method used. The analyzer is now calibrated and the sensor may be placed in the sample stream.

CALIBRATION PROCEDURE I-TFC/MAN. MODE

1. Connect chlorine sensor to input terminal as in Fig. 3. Install shorting plug on BNC connector.

2. § turn the analyzer on and prepare it for use in accordance with preliminary instructions.

3. Place the sensor and solution ground (connected to No. 14, Fig. 2) into a beaker with about 600 to 800 ml of chlorine demand free water on a magnetic stirrer. Do not run the stirrer so fast as to create air bubbles in the solution. Add 1 ml. of a pH 4 or 5 buffer. Allow the sensor to stabilize for about 1 minute.

4. Set function switch to TFC/MAN, display switch to pH and range switch to 1.

5. LCD display will flash on and off with switches in this configuration. Adjust the pH set control on the front panel until the display reads the value to which test solution pH was corrected to.

6. Set display switch to CL.

7. Adjust the CL ZERO TRIMPOT until the display reads 0.00.

8. Now add a dilute hyprochlorite solution drop wise until a reading of between 25 to 50% of range is obtained. Allow the solution to stabilize for about 2 to 3 minutes. (Note: to prepare dilute hyprochlorite solution, add 10 cc of 5% bleach, such as Clorox to 100 cc of water).

9. Withdraw sample of solution and check for concentration of chlorine using DPD-50 test kit or other test method.

10. Adjust the CL SPAN TRIMPOT (R820) to the value obtained with the test kit or other test method used. The analyzer is now calibrated and the sensor may be placed in the sample stream.

CALIBRATION PROCEDURE I-TFC/AUTO MODE

1. Connect the chlorine sensor and pH sensor to the input terminals as in Fig. 3.

2. Turn on the analyzer and prepare it for use in accordance with preliminary instructions.

3. Set function switch to TFC/AUTO, display switch to pH.

4. Place the pH sensor and solution ground in a beaker of pH 7 buffer solution and stir for a minute or two. Allow the reading to stabilize. Using the pH zero trimpot (R851) adjust until LCD display read 7.00.

5. Remove the sensor from the pH 7 buffer and rinse. Place the sensor in a pH 4 buffer solution and stir for a minute or two. Allow the reading to stabilize and adjust the pH SPAN TRIIPOT (R855) until the LCD display reads 4.00. Repeat steps 4 and 5 to check that the pH zero and pH SPAN adjustment hasn't changed. The instrument is now calibrated for pH.

6. To calibrate the analyzer in the TFC/AUTO MODE place the pH sensor, the chlorine sensor and the solution ground in a beaker of chlorine demand free water on a magnetic stirrer. Do not run the stirrer so fast as to create air bubbles in the solution. Add 1 ml. of a pH 4 or 5 buffer. Allow the sensor to stabilize for about 3 to 5 minutes.

7. Set the display switch to chlorine.

8. Set the range switch to its lowest setting (0-1 ppm) and adjust the CL ZERO TRIMPOT (R828) until the LCD display reads 0.00.

9. Now add a dilute hypochlorite solution drop wise until a reading of between 25 to 50% of range is obtained. Allow the solution to stabilize for about 2 to 3 minutes. (Note: To prepare dilute hypochlorite solution, add 10 cc of 5% bleach, such as clorox to 100 cc of water).

10. Withdraw sample of solution and check for concentration of chlorine using DPD-50 test kit or other test method.

11. Adjust the CL SPAN TRIMPOT (R820) to the value obtained with the test kit or other test method used. The analyzer is now calibrated and the sensor may be placed in the sample stream.

CALIBRATION PROCEDURE II

This procedure may be used to calibrate the analyzer and sensor while it is in the process water.

1. Turn the analyzer on and prepare it for use in accordance with steps 1 through 5 of calibration procedure I-FAC MODE.

2. Return the sensor to the process stream. Allow 2 or 3 minutes for meter to stabilize.

3. After the 2 or 3 minutes, withdraw a sample from the process water and determine concentration of chlorine using DPD-50 test kit or other recommended test.

4. Adjust CL SPAN TRIMPOT (R 820) to the value obtained with the test kit or test method used. The unit is now calibrated.

NOTE

The chlorine concentration in the process stream should not change during the calibration process.

DPD-50
TITRAMETRIC
WATER AND WASTEWATER
FAS-DPD CHLORINE DROP TEST KIT

PRINCIPLE

This test is an adaptation of procedure 408D in Standard Methods for the Examination of Water and Wastewater (15th ed., 1980).

This procedure yields results equivalent to other recommended tests including the iodometric-amperometric titration procedure (procedure 409C, Standard Methods, 14th ed.). It allows for the determination of FAC (free available chlorine) and TAC (total available chlorine).

The dropper tip closure supplied with the R501 FAS titrant is specifically designed to dispense 1/25ml. of titrant per drop and is a low cost substitute for the burrette. One drop of FAS titrant is equivalent to 0.2ppm as chlorine.

THE ANALYST SHOULD BE AWARE THAT THE ANALYSIS MAY BE SUBJECT TO INTERFERENCES FROM BOTH OXIDIZING AND REDUCING AGENTS PRESENT IN THE SAMPLE.

KIT COMPONENTS

1-R501	2 oz. droptip FAS titrant
1-R502	10 gm. DPD powder and buffer
1-R459A	15 gm. potassium iodide powder
2-No. 33	.2 gm. scoop
1-No. 30/No. 8	sample tube
1-	set of instructions
1-	storage case

GENERAL NOTES

1. When dissolving powders in sample tube, be sure to hold thumb on cap firmly while shaking.

2. In all tests with this kit, ignore further color development after initial color neutralization.

3. In both procedures (A and B) it is necessary totitrate the sample immediately after 30 seconds shaking

4. When dispensing drops, hold the FAS titrant bottle vertically.

PROCEDURE A

Free Available Chlorine (FAC)

1. Rinse the sample tube and cap with water to be tested.

2. Fill to 25 ml mark.

3. Add one level No. 33 scoop of R502 (DPD powder), cap and shake for approximately 30 seconds.

4. Add R501 dropwise keeping count ofdrops used until disappearance of pink color. Swirl the tube every few drops.

5. Multiply the number of drops times 0.2 to find CL2 content.

PROCEDURE B

Total Free Chlorine (TFC)

1. Rinse sample tube and cap with water to be tested.

2. Fill to 25 ml mark.

3. Add one level No. 33 scoop of R459A (potassium iodide).

4. Add one level No. 33 scoop of R502 (DPD powder). Cap and shake for 30 seconds to dissolve powders.

5. Add R501 dropwise, keeping count of drops used until disappearance of pink color. Swirl tube every few drops.

6. Multiply number of drops times 0.2 to find CL2 content.

MAINTENANCE

(ELECTRONIC BOARD ADJUSTMENTS)

PROCESSOR BOARD ADJUSTMENTS (Refer to Fig. 3 & 11)

The Model 924 has a test mode (Mode 0) of operation. This mode is entered by closing switch S4-1 located on the processor board near the bottom of the front panel. With S4-1 closed, all sampling of inputs from the input conditioner board is suspended. (It should be noted that the inputs are not physically disconnected, so that it is possible that some failure modes of the input conditioner could cause operational failure of Mode 0.) In Mode 0, the voltage at the arm of R35, located at the lower right corner of the processor/display, is used for the input parameter selected for display on the LCD readout. All other parameters retain the same input value as when the particular parameter was last displayed. For example, if R35 is set at the middle of its range and the front panel display selector is moved through all positions, the median value of all input parameters will be used to calculate the output parameters. An exception to this is the analog temperature output which is not calculated. This output is always determined by the value of resistance between the thermistor input terminals (3 and 5). Fig. 3. In Mode 0 the display will flash continuously.

There are three other potentiometers on the processor/display board, which should not require adjustment unless a D/A converter or voltage reference is changed. R5 is a single turn potentiometer used to trim the 2.5 volt reference to 2.500 volts. The total range of adjustment is approximately 200 millivolts. R24 and R25 are used to trim analog outputs 1 and 2 respectively. R24 is adjusted to give 10 volts between output terminals 1 and 7 (or between TP4 and analog return on the processor board) when the corresponding parameter display is at full scale. R 25 is adjusted to give 10 volts between output terminals 2 and 7 (or TP5 and analog return) when the corresponding parameter display is at full scale.

The 924 has three functional modes depending on the setting of the front panel FUNCTION switch. The FAC mode requires a chlorine sensor to be connected to input terminals 6 (red) and 7 (black) and a 3.00 kilohm thermistor to input terminals 5 and 3. A pH sensor may be connected to the BNC connector, but if not, it is good practice to short the BNC input to its shield connection. The TFC/AUTO mode requires both chlorine and pH sensors and a 3.00 kilohm thermistor. (The thermistor in the standard pH sensors is 1.00 kilohm.) In this mode, the chlorine sensor output is corrected by the processor using the thermistor and pH sensor outputs. In the TFC/MAN mode a fixed value is used for the pH correction. (Again it is good practice to short the BNC input.) This fixed value is entered by setting the display switch to pH and setting the screw-driver adjustment to the left of the FUNCTION selector to the appropriate value on the display. In this mode when pH is displayed, all calculations are suspended, the TFC output is held at its last value, and the pH output tracks the display.

INPUT CONDITIONER BOARD ADJUSTMENT (Refer to Fig. 6, 3, 12)

The input conditioner board has four adjustments: chlorine zero chlorine span, pH zero, and pH span. Since the pH sensor output is used to correct the chlorine sensor reading, it must be adjusted first. Two solutions of known pH are required, one of which has a pH of seven. With the sensor in this solution the zero adjustment (R851) should be set to give a reading of 7.00. With the sensor in the second solution the pH span (R855) should be adjusted to read to the value of this solution.

Chlorine zero is adjusted by R828. With the front panel FUNCTION, DISPLAY, and RANGE switches at TFC/AUTO, CL, and 1ppm; and the chlorine and pH sensors in a chlorine free solution, R828 should be adjusted to read zero on the display.

Chlorine span is adjusted by R820. With the front panel FUNCTION and DISPLAY switches at TFC/AUTO and CL; and the chlorine and pH sensors in a solution of known TFC, R820 should be adjusted to display the proper concentration.

The sensor may be simulated by inserting a current into input terminal 7. Input terminal 8 should be used for the return path of this current to bypass the sensor bias voltage. The input impedance between terminals 7, and 8 is 14.7 kilohms.

R851, R855, R828, and R820 can be adjusted independent of the processor display board by observing the outputs of the input conditioner. It should be noted, however, that no temperature compensation is made of the input conditioner board and that the following adjustment criteria apply at 25 degrees C. R851 should be adjusted while observing the voltage at pin M which is related to pH as follows:

$$E_M = 526.5 \times (\text{pH}-7.00)\ \text{mV}$$

R851 (offset) and R820 (span) are adjusted while observing voltage at pin K which has the relationship, for E_K in volts:

$$E_K = 0.220 \times (\text{ppm concentration})-4.167$$

The Model 924 input conditioner provides a battery to maintain bias voltage on the chlorine sensor when power is off. This battery is charged during normal operation. A fully charged battery will supply sensor bias for at least forty hours. When the instrument is turned on after a long off-period, the charge rate can be safely increased by installing a five thousand ohm resistor across R858 for ten operating hours.

Table 2

Model 924 Functional Modes

FRONT PANEL SETTING				OUTPUTS[2]	
FUNCTION SWITCH	DISPLAY SWITCH	RANGE SWITCH	FRONT PANEL DISPLAY	PARAMETER 1 [3] TERM 1-10V FS TERM 5-10mVFS	PARAMETER 2 [3] TERM 2-10V FS TERM 6-10mVFS
FAC	C1	10		10ppm HOCL FS	For all Front
		5	HOCL in ppm	5ppm HOCL FS	Panel settings
		1		1ppm HOCL FS	this parameter gives pH from 0-14 FS.
	TEMP	10		10ppm HOCL FS	
		5	Temp in deg-C	5ppm HOCL FS	
		1		1ppm HOCL FS	
	pH	10		10ppm HOCL FS	
		5	pH Sensor out-	5ppm HIOCL FS	
		1	put	1ppm HOCL FS	
TFC/AUTO	CL	10		10ppm TFC FS	
.(pH SENSOR)			5	TFC in ppm	5ppm TFC FS
		1		1ppm TFC FS	
	TEMP	10		10ppm TFC FS	
		5	Temp. in C	5ppm TFC FS	
		1		1ppm TFC FS	
	pH	10		10ppm TFC FS	
		5	pH Sensor out-	5ppm TFC FS	
		1	put	1ppm TFC FS	
TFC/MAN	CL	10		10ppm TFC FS	
(pH FIXED)		5	TFC in ppm	5ppm TFC FS	
		1		1ppm TFC FS	
	pH[1]	10		10ppm TFC FS	
		5	Current fixed	5ppm TFC FS	
		1	pH	1ppm TFC FS	

NOTES:
1) When the FUNCTION switch is set to TFC/MAN and the DISPLAY switch to pH, the instrument will be in the "pH SET-UP" mode. In this mode all calculations are suspended to allow pH to be entered manually. Parameter 1 output is the value of TFC immediately prior to switching to this setting. Parameter 2 is the current value of the pH setting.. The data base is initialized when leaving this setting.
2) Temperature indication is always available at output terminal 3, 0-10V representing 0-50C.
3) Common for all voltage outputs is output terminal 7.

SERIAL INPUT/OUTPUT BOARD ADJUSTMENTS (OPTIONAL)

This board provides an RS-232 serial link with the processor. Consult factory.

DUAL ALARM BOARD ADJUSTMENTS (OPTIONAL) Refer to Fig. 13

An alarm condition is also recognized by the processor which gives the message indicated by Table 5 alternately with the normal parameter being displayed. Either alarm may be connected to either parameter by means of jumpers on the board. Either alarm may also be configured to alarm on a "high" or "low" condition by means of a pair of Jumpers for each alarm.

Switches S501-1 and S501-2 on the board determine whether or not the alarm relays 1 and 2 respectively latch or are released when the alarm condition is no longer present. Latching is inhibited when the switch is closed. A latched condition may be reset by momentarily closing the appropriate switch or by momentarily shorting the ALARM RESET terminals on the I/O connector board. A latched alarm can also be reset by software.

Setpoints are easily adjusted by operating in Mode 0 and using R35 to set the desired- level. The set point potentiometers (R501 and R502) can then be adjusted to give the alarm indication on the display. In adjusting the setpoints it should be noted that a hysteresis of several hundred million volts is normal.

Table 3

ALARM MESSAGE

CONDITION	DISPLAY
ALARM 1 ACTIVE	1.-.-.-
ALARM 2 ACTIVE	-.-.-.2
BOTH ALARMS ACTIVE	1.-.-.2

ISOLATED CURRENT OUTPUT BOARD ADJUSTHENTS (Optional) (Refer to Fig. 14)
The isolated current card may be configured by means of a jumper to operate from either output parameter. A jumper also determines whether zero input volts results in zero or four output milliamperes. Ten volts produces 20 mA in both cases.

To adjust the offset and gain adjustments set switch S4-1 on the processor board for mode 0 operation. Using R35 set meter for zero voltage and adjust R629 for zero current output or 4 mA output. Using R35 set front panel display to 10.00 and adjust R612 for a 20 mADC output.

If one 4-20 mA output is selected for temperature value transmission, during adjustment of the 4 mA and 20 mA levels the display will be in engineering units. For example, 0:0 display will correspond to 4 mA and a 50:0 display will correspond to 20 mA. To minimize power dissipation, the current output terminals should be shorted when not connected to an external instrument.

CHLORINE SENSOR MAINTENANCE

The sensor, like the instrument, is constructed of durable, corrosion-resistance materials. See Figure 4. It is designed to withstand rough use in laboratories, industrial installations, or waste treatment systems. The sensor may be used in any water solution, but will be attacked by organic solvents such as chloroform, benzene, or ethyl acetate. Special sensors are available for use with such materials, and for temperature extremes. Consult the factory for details.

The only service required on the sensor is changing the electrolyte every 12 months and replacement of damaged membranes as necessary.

ELECTROLYTE LEVEL: The electrolyte reservoir must be correctly filled for proper operation of the sensor. Check this from time to time. Hold the sensor vertically with filling screw facing upward, and remove screw. If necessary, add electrolyte. Use the dropper cap supplied with NO. R-448 Electrolyte and fill the reservoir all the way to the middle of the pressure proof membrane. There should be a free air space above the electrolyte. This may be noted on the pressure proof glands on the side of the probe. Replace the screw and tighten firmly.

ELECTROLYTE REPLACEMENT: It is recommended that the electrolyte be replaced every 12 months. Of course, a damaged membrane will cause replacement to be required sooner. Exhaustion of electrolyte indicated when the instrument loses sensitivity and cannot be brought to the proper meter reading during calibration, or by excessive drift of the calibration setting. To replace the electrolyte, remove the filling screw. Tip the sensor so that the fill hole faces downward and shake out the electrolyte. Refill completely as described above and tighten fill screw.

REPLACING THE MEMBRANE: The sensor has a screw-on membrane cap. It does not have to be replaced except in the event the membrane has become torn or punctured, or is being replaced due to slow response as described below. Use one of the replacement caps supplied in the No. 824240 Refill Membrane Kit. The kit contains 3 membrane caps, and a 4 oz. bottle with dropper cap, of No. R-448. Unscrew the old membrane cap. Flush the tip of the sensor with distilled water and wipe clean. Place 5 to 9 drops of R-448 Electrolyte into a new membrane cap. Holding the sensor with the tip facing downwards, screw the membrane cap in place, from below. Tighten the cap slowly, but thoroughly, using finger pressure only. Do not use tools. Refill the reservoir if necessary.

CAUTION

When the new cap has been screwed fully into place, the membrane becomes correctly stretched across the slightly curved cathode. Once so stretched, it would become "too loose" if the cap were unscrewed, even partially. For this reason, NEVER unscrew the membrane cap, even partially, unless it is being completely replaced. It is important. to instruct all personnel NOT to tamper with the cap, because once loosened, it must be fully removed and discarded! Loosened membranes can cause sluggish responses, and faulty reading!

NOTE

Used membrane caps can be rebuilt, consult the factory.

After replacing membrane-cap, turn the instrument on for at least 30 minutes to stabilize the sensor, and then re-calibrate. Low sensitivity or slow response indicates an improperly installed membrane-cap. Replace with a new cap.

The membrane need be changed only when accidentally torn or punctured, no matter how long the sensor has been in service. Occasionally the membrane may develop a tear or pin hole which cannot be seen with the naked eye. This will result in a sudden rise in reading, even over the top of the meter. Should this occur, replace the membrane promptly, to avoid depletion of the electrolyte. Refill the sensor with fresh electrolyte.

ALGAE AND OTHER,GROWTHS ON SENSOR: Algae or other growths may develop on the tip if the sensor is left immersed in certain samples. These growths may interfere with accuracy and should be removed. Dip the tip of the sensor into a beaker containing hydrochloric acid (not sulfuric or nitric) of approximately 6N to 8N strength (50-60Z solution) for a few moments and then thoroughly flush with clean tap water. Experience with local conditions will determine the frequency of such cleaning. This may also be done before use as a preventive measure if the sensor
is used when slime may grow on it.

Long storage of the sensor in a beaker of distilled water may cause a build-up of bacterial slime. This can be prevented by adding a few drops of Formaldehyde to the water in which the sensor is stored. If this is not practical, remove the slime as described above. If hydrochloric acid is not available, the slime may be removed with wet paper or cloth and a detergent. Exercise care to avoid loosening or damaging the membrane.

PREVENTIVE MAINTENANCE: To avoid malfunction and possible breakdown, the preventive maintenance checks listed in the table below should be performed on a regular basis.

INTERVAL	ITEM	MAINTENANCE FUNCTION
As required by plant conditions	Cleaner/Agitator (if used)	Check for grease buildup, lint fouling, or mechanical damage.
Monthly	Sensor	Check condition of membrane and gold cathode. Gold cathode should be clean and have a bright satin finish. Replace membrane if torn or punctured.
When replacing membrane	Sensor	Check for proper wicking action. Dry sensor tip off and hold vertically with the tip down. In a short period of time the three wicks should begin to "weep". If this does not occur, then the old electrolyte should be drained and the sensor flushed with warm water. (Several flushings and an acid rinse may be necessary in some cases.)
Monthly	Cleaner/Agitator	Place cleaner/agitator in a bucket of water. Check operation of paddle for proper movement. If it appears too slow, check power supply for low voltage. Bimonthly
Bimonthly	Analyzer	Check calibration. (Refer to calibration section.)

HELPFUL OPERATING HINTS

Errors in Chlorine readings are often caused by improper operation the analyzer. If analyzer readings do not agree with test result listed below are some typical problems which can cause this.

TIP PROTECTOR NOT REMOVED: Make sure the Tip Protector is removed from the sensor before operating or calibrating the instrument.

If the above steps do not result in proper operation, proceed follows:

PREVIOUSLY LOOSENED MEMBRANE CAP: This is another frequent cause of improper operation. Once a membrane cap is installed and loosened, it will never operate properly again, even if tightened. Once loosened, the membrane cap must be replaced with a new one. See SENSOR MAINTENANCE.

INSUFFICIENT STIRRING RATE: Is another cause of improper operation. If the natural rate of flow is not rapid enough a Remote Stirrer must be used.

IMPORTANT: Make sure the sensor is located so that it will always remain submerged.

ELECTROLYTE LEAKAGE: The sensor will operate if it is not absolutely full. It is a good idea, however, to check it periodically and fill it if necessary. If it is necessary to fill the electrolyte reservoir, check the following:

1. Check the membrane. Sometimes a sharp object will puncture the membrane causing a pinhole too small to be seen. Replace membrane if necessary. See SENSOR MAINTENANCE.

2. Check the electrolyte fill screw. It should be tight and there should always be an O-ring under it for proper sealing.

ALGAE AND OTHER GROWTHS ON SENSOR: Algae and other growths may develop on the tip in certain applications. These growths may interfere with accuracy and should be removed. See SENSOR MAINTENANCE.

INTERFERENCES

The sensor supplied with the instrument is, for all practical purposes, interference free.

RECORDERS

Refer to external wiring diagram. (Fig. 3)

OPTIONAL PH SENSOR MAINTANCE

The sensor, like the instrument, is constructed of durable, corrosion resistance materials, See Figure 6. It is designed to withstand rough use in laboratories, industrial installations, or waste treatment systems. The sensor may be used in any water solution, but will be attacked by organic solvents such as chloroform, benzene, or ethyl acetate, Special sensors are available for use with such materials, and for temperature extremes. Consult the factory for details.

The only service required on the sensor is keeping the measuring glass clean.

HELPFUL OPERATING TECHNIQUES

1. As shipped, the electrode tip is covered by a protective cap which serves both to keep the reference from drying and to prevent breakage. This cap is a snug fit and it contains a pressure relief hole to facilitate removal and installation. As supplied, this hole is covered by a piece of vinyl tape to retain moisture inside the cap. Before removing or reinstalling cap, the tape must be removed to expose the pressure relief hole.

2. During shipment the air pocket in the electrode's stem may move into the bulb area. If bubbles are seen in the bulb area, hold the electrode by its top cap and shake downwards as is done with a clinical thermometer.

3. Vigorously stir the electrode in the sample, buffer or rinse solution. This action will bring solution to the electrode's surface more quickly and improve speed of response.

4. After exposure to a sample, buffer or rinse solution, shake the electrode with a snap motion to remove residual drops of solution. This action will minimize contamination from carryover.

5. As a rinse solution, use a part of the next sample or buffer which is to be measured. This action also will minimize contamination from carryover.

6. When calibrating, use a buffer close in value to that expected from the sample. This action will minimize any span errors.

7. Keep buffers and samples at the same temperature. This action will eliminate the need to correct values for temperature effects 8. pH readings stabilize faster in some solutions than others; allow time for the reading to stabilize. In general, buffers provide stable readings in several seconds (tris buffers take somewhat longer) while samples usually take longer times.

9. Keep in mind that all pH electrodes "age" with time. Aging is characterized by shortened span and slower speed of response. If pH meter has a "slope" (span) control, the calibrate control can be adjusted to compensate for electrode span errors (but will not

affect speed of response). Aging is best detected by calibrating the electrode in, for example, 7 buffer and then rinsing and placing the electrode in 4.01 buffer. As a rule, if the span if 10% or more in error (a reading of 4.3 or higher for this example the electrode should be cleaned and/or reconditioned and retested. If reconditioning does not restore performance the electrode should be replaced.

RECONDITIONING

When reconditioning is required due to electrode aging (see Helpful Operating Techniques, Pg. 18), the following chemical treatments should be tried. They are presented in the order of the severity of their attack on the pH glass and may not improve (and in some cases actually further deteriorate) electrode performance.

NOTE

1. **Immerse the electrode tip in 0.1N HCL for 15 seconds, rinse in tap water and then immerse tip in 0.1N NaOH for 15 seconds and rinse in tap water. Repeat this sequence several times and then recheck electrode performance. If performance has not been restored, try Step 2.**

2. **Immerse the tip in a 20Z solution of NH4F.HF (ammonium bifluride) for 2 to 3 minutes, rinse in tap water and recheck performance. If performance has not been restored, try Step 3.**

3. **Immerse electrode tip in 10X HF for 10 to 15 seconds, rinse well in tap water, quickly rinse in 5N HC1, rinse well in tap water and recheck performance. If performance has not been restored, it is time to get another Delta electrode.**

ELECTRODE STORAGE

When pH readings are made infrequently, for example, several' days or weeks apart, the electrode can be stored simply by replacing its protective cap. Make certain that the cotton inside the cap is wet (use distilled water), that the cap pressure relief hole is open and slowly push the cap into position. Then, cover the hole in the cap's side with a piece of tape. For very long term storage, taping the top of the cap to the electrode's body will provide additional protection against water loss.

TROUBLESHOOTING

The localization of faults in electronic equipment is often the most difficult part of the service work, and no written instruction on the subject can replace familiarity with the instrument and knowledge of its construction. The built-in self diagnostics of the microprocessor will help facilitate systematic troubleshooting of the system, however, this section cannot cover every possible problem. The most likely sources of trouble are listed together with the appropriate corrective measures.

Before beginning troubleshooting procedures, check that the proper power source is being applied to the system. Also check that the sensor and its cable are undamaged. A digital multimeter can be used for checking voltages and current outputs.

By using the test mode (Mode O) of operation, the built-in simulator and front panel controls and display it is possible to simulate input parameters. This can be used to verify proper internal functioning of the analog to digital conversions, processing, outputs and alarms.

The built-in self diagnostics can display two types of error messages; operational and equipment malfunctions.

Table 4

OPERATIONAL ERRORS

E101	Calculation results in questionable valve.
E102	Insufficient data (a required input parameter not available) See sensor troubleshooting section.
E103	Excessive input noise this can be caused by excessive stray voltage in the process where the sensor is located.
E104	Input Measurement out of range.
E105	Calculated results out of range.

EQUIPMENT PROBLEMS

H001	Read-only-memory of processor fails. Check sum. Permanent program failure.
H002	Random-access-memory failure (Unable to write or read back correctly).
H003	Identification error. During every program cycle the input board I.D. is checked.
H004-	A circuit board in wrong slot.
H005-	Display switch failure.
Hi006	Not programmed for P.C. Board identity (wrong or no input card).

SENSOR TROUBLESHOOTING

MALFUNCTION	PROBABLE CAUSE
No LCD Display	A. Instrument not connected to power source. B. Power fuse blown.
No Temperature readout or E102 code in Chlorine or temperature mode.	Check 3 Kohm thermistor in sensor-brown and blue leads.
Chlorine display shows erratic action.	A. Tap the sensor shell with a screwdriver handle. If the indicator becomes erratic, a bad connection(s) exists in the sensor. B. The membrane may be punctured. C. The gold cathode in the tip may be dented. D. The membrane cap may not be screwed on tight enough, causing the membrane to lift off the cathode with the turbulent water action. E. The sensor is not wicking properly. F. The power supply is varying. Put a meter in series with lead number and observe the micro-amp current (approximately 3 microamp/ppm). It should remain steady.
No Chlorine reading, or E102 code on LCD display	A. Input amplifier board not working. B. Cleaner/agitator not working.
No Chlorine output (optional 4-20 mA) or constant signal.	Note display action. If Chlorine is indicated and no output is present (4-20 mA DC) at output terminals then the 4-20 output board is at fault and should be replaced.

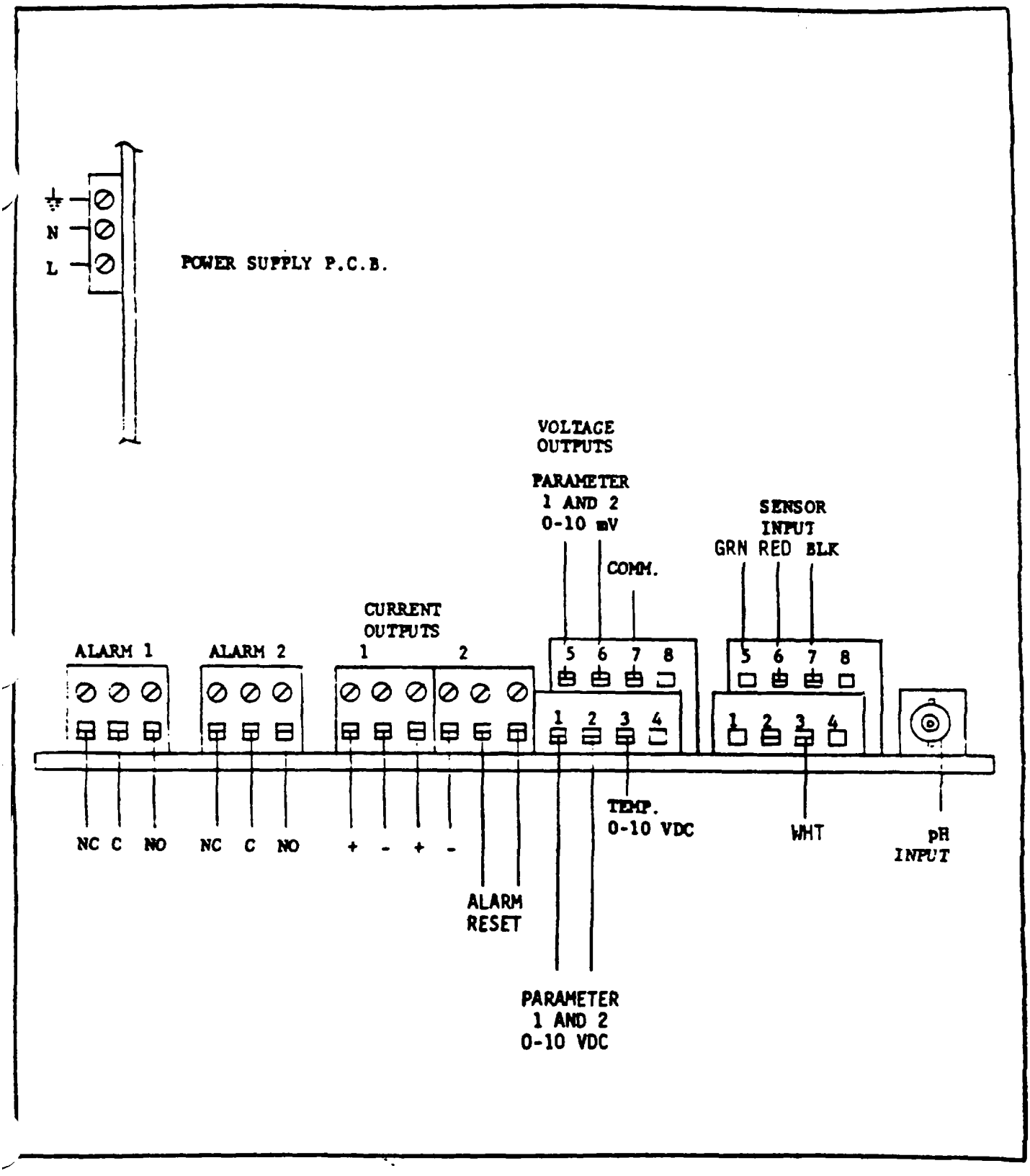


Fig. 3 - 924 External Connections

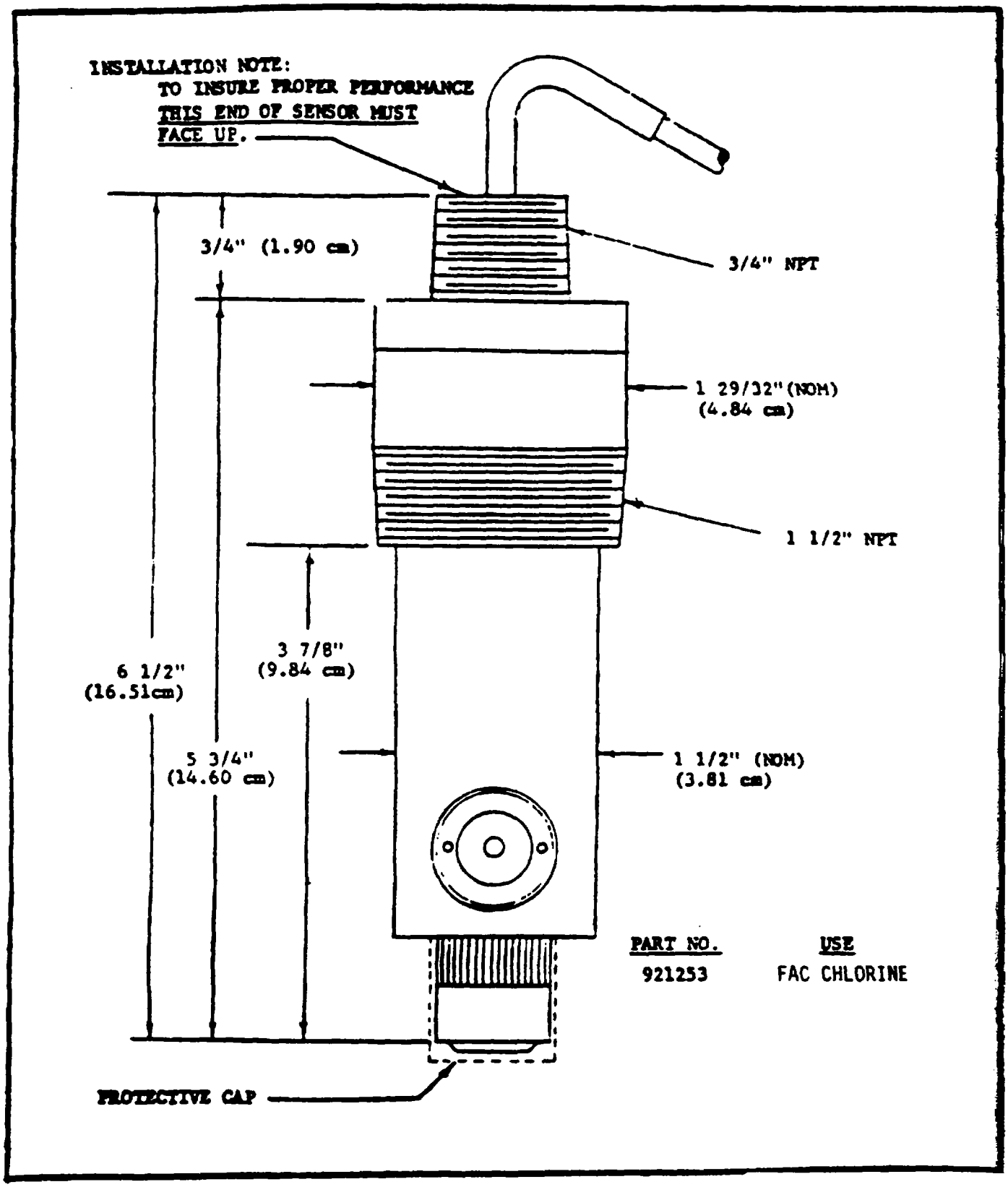


Fig. 4 - Sensor Dimensional

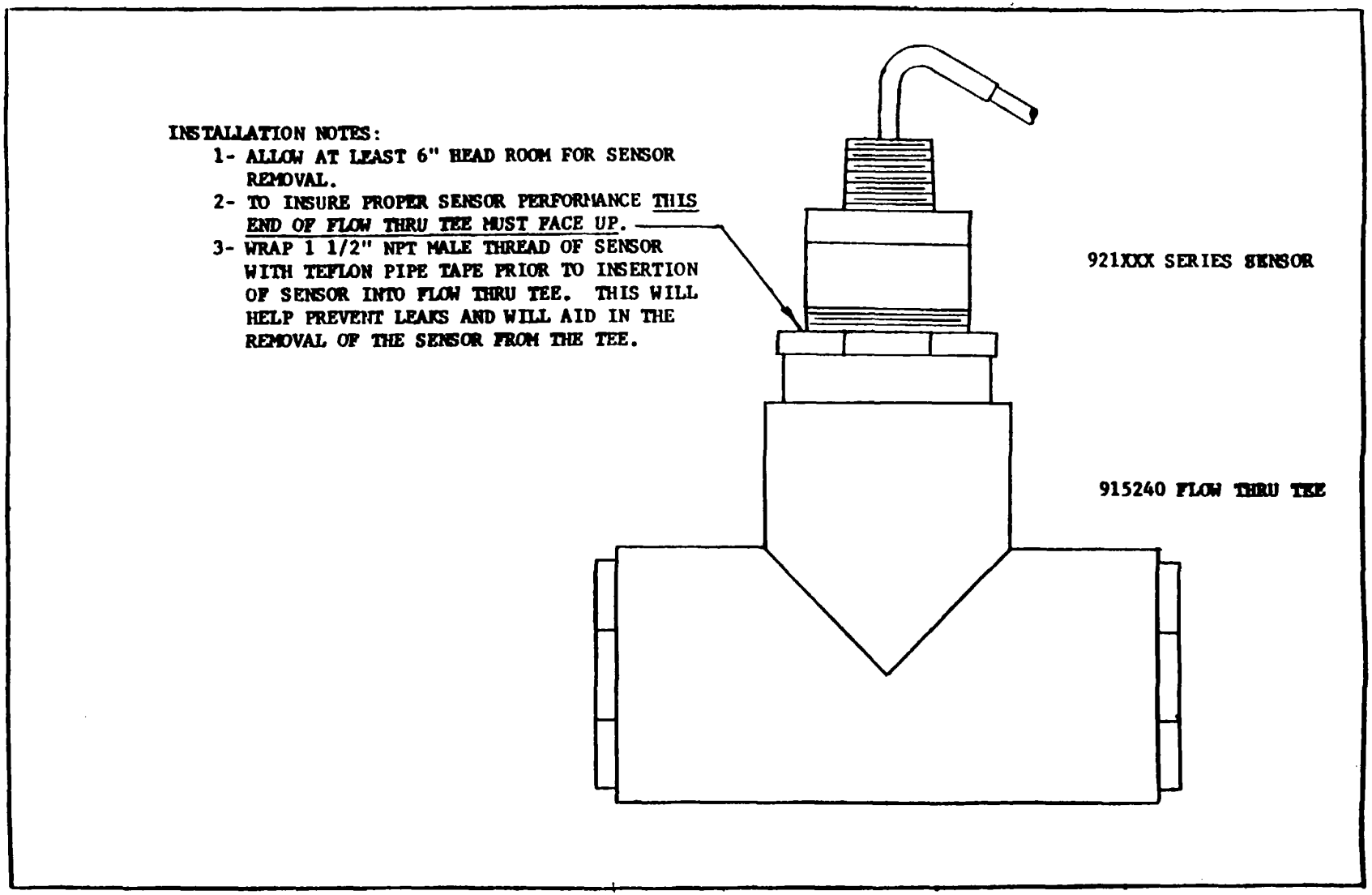


Fig. 5 - Flow Thru Tee

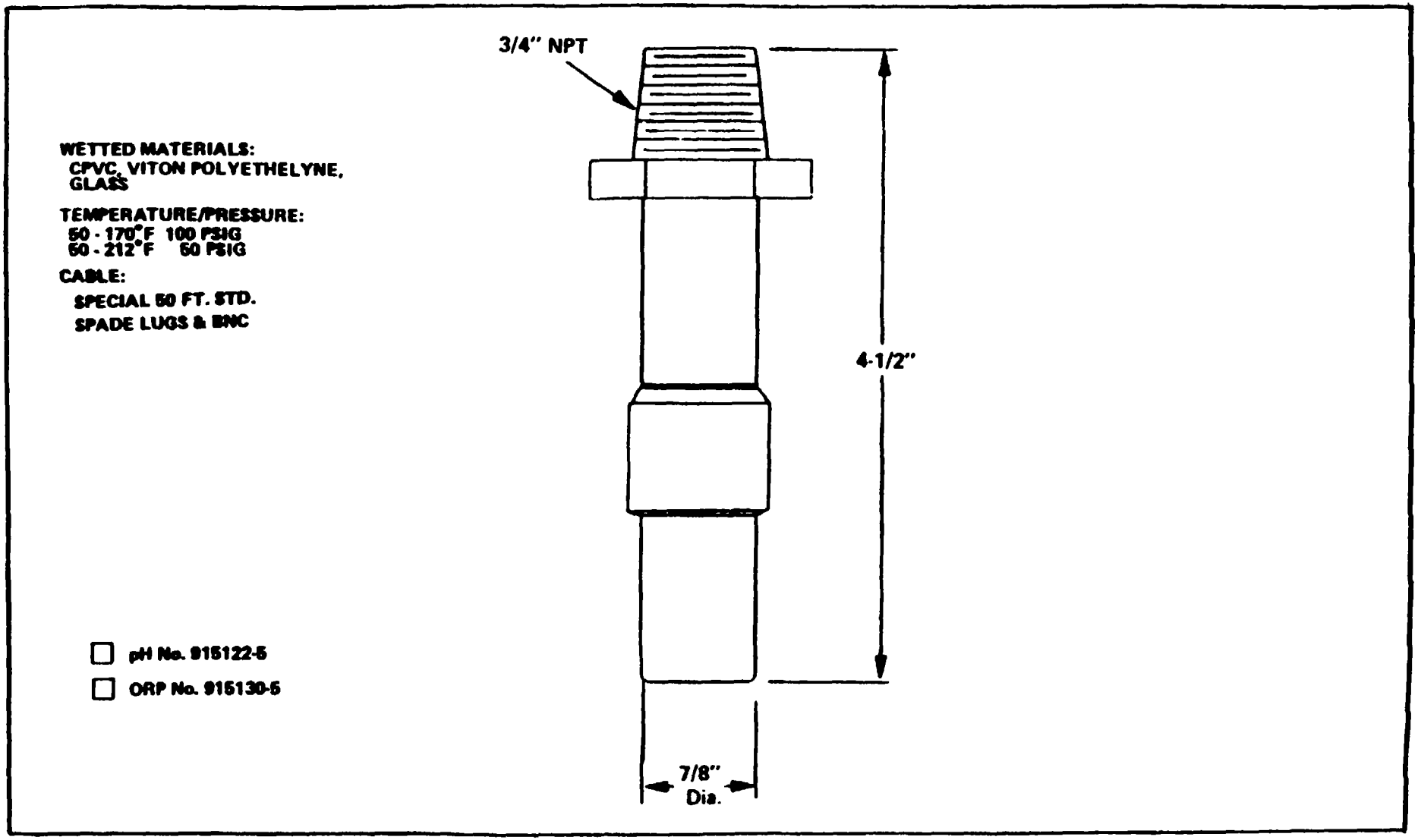


FIG. 6 - Optional pH Sensor Dimensional Dwg.

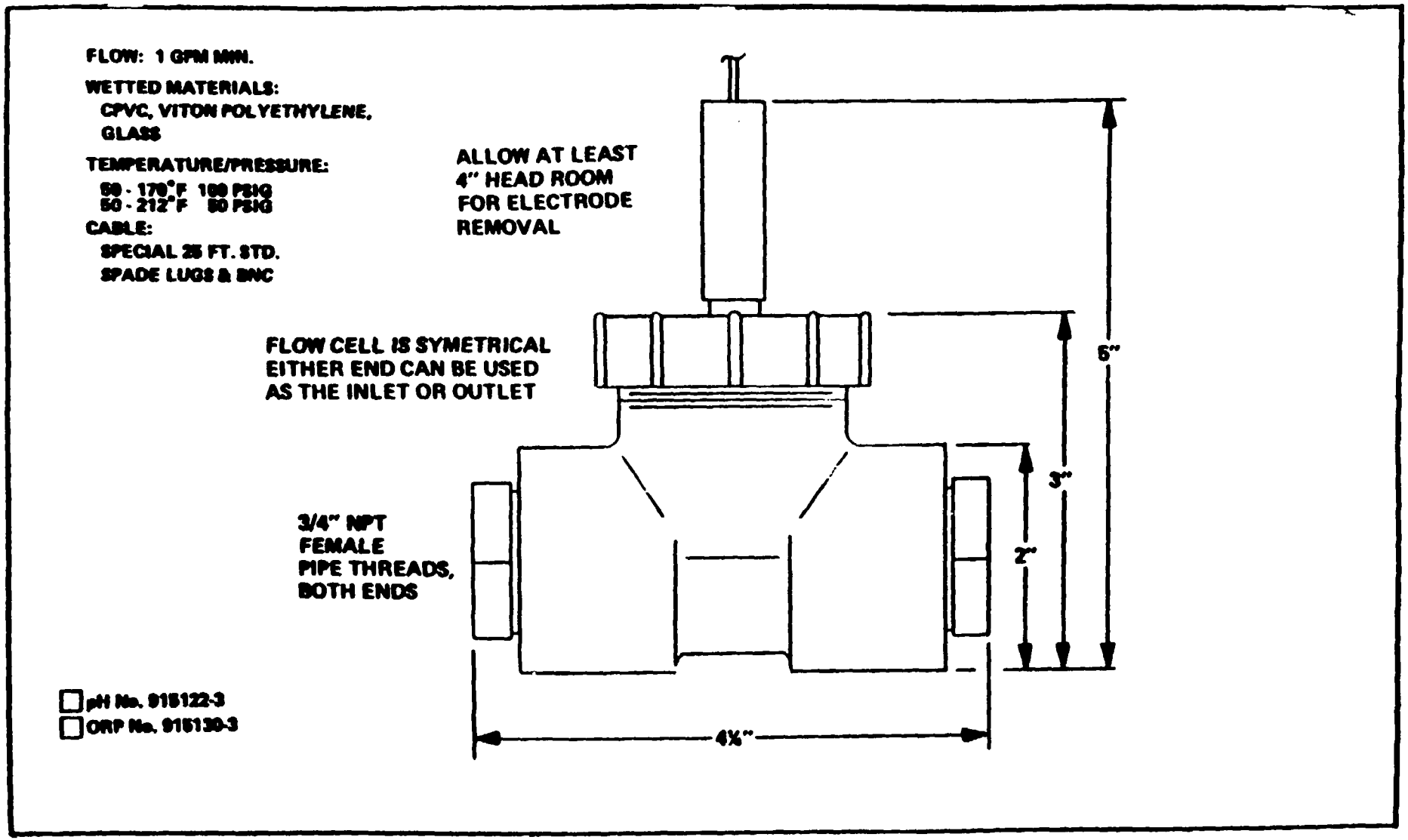


FIG. 7 - Optional pH Flow-Thru Sensor Dimensional Dwg.

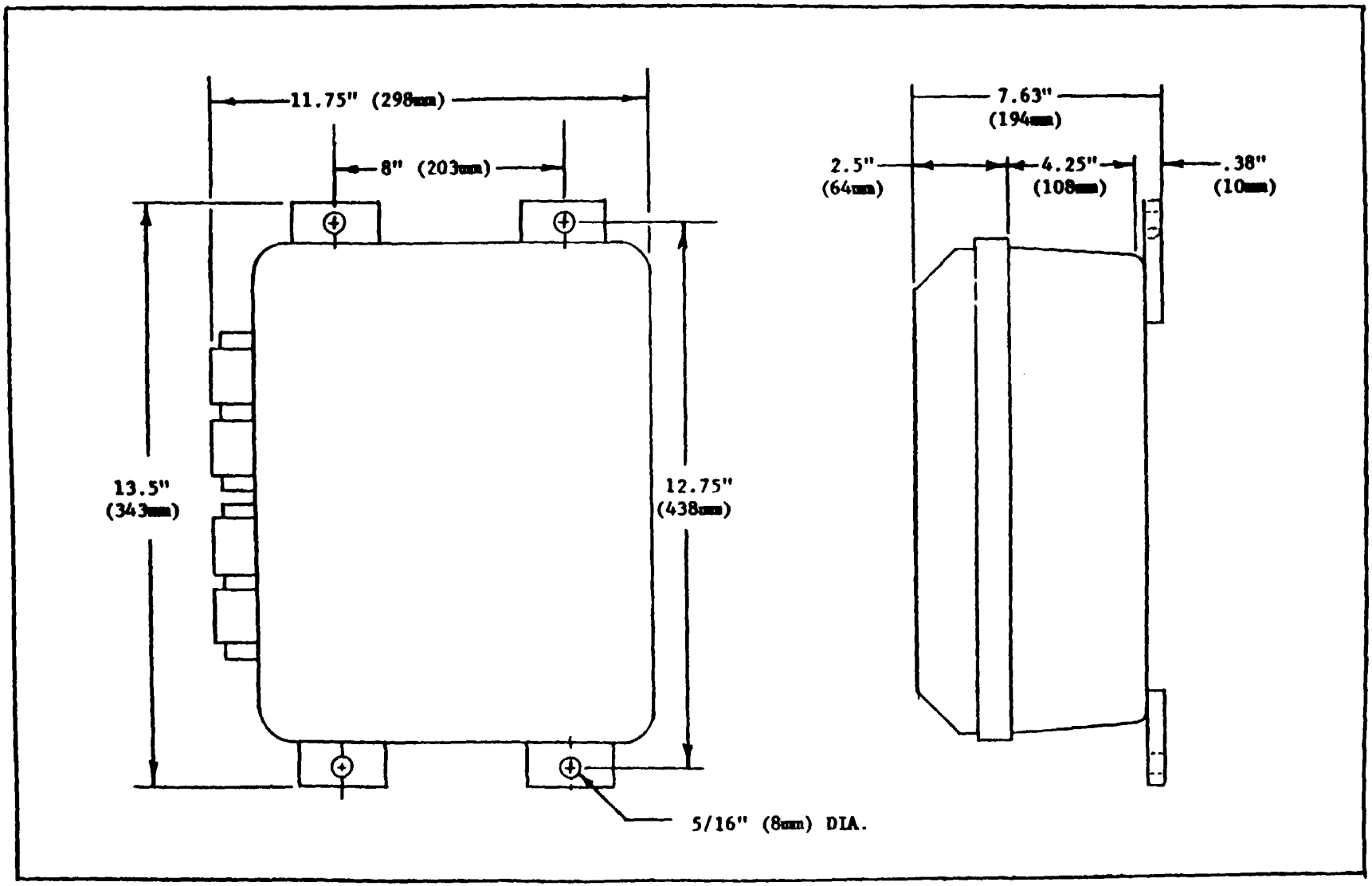


Fig. 8 Analyzer Dimensions

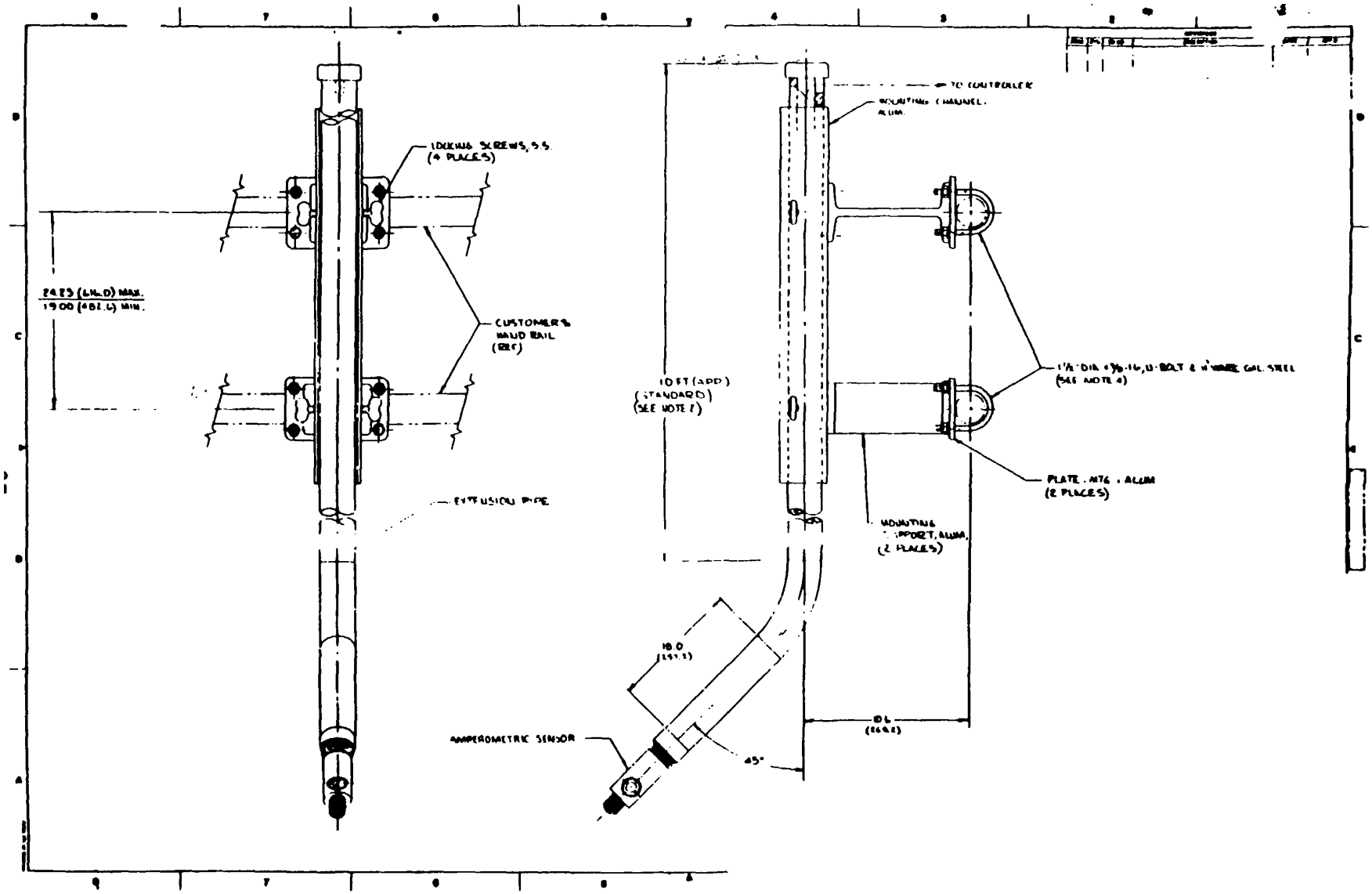


Fig. 9 - Sweep E11

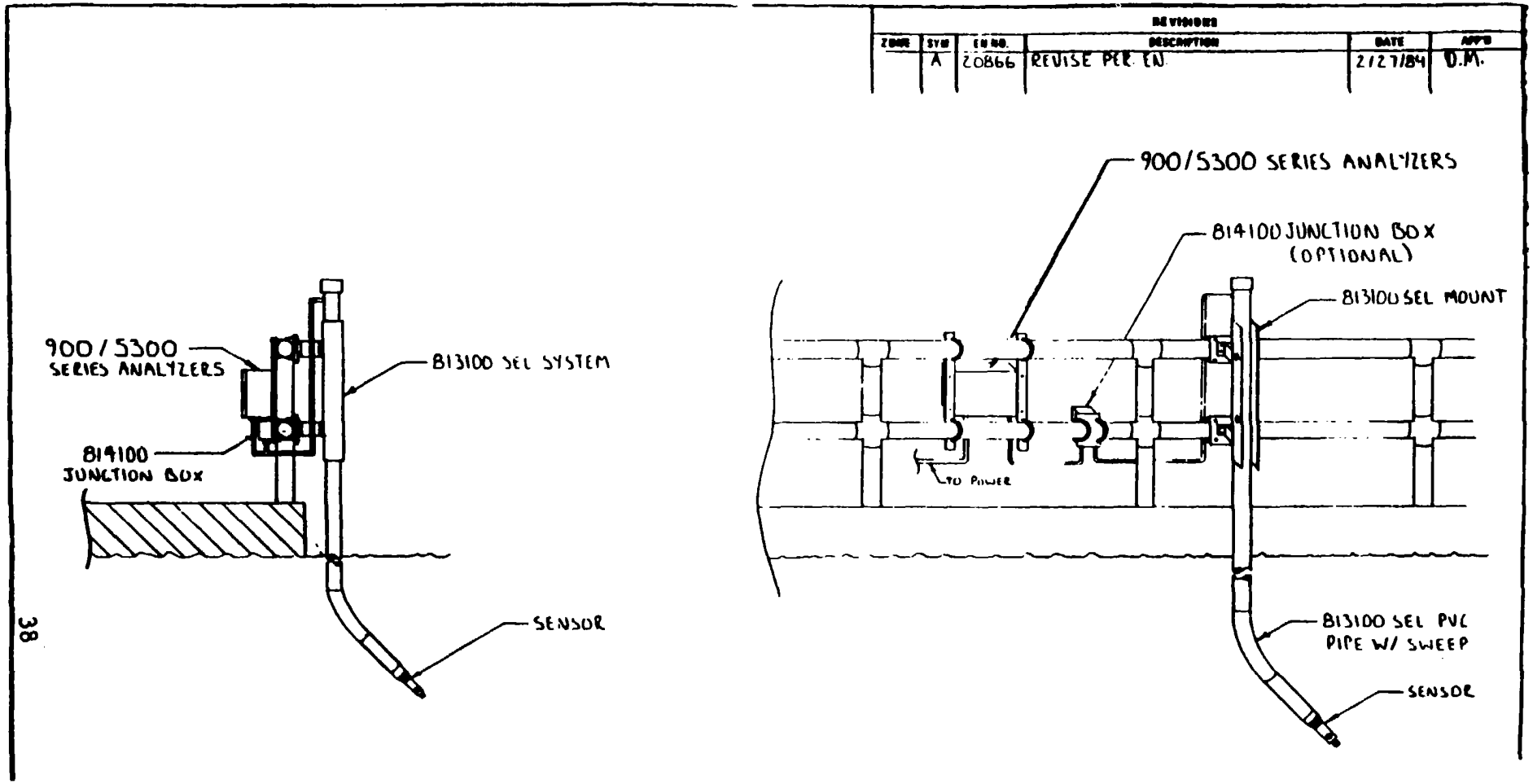


Fig. 10 - Typical Handrail Mounting

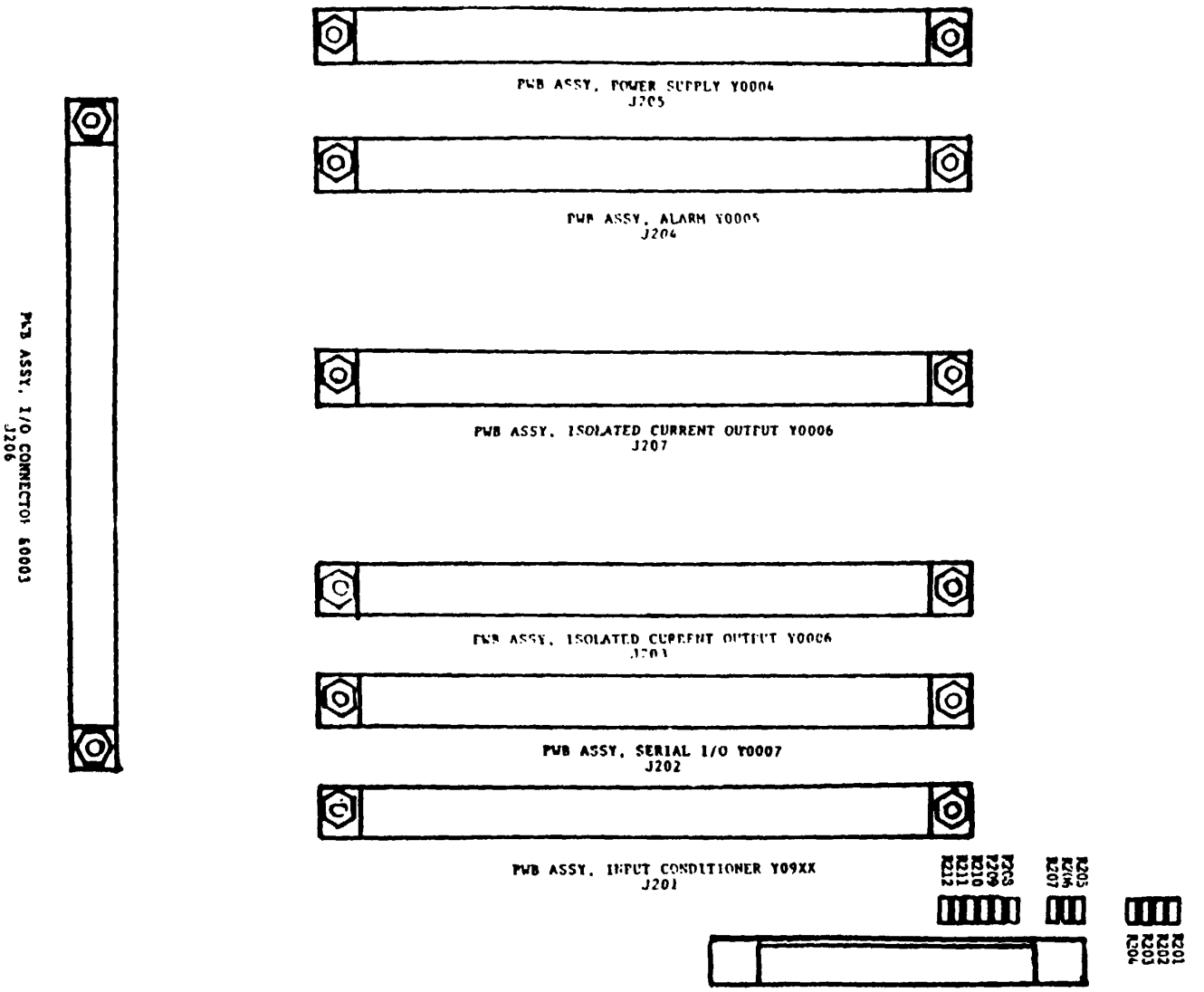


Fig. 11 - Motherboard

XERTEX

DELTA ANALYTICAL

250 MARCUS BOULEVARD HAUPPAUGE, NEW YORK
TELEPHONE (516) 273-6190 • TELEX 144545

WARRANTY

For the benefit of the original Purchaser, Delta Analytical warrants all products of its manufacture to be free from defects in material and workmanship when installed, serviced and operated according to Delta Analytical instructions. Delta Analytical will repair or replace, F. O. B. its plant or other location designated by it, any part(s) which examination shall show to be defective under normal use within one year from date of installation or eighteen months from date of shipment to the original Purchaser, whichever comes first. For component equipment not of Delta Analytical manufacture, Delta Analytical assumes no obligation for design or construction, but shall, upon notification by Purchaser either arrange for on-site repair by the manufacturer's authorized service facility or return to our plant for repair or replacement as required. Delta Analytical's obligation under this Warranty is based upon its receiving prompt notice of claimed defects which shall in no event be later than 30 days after the end of the warranty period.

Any special test or requirement placed upon Delta Analytical products must be mutually agreed upon in writing between Delta Analytical and the Purchaser at the time of contract acceptance. If Delta Analytical sells any equipment not of its manufacture but as part of a system sale and necessary for the operation of the system, Delta Analytical warrants such equipment to be free from defects in material and workmanship for 90 days from date of installation at original Purchaser's site.

This Warranty shall not apply to products or parts which have been altered or repaired outside Delta Analytical's plant or with other than Delta Analytical's replacement parts, without it's prior written consent, or damaged by improper installation, application, erosion or corrosion, or subject to misuse, abuse, neglect or accident. Any labor or material backcharges or product returned for refund must receive Delta Analytical's prior written authorization.

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Transamerica Delaval

GEMS®

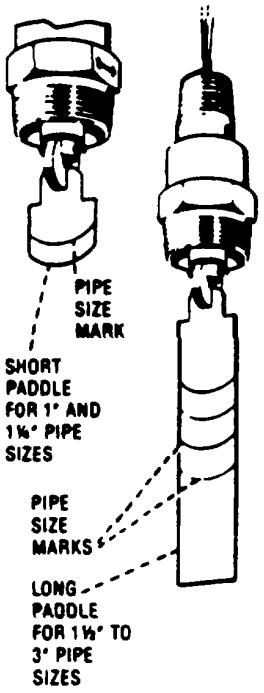
FLOW SWITCHES PADDLE TYPE

FS-550, FS-600 SERIES

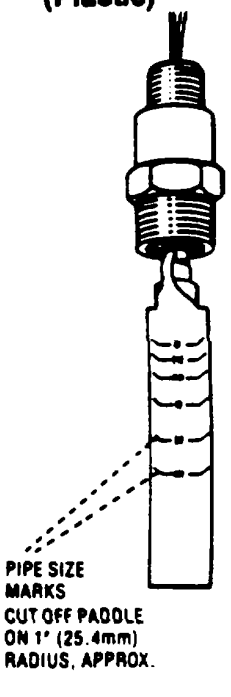
INSTALLATION AND MAINTENANCE

Flow Switch Paddle Details . . .

FS-550 Series



FS-600 Series (Plastic)



Before Installing Unit...

Paddle length establishes approximate actuation setting of Flow Switch unit. Cut off paddle at proper pipe size mark on paddle for system pipe line size and the desired flow setting (see chart below or at right). For flow setting other than standard, cut off paddle at intermediate point. Consult Gems Sensors Division for any additional information.

FS-600 Series Actuation Flow Rates, Standard

Pipe TEE Size	Dim. "L" to Cutoff Size	Actuation Flow Rate—GPM	
		Increas. Flow	Decreas. Flow
1"	⅞" (22.2mm)	10	5
1¼"	1⅛" (28.6mm)	10	5
1½"	1⅜" (34.9mm)	15	10
2"	1⅞" (47.6mm)	20	10
2½"	2⅜" (60.3mm)	25	15
3"	2⅞" (73.0mm)	30	20

FS-550 Series Actuation and De-actuation Set Points, Standard

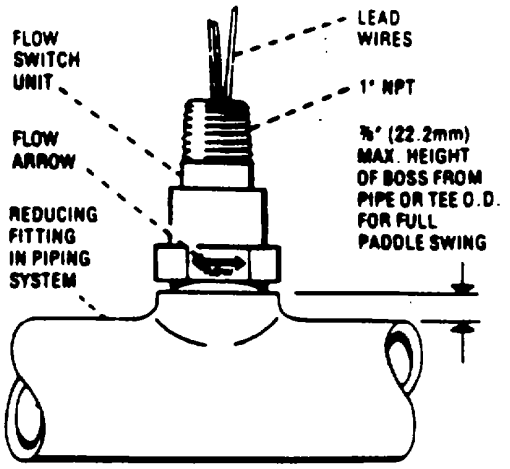
	Pipe Size Marked at Paddle Cut-off Point	Pipe Line Sizes											
		1"		1¼"		1½"		2"		2½"		3"	
		Actuation and De-actuation Flow Rates—GPM Water											
		Act.	De-Act.	Act.	De-Act.	Act.	De-Act.	Act.	De-Act.	Act.	De-Act.	Act.	De-Act.
Short Paddle Unit	1"	5	4	8.5	6.5	12	9	17	15				
	1¼"			6.5	4.5	9	7	15	12	23	20		
Long Paddle Unit	1½"					14	10	23	16	32	25		
	2"							18	12	24	17	33	27
	2½"									20	13	27	22
	3"											22	16

All flow rate tests for the "Set Points" table were conducted with the FS-550 installed in standard "T" fittings. For calculation of flow rates in pipe sizes larger than 3" . . . a flow velocity of approximately 0.5 ft. per sec. actuates the FS-550 wiht a full length (5") paddle.

To Install Unit . . .

Mounting is 1" NPT on FS-550 and FS-600 Series units. Locate Flow Switch unit in system to allow at least three pipe diameters of straight, horizontal piping run in both directions. Install unit in vertical position, lead wires up, in standard pipe tee or reducing fitting as shown at right.

Be sure flow arrow on housing is parallel with pipe run. Use standard pipe fitting procedures for FS-550 and FS-600 Series units. Use tape to seal the 1" NPT. Be careful not to over-tighten FS-600 Series, plastic unit.



GEMS Paddle Type Flow Switch unit installed in reducing fitting.

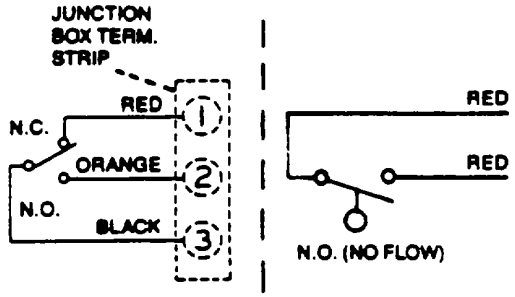
Electrical Connection . . .

Wire leads and ½" NPT for conduit connection are provided at top of unit. FM-approved, FS-550 units equipped with junction boxes are available.

Maintenance . . .

Occasional cleaning to remove excessive particle build-up is the only maintenance normally required. Remove unit from system to clean, or to check operation (by manually actuating paddle).

Typical Wiring Diagrams . . .



FS-550 Series | FS-600 Series

WARNING

Product must be maintained and installed in strict accordance with the Gems technical brochure and installation, operation and maintenance bulletin. Failure to observe this warning could result in serious injuries or damages.

For hazardous area applications involving such things as (but not limited to) ignitable mixtures, combustible dust and flammables, use an appropriate explosion-proof enclosure or intrinsically safe interface device.

CAUTION

The pressure and temperature limitations shown on the individual catalog pages and drawings for the specified flow switches must not be exceeded. These pressures and temperatures must take into consideration possible system surge pressures/temperatures and their frequencies.

The liquids used must be compatible with the materials of construction. Specifications of materials will be given upon request.

Life expectancy of switch contacts varies with applications. Contact the factory if life cycle testing is required.

Ambient temperature changes do affect switch set points, since specific gravities of liquids vary with temperature. Consult factory for assistance.

Flow switches have been designed to be shock and vibration resistant; however shock and vibration should be minimized. Consult factory for assistance.

Excessive contaminants in fluid may inhibit float operation and occasional wipe-down may be necessary. Consult factory for assistance.

Troubleshooting and maintenance of flow switches should be in strict compliance with procedures set forth in the troubleshooting and maintenance sections of the technical brochure or an installation, operation and maintenance bulletin.

Electrical entries and mounting points require liquid/vapor sealing.

Flow switches must not be field-repaired.

Physical damage to product may render product unserviceable.

Transamerica Delaval

TRANSAMERICA DELAVAL INC.
GEMS SENSORS DIVISION
Cowles Road
Plainville, Connecticut 06062-9990, U.S.A.
Tel. 203-677-1311 Telex 99-306

162-682

Printed in U.S.A.

Tank Air Escape Valves

Model 1600

Description: Model 1600 Wager Tank Air Escapes consist of a body (of any material) equipped with a 30 x 30 mesh monel flame screen and a ¼ x ¼ mesh monel protecting screen, separated by a spacer ring. These parts are held in place on the body by means of a monel cap and #316 stainless steel screws.

Connections are either screwed IPS, flanged ASA or weld type as required.

Although somewhat similar in design to the Wager Inverted Vent Check Valves, these Tank Air Escapes are *not* equipped with a ball float.

Function: Wager Tank Air Escapes serve to allow the free passage of air into tanks, dry cargo holds, or storage spaces . . . and prevent vacuum or pressure build-up during pumping operations. Since these valves have no float for automatic closing, they should be placed in locations which are not accessible to sea water. The fine monel flame screen protects tank fluids or dry cargo dust from igniting in the event of deck fires , prevents the entrance of insects into areas serviced by these valves.

A coarse monel Protecting Screen, separated from the Flame Screen by a spacer ring, prevents any mechanical damage to the Flame Screen and acts as a deterrent to clogging this inner screen with paint.

Features:

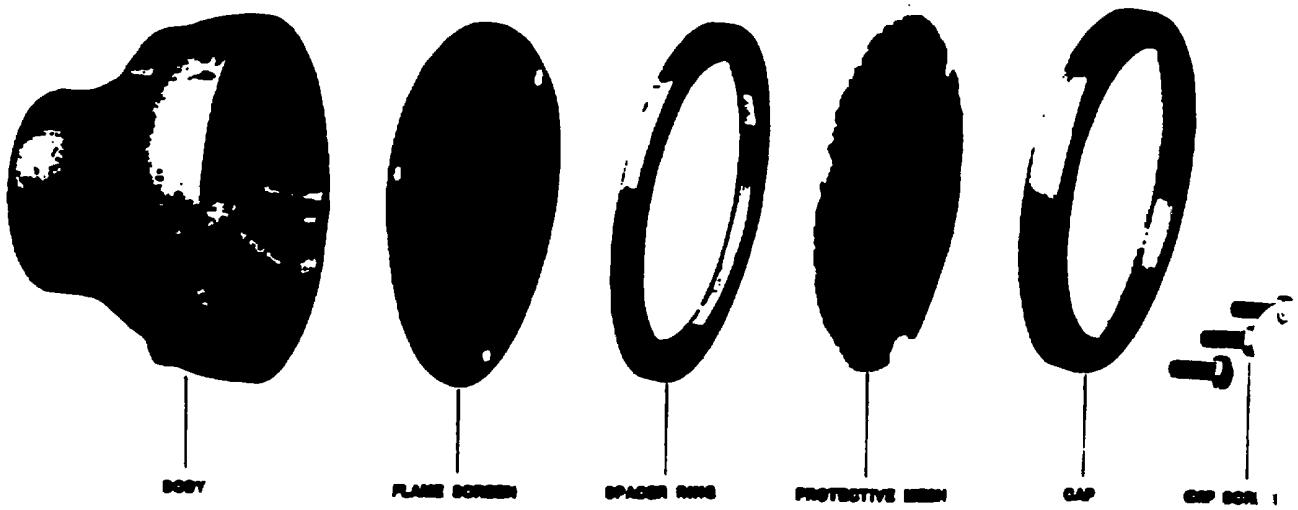
1 — OPEN AREA RATIO: Meets latest requirements for ABS, USMA, USCG and U. S. Navy.

2 — ACCESSIBILITY OF PARTS: Removal of the cap screws facilitates cleaning, inspection and/or replacement.

3 — RESISTANCE TO CORROSION: Monel and Stainless Steel are used for trim insuring long life.

4 — BODY MATERIAL: Steel, Stainless Steel, Cast Iron or Bronze.

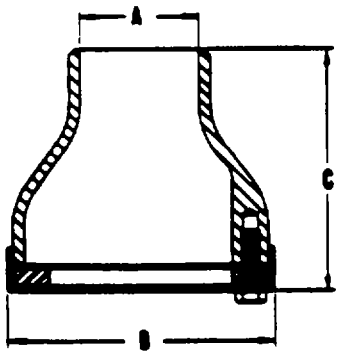
Exploded View



Robert H. Wager Co., Inc.- Passaic Ave.. Chatham, N.J. 07928 .Tel. 201-6354200

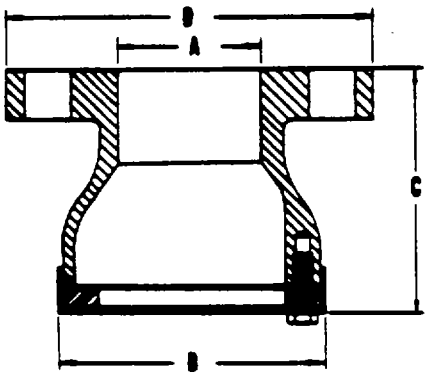
Tank Air Escape Valves

Weld Type 1600-W



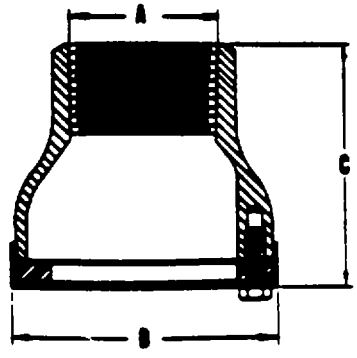
A	1-1/2	2	2-1/2	3	3-1/2	4	5	6	8	10	12
B	3-5/8	4-1/2	5-3/8	6-1/4	–	7-1/4	10-1/4	11-1/2	14-1/2	17-1/8	20-3/4
C	3-11/32	3-11/32	3-27/32	3-27/32	–	4-11/32	7-3/4	8-3/4	9-3/4	12-3/4	15-1/8
Wt.	2-1/2	3-1/4	4-1/4	5	–	6-1/2	25-1/2	35	60	80	100

Flanged Type 1600-F



A	1-1/2	2	2-1/2	3	3-1/2	4	5	6	8	10	12
B	3-5/8	4-1/2	5-3/8	6-1/4	–	7-1/4	10-1/4	11-1/2	14-1/2	17-1/8	20-3/4
C	3-11/32	3-11/32	3-27/32	3-27/32	–	4-11/32	7-3/4	8-3/4	9-3/4	12-3/4	15-1/8
B	5	6	7	7-1/2	–	9	10	11	13-1/2	16	19
Wt.	5-1/2	6-1/4	10	13	–	19-1/2	41	52	87	120	200

Threaded Type 1600-T



A	1-1/2	2	2-1/2	3	3-1/2	4	5	6	8	10	12
B	3-5/8	4-1/2	5-3/8	6-1/4	–	7-1/4	10-1/4	11-1/2	14-1/2	17-1/8	20-3/4
C	3-11/32	3-11/32	3-27/32	3-27/32	–	4-11/32	7-3/4	8-3/4	9-3/4	12-3/4	15-1/8
Wt.	2-1/2	3-1/4	4-1/4	5	–	6-1/2	25-1/2	35	60	80	100

By Order of the Secretary of the Army

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General, United States Army
Chief of Staff

Official: 

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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 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 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

Liquid Measure

1 centiliter = 10 milliters = .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

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. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. 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: 065353-000