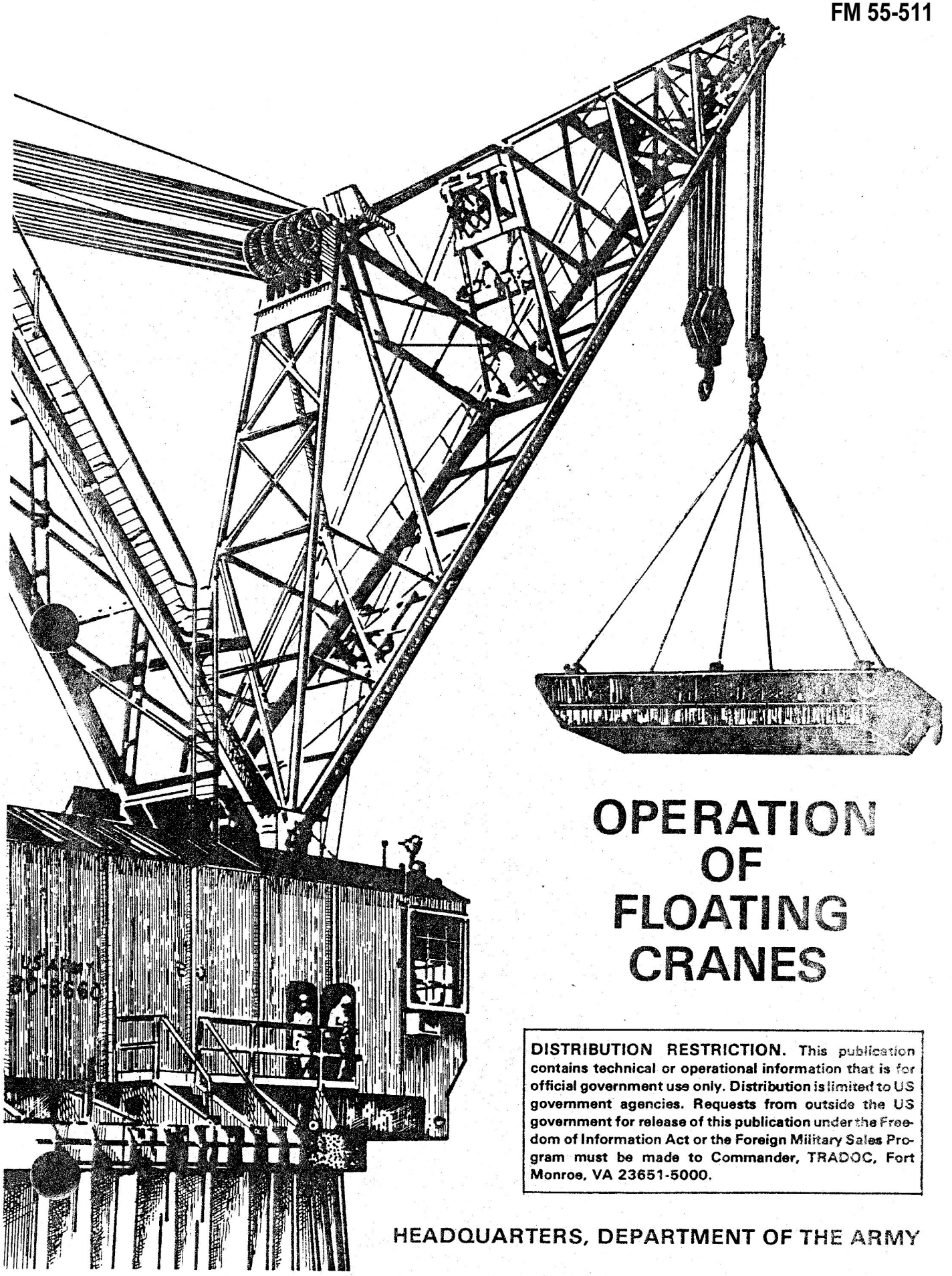
FM 55-511



OPERATION OF FLOATING CRANES

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HEADQUARTERS, DEPARTMENT OF THE ARMY

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FIELD MANUAL
No. 55-511

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 12 December 1985

Operation of Floating Cranes

PREFACE

This manual provides technical information on the operation of the 100-ton floating crane (Design 264B) after its rehabilitation under the Product Improvement Program (PIP). The PIP provided–

Ž Installation of two electrical systems, alternating current (AC) for the ship's services and direct current (DC) for the crane's hoist and rotate machinery.

• A fixed fire-fighting system.

Ž A self-contained sanitation system to meet federal pollution control standards.

Ž Modernization of the crew's quarters.

• Upgraded capacity of the auxiliary lift to 28 short tons (STONs).

This manual describes both the new AC-powered equipment and the DC-powered engines and equipment, as well as operation and maintenance procedures. Corresponding information for the 60-ton floating cranes (Design 413D) still in use is provided in Appendix A.

For any maintenance beyond preventive maintenance, refer to the applicable technical manuals (TMs) or technical bulletins (TBs) for those specific items of equipment. For specific requirements on deck maintenance, marlinspike seamanship, and fire fighting, refer to FM 55-501.

The proponent of this publication is HQ TRADOC. Submit changes for improving this publication on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward it to Commandant, US Army Transportation and Aviation Logistics Schools, ATTN: ATSP-TDL, Fort Eustis, VA 23604-5399.

Unless otherwise stated, whenever the masculine gender is used, both men and women are included.

*This manual supersedes TM 55-511, 18 July 1988.

CHAPTER 1

GENERAL

This chapter describes the duty assignments of personnel assigned to a floating crane. Also described are the hand signals used during crane operations and the overall safety procedures and requirements that must be observed during crane operations.

DUTY ASSIGNMENTS

The number of personnel and their duty assignment aboard a floating crane vary. The number of people assigned and their specific MOS will also vary depending on the mission and where the floating crane is assigned. The 100-ton floating crane has an authorized strength of 15 personnel whose primary duties are described below.

CHIEF ENGINEER (CRANE MASTER), 510A1 WARRANT OFFICER

As commanding officer of the crane, the crane master is responsible for technical training, safety, and conduct of the crew. The crane master is a qualified engineering warrant officer and has first-hand information on all moving parts of the crane. He is responsible for the employment and operation of the crane. His responsiblities include:

- Directing the operation, repair, and maintenance of crane equipment.
- Conducting daily inspections of the crane to ensure that security, operating conditions of the crane and its equipment, general maintenance, and living conditions are consistent with Army standards.
- Ensuring that a record of operation for each item of PIP-affected machinery, the engine, and the motor is kept on a daily basis in the engineer log, DA Form 4993 (Harbor Boat Engine Department Log for Class A and B Vessels).
- Ensuring that the deck log is maintained on a daily basis. The deck log, DA Form 4640 (Harbor Boat Deck Department Log for Class A and B Vessels), is the record of daily operational activities that have occurred aboard the crane and is signed each day by the crane master. It includes the time, number, and weight of each lift made and a brief description of the prevailing weather.
- Preparing repair and maintenance requests and ordering spare parts, tools, and supplies for the crane.
- Maintaining the air-conditioning and refrigeration units aboard the crane.
- Ensuring that personnel are trained and qualified to signal for crane operations and to communicate from crane to shore and crane to other vessels by radio.
- Supervising the deactivation, towing preparation (including the rigging and display of towing lights and day signals), and activation of the floating crane.

BOATSWAIN (WATERCRAFT NCO), 61B30, E-6

The boatswain assumes the duties of the crane master during the crane master's absence. The boatswain is responsible for the safety of all personnel working above deck with the crane during its operations; for personnel training in fire, abandon-ship, and man-overboard drills; and for first aid. He is also responsible for maintenance and upkeep of the outside hull from the waterline up, the barge machinery house, and the boom. His responsibilities include the following:

- Ordering and storing deck stores and supplies.
- Communicating by radio with shore, other floating craft, and the crane operator.
- Operating the capstans, winches, and windlass during anchoring operations or while warping the crane into dockside or alongside vessels.
- Entering the daily operations of the crane, including the number of lifts, weights, operating times, brief description of weather, and other pertinent data, in the deck log (DA Form 4640) for the crane master's signature.

- Activating the outside portion of the floating crane above the waterline.
- Preparing the crane for oversea delivery.
- Ensuring that the proper towing lights and day shapes are displayed.

SENIOR MARINE ENGINEER, 61C20, E-5

The senior marine engineer is responsible for the general upkeep and preventive maintenance of all machinery aboard the crane. He is also responsible for the following:

- Starting and stopping the main and auxiliary engines and generators.
- Monitoring the operation of the engines for indications of trouble.
- Repairing the main and auxiliary engines as required, and keeping a log on the running time of all engines, the repairs made, and the repairs to be made by higher category maintenance.
- Inspecting and repairing the capstans, winches, and windlasses and lubricating all moving parts of the crane as required by current lubrication orders (LOs).
- Supervising the loading of fuel and water aboard the crane.
- Having daily inspections of the bilges and, if needed, having them pumped dry.
- Painting and cleaning all engine spaces and machinery.
- Supervising and training assigned enginemen.

CRANE OPERATOR, 62F20, E-5

The crane operator uses the proper controls to move the crane as directed by the signalman, He must be alert constantly to the proper operation of the crane controls and be certain that the safety limit switches are functioning properly. During sluing operations, when the signalman is out of the line of vision, the crane operator must be extremely cautious to prevent the boom from striking the masts, yardarms, guys, antennas, or any part of the superstructure of another vessel, as well as dockside power lines, structures, and poles. When the crane operator cannot see the load being lifted or transported, he must be able to see the signalman and carry out every signal by properly coordinating the controls. The crane operator's responsibility for accident prevention is greater than that of any other crew member. Another responsibility is to train the assistant crane operator in all aspects of crane operations.

ASSISTANT CRANE OPERATOR, 62F10, E-4

The assistant crane operator will operate the crane under the direct supervision of the crane operator until it is determined that the individual can safely operate the crane. The assistant crane operator will assist the crane operator in the daily routine.

POWER GENERATOR EQUIPMENT REPAIRER, 52D10, E-4

The power generator equipment repairer is responsible for the entire electrical system of the crane and for the daily checkout of the electrical panel board, controller, navigation lights, signal lights, and floodlights. These responsibilities include–

- Checking for grounds, blown fuses, and short circuits.
- Making certain that the correct operating voltage is available.
- Making repairs as required.
- Acting as signalman for communications between crane and shore or crane and other floating craft during crane operations.

ENGINEMAN, 61C10, E-4 AND E-3

Two enginemen are authorized for the crane. The enginemen lubricate the main and auxiliary engines, hoisting machinery, and deck machinery. They also operate the main and auxiliary engines under the supervision of the senior marine engineer. They are

responsible for packing and repairing pipe fittings, keeping the engine room clean, and assisting the senior marine engineer in daily engine room duties.

RIGGER, 51C10, E-4

The rigger is responsible for rigging and reeving the crane. The rigger inspects the wire hoisting rope daily for frayed or broken wires and replaces the wire rope as required. The rigger is also responsible for–

- Lubricating the crane's sheaves daily.
- Inspecting the upper and lower load blocks daily for cracks or worn pulleys and pins; repairing or replacing components as required.
- Making up the wire rope sling to be used for hoisting.
- Ensuring that the correct sling is used for each lift.
- Being the signalman for the barge crane operator.
- Knowing all hand signals used for hoisting operations.
- Estimating the weight of each lift and relaying this information to the crane operator so the operator can adjust the boom for the weight to be lifted.
- Storing all lifting equipment and slings.

SEAMAN, 61B10, E-4 AND E-3

The seamen handle lines and hawsers when docking, anchoring, or moving into position for making lifts. Moreover, seamen must–

- Assist in maintaining and operating deck machinery.
- Stand watches: transmit signals and communications' as directed by the crane master.
- Clean decks and quarters.
- Scrape paint and maintain the outside area of the barge, machinery house, and barge equipment.
- Splice and repair shipboard lines.
- Assist the rigger in splicing wire rope slings and bridles and in reeving and repairing wire rope.

SENIOR COOK, 94B30, E-6

The cook (authorized for the 100-ton crane) is responsible for requesting and maintaining an adequate supply of food aboard the crane barge. The cook prepares and cooks fruits, vegetables, meats, seafood, and poultry. He must be able to bake rolls, breads, cakes, and pies. Moreover, the cook must maintain the galley, stove, and refrigerator according to prescribed sanitary standards.

SIGNALS

The crane operator regulates the movements of the crane according to signal instructions from the signalman. These signals must be given correctly to ensure proper handling of equipment and materials and to safeguard personnel. The signalman, as opposed to the crane operator, has an unobstructed view of the entire operation.

IMPORTANCE OF SIGNALMAN

Crane operations require close coordination between the crane operator and the signalman. The signalman not only sees what is going on but also hears. If, at deck level, something is seen or heard that is not right, the signalman must immediately stop the operation. Communications between the signalman and the crane operator must be rapid, clear, and understood. Sometimes it is necessary to have more than one signalman. For example, when the crane is being used to handle equipment in the hold of a vessel, a signalman would be required in the hold as well as on deck. The signalman on deck would be in full view of both the crane operator and the signalman in the hold. During this operation, the signals are given by the signalman in the hold to the signalman on deck. The

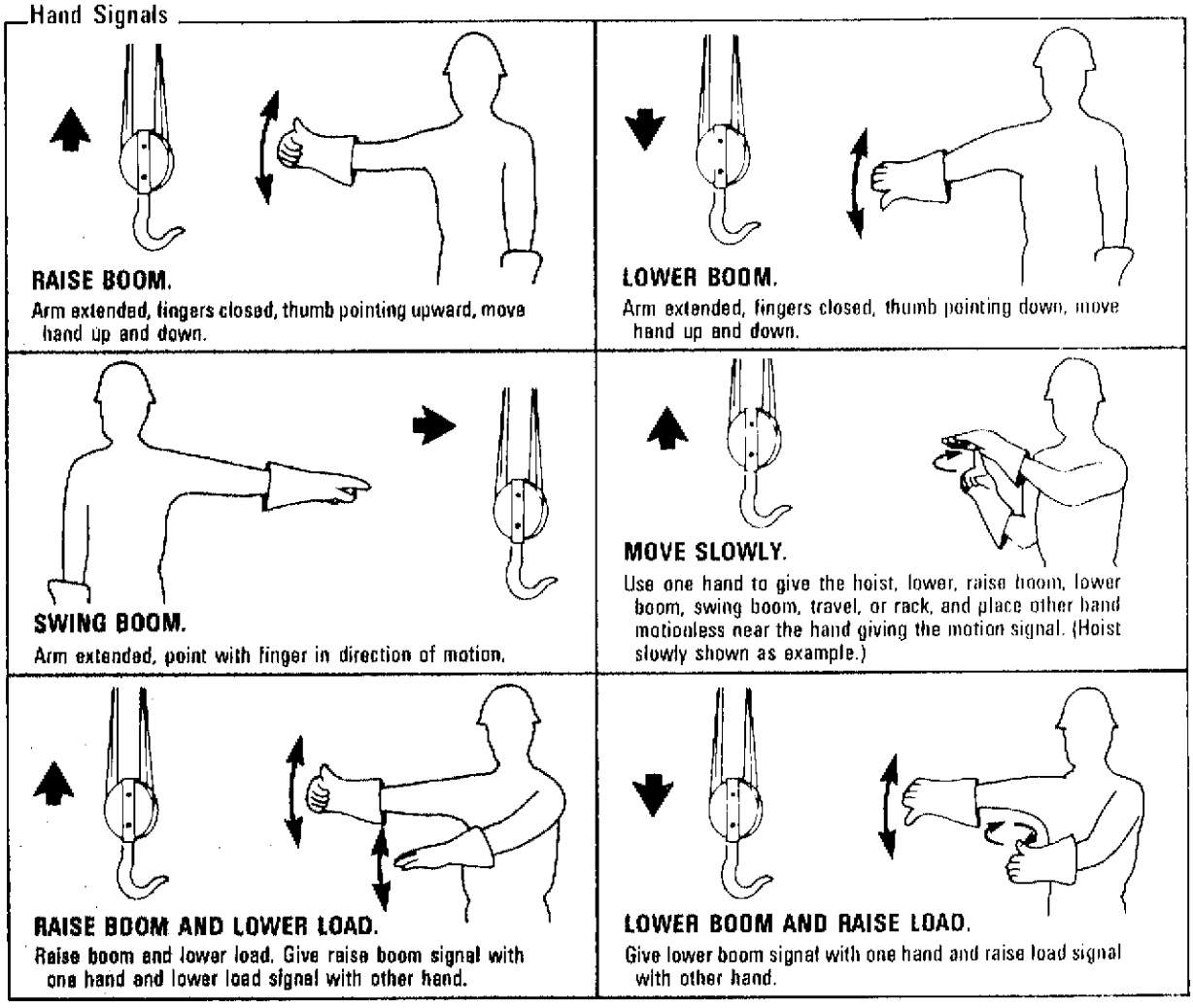
signalman on deck, in turn, conveys the signals to the crane operator When two signalmen are required, exact duplication of signals must be communicated between them for correct movement by the crane operator.

TYPES OF SIGNALS

Two types of signals may be used, depending on the visibility of the signalman to the crane operator, Hand signals avoid confusion and are the most reliable type of communication inadequate lighting is available. Light signals may be used during darkness or inclement weather. The crane cannot be operated efficiently and safely without thorough coordination and understanding between the operator and signal. man. There must be strict adherence to a prearranged set of rules and signals.

When hand signals are used, the hand movement must be made in phase with the work in progress, The crane operator could misinterpret unnecessary hand movement, which could create a hazardous condition The use of white or brightly colored gloves by signalmen will give the crane operator a better visual contact. The signalman should always face the crane operator when giving hand signals

Hand Signals



RAISE BOOM.
Arm extended, fingers closed, thumb pointing upward, move hand up and down.

LOWER BOOM.
Arm extended, fingers closed, thumb pointing down, move hand up and down.

SWING BOOM.
Arm extended, point with finger in direction of motion.

MOVE SLOWLY.
Use one hand to give the hoist, lower, raise boom, lower boom, swing boom, travel, or rack, and place other hand motionless near the hand giving the motion signal. (Hoist slowly shown as example.)

RAISE BOOM AND LOWER LOAD.
Raise boom and lower load. Give raise boom signal with one hand and lower load signal with other hand.

LOWER BOOM AND RAISE LOAD.
Give lower boom signal with one hand and raise load signal with other hand.

The illustration shows the meaning and method of conveying each type of hand signal. In some instances, two signals have the same meaning but are conveyed by different methods.

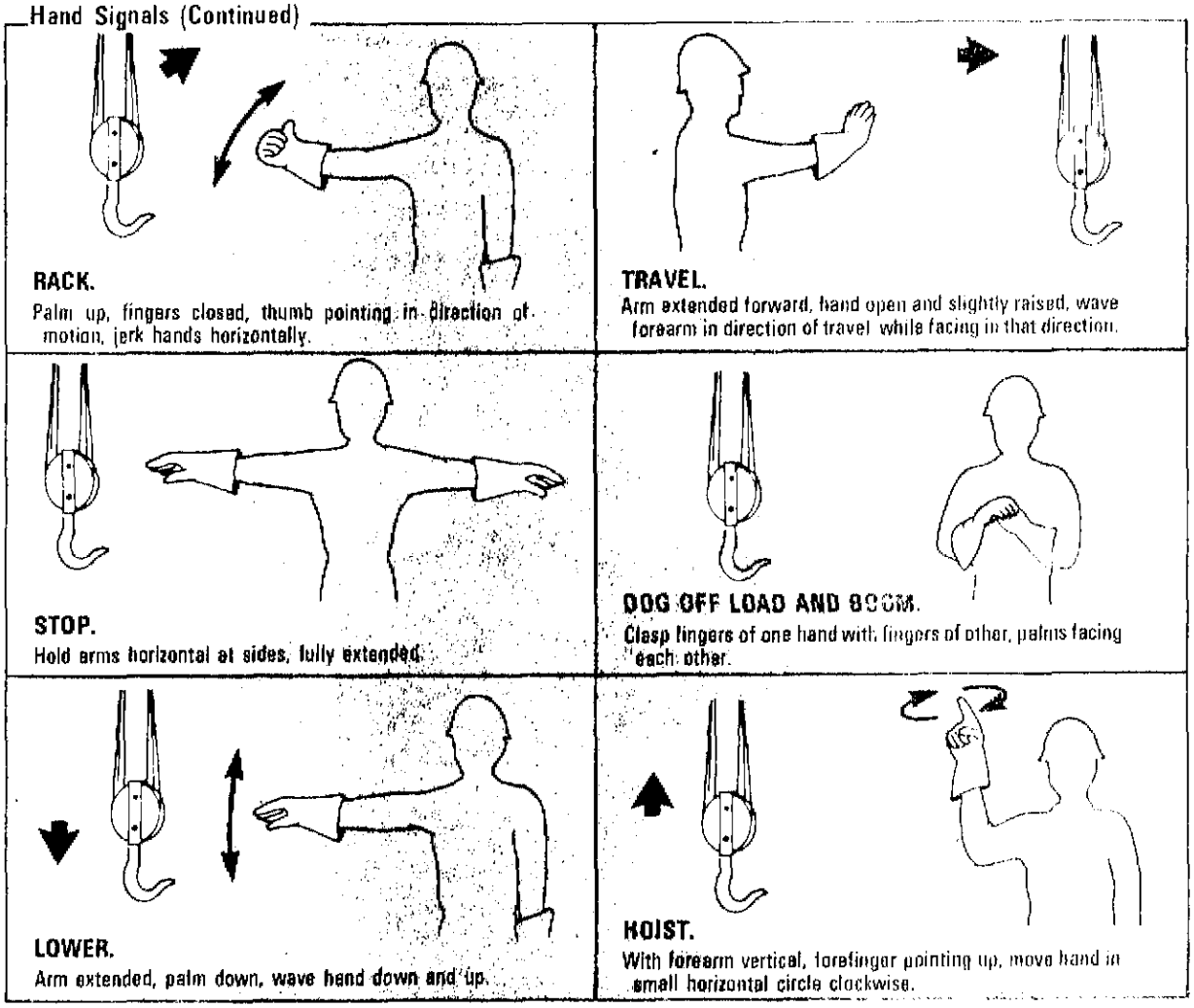
Light signals are conveyed in the same manner as the hand signals described previously, by holding a flashlight in each hand. The signalman will place a colored lens in each flashlight to distinguish his lights from other lights. Light signals must be given slowly and precisely. The signalman should get in a position where the background is least lighted to aid the crane operator in distinguishing the signal lights,

The type of signal used depends on these factors:

ŽVisibility is the deciding factor as to which signal will be used. During darkness, light signals will be used instead of hand signals, especially if the area is not illuminated enough by floodlight.

ŽDistance between thecrane operator and the signalman must be considered when determining the signal to be used. A relay signalman may he required when the distance creates a visibility problem.

Hand Signals (Continued)



SAFETY

Adequate safety precautions must be followed by all personnel during crane operation. Proper supervision and good judgment are paramount when considering personnel safety. The following specific safety precautions will be observed:

- Caution will be used when handling metallic components of cranes. At certain frequencies, high-frequency shipboard radio transmitter antennas in the vicinity can induce voltage in the rigging that can cause painful burns on contact.
- Personnel riding on load hooks is strictly prohibited.
- Loose articles of clothing that could become entangled in operating equipment will not be worn.
- Operating personnel will keep a secure footing and firm balance at all times.
- Loads must not be rotated or suspended over personnel.
- Before performing maintenance, equipment will be properly secured. Power will be turned off to remain off and tagged "Out of Service."
- Safe working load of the crane will not be exceeded.
- Communications will be maintained among all personnel involved in any operation. A person who is familiar with the signal code in use will be assigned to act as signalman when the crane operator cannot see the load being handled.
- Personnel will not be permitted to be in the potentially hazardous area between a swinging load and a fixded object.
- Before a load or empty lifting gear is raised, lowered, or rotated, a warning will clearly be given to personnel near the operation.
- When making a heavy lift, the load will be hoisted slowly for a minimal distance to check the sling for soundness and the load for balance.
- Operators will not leave the winch controls with a load suspended on the rig. They must deactivate electrical power to all winches in their rig before leaving the controls unattended. A signalman or a winch tender will be employed to aid an operator who cannot see the winches and both areas of the rig's operation.

CHAPTER 2

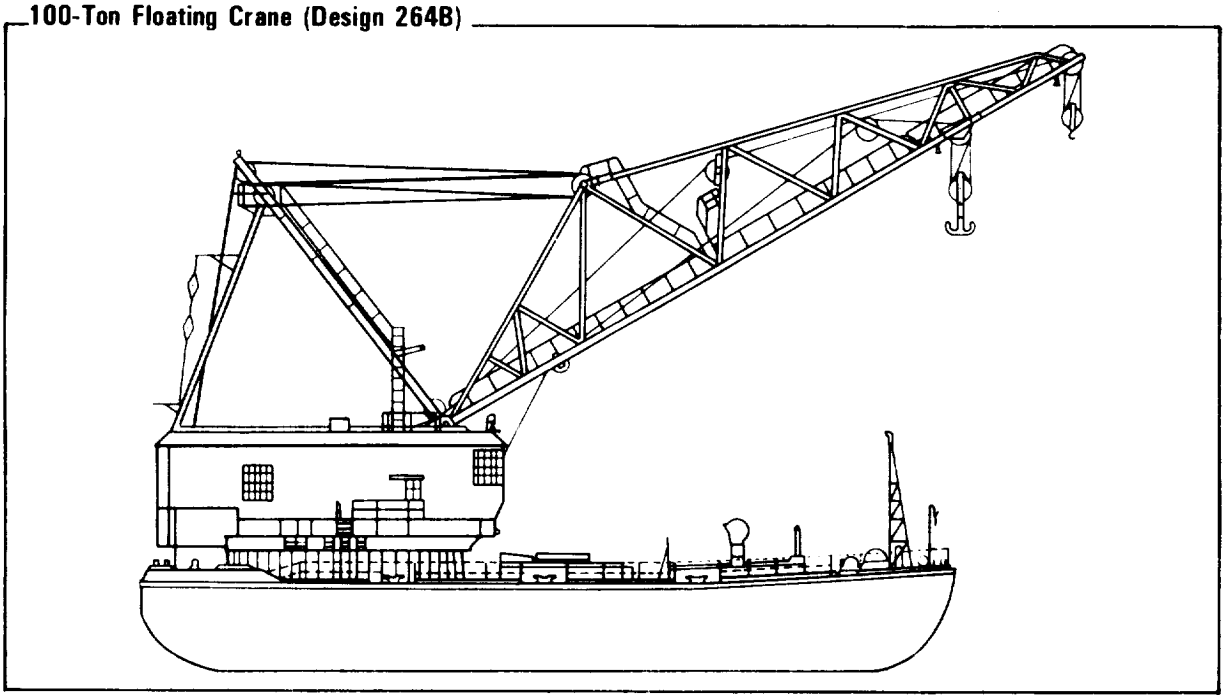
THE 100-TON FLOATING CRANE

The specific purpose and function of the 100-ton floating crane is to move loads that are within its rated capacity. This crane (Design 264B) has been reconditioned and modernized under the PIP. One of the improvements is the upgrading of the auxiliary lift to 28 STONs, making the crane adaptable to container operations. The crane is equipped with two power-generation systems. The original DC power system is still used to power the hoisting and rotating machinery. Under the PIP a second power system was installed, providing AC power for the ship's services. The crew's quarters and shipboard sanitation system have also been modernized. Although the floating crane must be towed to each work site, it is self-sustaining and classified as a Category C-1 vessel. A broad description of the crane and its operation is given in this chapter. Succeeding chapters describe the function, operation, and maintenance requirements for those new items and systems brought aboard through the modernization program. This includes the AC power-generating systems and those items that operate on it.

SPECIFICATIONS

The 100-ton floated crane is mounted on a rigid, welded steel barge having a length overall (LOA) of 140 feet, a beam of 70 feet, and a depth of 12 feet 6 inches. The main hoist has a maximum-rated lift capacity of 200,000 pounds or 100 STONs. The auxiliary lift has a maximum rated lift of 56,000 pounds or 28 STONs. The crane has a turning radius of 360 degrees. The crane is unique in having two separate power systems, The set of DC generators powers the crane's hoisting and rotating equipment found in the machinery house and operator's cab. The set of AC generators provides for the ship's service. With a maximum authorized crew of 15, the floating crane is self-sustaining and capable of being towed overseas. The following illustration and table show the 100-ton floating crane and give its specifications.

100-Ton Floating Crane (Design 264B)



100-Ton Floating Crane (Design 264B)

BARGE DATA

Length, overall	140 feet (ft)
Beam (molded)	70 ft
Depth (molded)	12 ft 6 inches (in)
Displacement (full load)	1,630 long tons (LTONs)
Draft (full load): mean	6 ft 3 1/4 in
Freeboard (full load): mean	6 ft 2 3/4 in
Capacity:	
Fuel	15,000 gallons (gal)
Lube oil	110 gal
Potable water	6,700 gal
Anchors (2)	4,200 pounds (lb) stockless
Anchor chains (2)	30 fathoms, 1 1/2 in

GENERATOR DATA

Main generators (2):	
Current	DC
Output	125 kilowatts (kw)
Voltage	240 VDC
Engines (2):	
Type	diesel
Horsepower	200 brake horsepower (BHP) @ 514 RPM each
Auxiliary generators (2):	
Current	3-phase AC
Output	30 kw
Voltage	240/277 VAC
Engines (2):	
Type	diesel
Horsepower	70 BHP @ 1,800 RPM

CRANE DATA

Main hoist:	
Boom length	123 ft 6 in
Main block:	
Capacity	200,000 lb @ 80-ft radius; 168,000 lb @ 104-ft 6-in radius
Speed	14 ft per minute (FPM)
Auxiliary hoist:	
Capacity	56,000 lb @ 122-ft 6-in radius
Speed	80 FPM
Reach below waterline	25 ft
Operating range	360°
Rotating speed	0.333 revolutions per minute (RPM)
Hoist, gear-driven:	
Size of drums (4):	
Main (2)	51 in x 98 7/8 in
Boom luffing (1)	75 in x 90 7/8 in
Auxiliary (1)	36 in x 89 1/4 in
Drum line pull:	
Main	16,150 lb each
Boom luffing	49,000 lb for 2 ropes
Auxiliary	9,065 lb
Wire rope (improved plow steel):	
Main	6 x 37, 1 1/8-in diameter, 2,530 ft
Boom luffing (2)	6 x 30, 1 1/4-in diameter, 1,050 ft
Auxiliary	6 x 37, 7/8-in diameter, 1,100 ft

EQUIPMENT LAYOUT

GENERAL LAYOUT

A portion of the floating crane barge is used as the crew's quarters. This area is air-conditioned, and the sleeping area can accommodate six bunks. The galley area is equipped with an electric range, an 8-cubic-foot refrigerator, a 120-gallon freshwater tank, and mess facilities.

The engine room portion of the 100-ton floating crane barge has two generator sets (30 kw, 240 VAC) for the ship's services, a hot-water boiler, a 23-CFM (cubic feet per minute), 250-psi air compressor, oil-water separator system, DC generators, carbon dioxide (CO_2) fire system, and other miscellaneous items of machinery. The DC generator sets, located in the engine room, are used to operate the crane mechanism.

The operator's cab is equipped with all required operating controls, an AN/URC-80(V)1 radio set, and a 12,000 BTU/hour air conditioner. For on-board communication, portable radio sets are provided to the crew.

A fire main system and sewage waste system with a 500-gallon holding tank are installed on the 100-ton floating crane barge. The federal pollution abatement requirements are now met with the installation of self-contained bilge water processing, fuel oil handling, and sewage disposal.

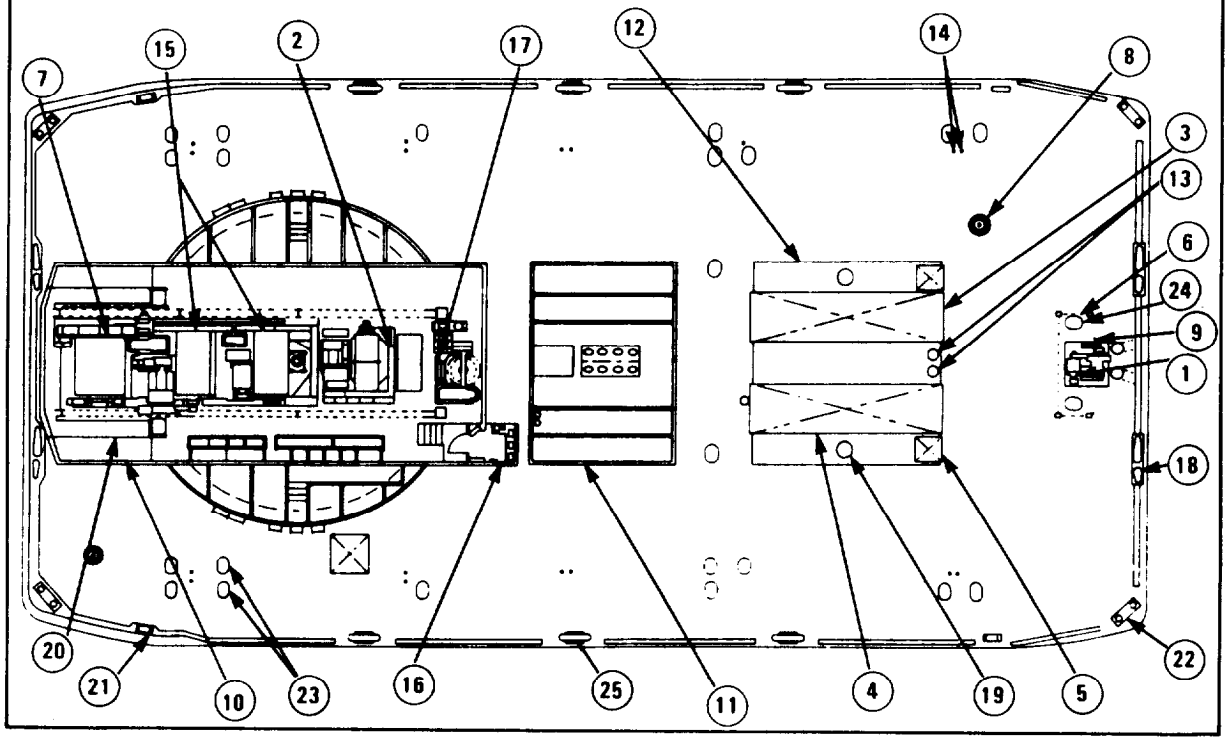
The oil water accumulated in the bilges of the engine room is pumped through the oil-water separator into the holding tank for later disposal to shoreside. The bilge piping system is arranged so that the oil-water separator pump provides suction from the bilge pockets to the holding tank. This piping arrangement also permits the oil-water separator to provide suction of the oily waste from the holding tank to the deck connection for transfer to a shore facility.

The piping for the fuel oil transfer point is modified to contain accidental oil spills during fueling or transfer operations.

The sanitation system for human wastes is self-contained. The sewage disposal requirements are met by using a standard commode which uses oil as a flushing medium. The below-deck, oil-flush sewage system and 500-gallon holding tank provide for sewage containment until shore discharge is required.

100-Ton Floating Crane (Design 264B)

1 ANCHOR WINDLASS
2 AUXILIARY HOIST
3 BOLTED WT HATCH
4 BOLTED WT HATCH
5 BOOBY HATCH
6 BOOM CRADLE
7 BOOM HOIST
8 CAPSTAN
9 CHAIN LOCKER BELOW P & S
10 COUNTERWEIGHT BOX
11 CREW'S QUARTERS
12 ENGINE ROOM, DIESEL - ELECTRIC GENERATING PLANTS AND AUXILIARY PLANT
13 EXHAUST VENTS
14 FILL CAPS
15 MAIN HOISTS
16 OPERATOR'S CAB
17 SWINGER
18 TRIPLE ROLLER CHOCK
19 VENTILATOR
20 WALKWAY
21 9-IN CLOSED CHOCK
22 10-IN DOUBLE BITT
23 10-IN x 24-IN HATCHES
24 18-IN x 24-IN HATCH P & S
25 48-IN CLEAT



ENGINE ROOM

The engine room is located within the hull between the forward collision bulkhead and the first transverse bulkhead. The sides are formed by the first longitudinal bulkhead off the centerline. An engine room trunk extends above the deck line and is fitted with port holes. Access to the engine room is provided by two trunks on the forward end of the trunk. The engine room contains the main and auxiliary engines, generators, and related equipment.

Power plant

The crane is equipped with two industrial diesel engines of the solid-injection, cold-starting type. These engines provide the power to drive the main diesel generators. Each engine is a 4-cycle, 6-cylinder, vertical type. The main power plant consists of two 2-wire or two 3-wire, 125-kw, 240-volt, compound-wound, DC generators, each directly driven by a diesel engine. These engines have a closed-type cooling system using salt water as a coolant for the fresh water in the heat exchange coils. Each engine has an integral lubricating oil pressure system equipped with a built-in, engine driven lubricating oil pressure pump. An integral fuel system is installed with each engine. A low pressure oil transfer pump draws oil from a storage tank and discharges the oil into a combination day tank and strainer. Fuel pressure is preset and can be changed only by controls on the engine. Fresh air for the engine room is controlled by a blower and an exhaust vent mounted on the deck above the engine compartment. The engines are air-started.

The auxiliary diesel engines are located in the aft section of the engine room. They are part of the AC power-generation system. Two 2-cycle diesel engines are used to drive two AC generators which generate power for the operation of all AC-operated equipment on the barge. Each engine has a hydraulic speed-droop governor to maintain reasonably constant engine speeds during load fluctuations. Engine speed can be adjusted locally and remotely so that the operator can synchronize the generators.

Power distribution panels

There is one power distribution panel (switchboard) for the AC and one for the DC power systems. These panels are located on the aft bulkhead on the starboard side of the engine room. These two switchboards control and monitor the output of the generators which supply all the AC and DC equipment on the crane.

Battery charger

The battery charger charges the 24-volt battery banks (two 12-volt batteries in series) used to start and run the diesel engines. One battery bank is used for each engine. The charger works in conjunction with a pair of control relays (one for each battery bank), which will allow the battery bank to be charged by the charger when the diesel engine is not running, and to be charged by the engine alternator while the engine is running.

Hot water system

The hot water boiler is an oil-fired, fully automatic, central heating unit. A circulating pump supplies hot water for the space heaters and for general use on the barge. A 25-gallon compression tank is provided.

Air compressor

The air compressor is a V-type, single acting, positive-displacement, two-stage, reciprocating-type unit. It maintains the pressure in a low-pressure air service tank located in the engine room and is used to start the main diesel generator set (or sets).

Pumps

Three types of pumps are provided: the fuel oil pump, the raw water pump, and the fire pump. Two fuel oil pumps are used to transfer fuel oil from the main tank to the two day tanks. These tanks supply fuel oil to operate the two main engines. Two raw water pumps are used for cooling the two main DC generator engines. The fire pump at the starboard bulkhead supplies pressurized water for operation of a portable eductor to drain the galley-quarters area and the storeroom under the galley area.

Lube oil filter

The lube oil filter is used to filter the dirt out of the lube oil that is circulating through the

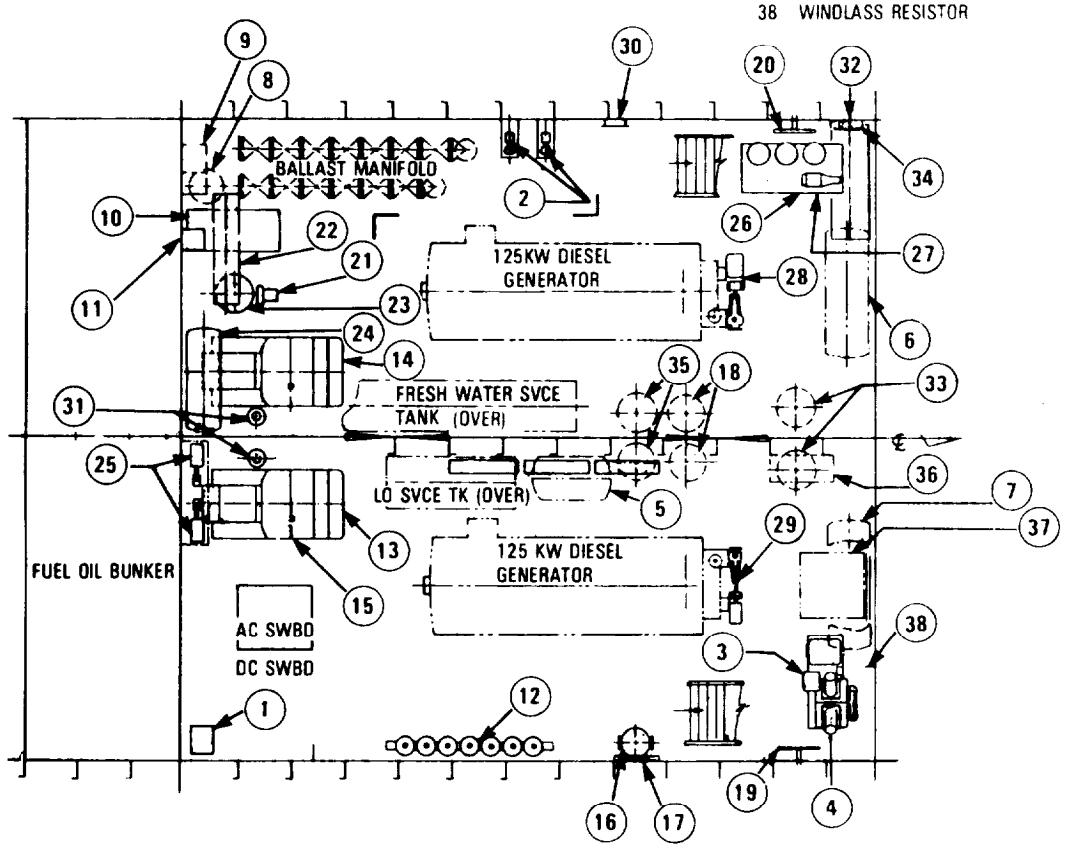
lubricating oil system when the engines are running.

Fire-fighting system

The fire-fighting system installed in the engine room is automatically operated. It can be activated at several places in the engine room to discharge CO_2 on and around the engines. The discharge nozzles are connected by piping to seven 50-pound CO_2 cylinders. A warning alarm is located on the starboard side next to fire station 1.

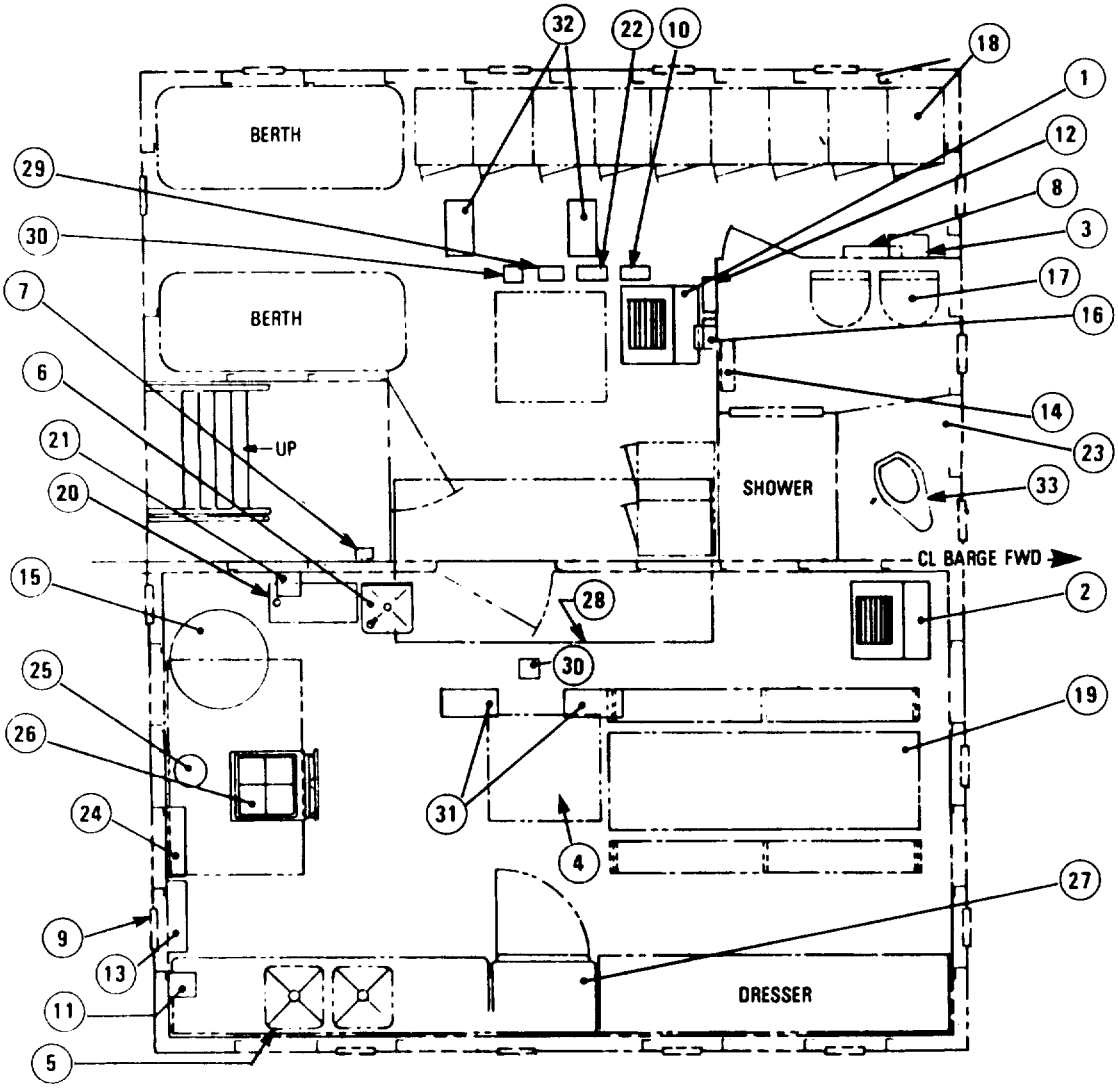
Engine Room

1 AC TRANSFORMER (STACKED 3 HIGH)
2 A/C SW CIRC PUMP
3 AIR COMPR
4 AIR DISCH
5 AIR SVCE TANK (OVER)
6 AIR SVCE TK (OVER)
7 AIR SVCE TK (OVER)
8 BALLAST PUMP
9 BALLAST PUMP CONTROLLER
10 BATTERY BOX
11 BATTERY CHARGER (WITH CHARGER MOUNTED UNDER)
12 CO_2 BOTTLES
13 30 KW DIESEL GENERATOR
14 30 KW DIESEL GENERATOR
15 ENGINE EXHAUST
16 FIRE PUMP
17 FIRE STATION 1
18 FO DAY TANK 25 GAL (OVER)
19 HANDWHEEL FOR SEA CHEST VALVE
20 HANDWHEEL FOR SEA CHEST VALVE
21 HW CIRC PUMP
22 HW COMPR TANK
23 HW BOILER
24 HW TANK & HEATER
25 MOTOR
26 OIL/WATER SEPARATOR (BD-6659 ONLY)
27 OIL/WATER SEPARATOR (ALL MODERNIZATIONS EXCEPT BD-6659)
28 RAW WTR PUMP
29 RAW WTR PUMP
30 SHORE POWER CABLE STORAGE RACK MOVED FROM STBD SIDE TO PORT TO ACCOMMODATE CONTROLLER FOR AIR COMPRESSOR
31 SILENCER
32 SLOP OIL TANK
33 SPARK ARRESTOR SILENCER
34 SUCTION HOSE FOR SAREX
35 SURGE TANK (OVER)
36 TOOL LOCKER
37 WINDLASS CONTROLLER
38 WINDLASS RESISTOR



Crew's Quarters

1 AIR CONDITIONER
2 AIR CONDITIONER
3 CREWS QUARTERS LTG PANEL
4 DECK HATCH P/S
5 DRESSER WITH SINKS
6 DRINKING FOUNTAIN
7 EMER STOP VENT FANS
8 FIRE STATION NO 2
9 FIXED LIGHTS
10 GALLEY A/C (MOUNTED OVERHEAD)
11 GALLEY AND CHT SUPPLY FAN CONT
12 GALLEY AND QUARTERS POWER PANEL
13 GALLEY POWER PANEL
14 HEATER
15 HYPROPNEUMATIC TANK
16 ISOLATED RECEPTACLE
17 LAVATORIES
18 LOCKERS
19 MESS TABLE W/BENCHES
20 POTABLE WATER PUMP
21 POTABLE WATER SUPPLY PUMP CONTROL
22 QUARTERS A/C SW SUPPLY PUMP CONTROL
23 RAISED DECK
24 RANGE REMOTE CONTROL BOX
25 RANGE VENT
26 RANGE
27 REFRIGERATOR
28 SKY LIGHT OVER
29 SW SUPPLY PUMP CONTROL RELAYS (2)
30 UNIT HEATER CONTROL RELAY
31 UNIT HEATERS
32 UNIT HEATERS
33 WATER CLOSET



CREW'S QUARTERS

This section describes the crew's quarters, galley, and sanitation system as it has been modernized under the PIP. All electrical services in the crew's quarters and galley are AC-powered. The function, operation, and maintenance for those specific items of equipment installed with the modernization program are discussed in greater detail in succeeding chapters.

The crew's quarters are located within the hull, just aft of the engine room and with the sides formed by the first longitudinal bulkhead on either side of the centerline. A crew's quarters trunk extends above the deck line and is fitted with portholes. Entrance to the quarters is through a hatch on the aft section of the trunk.

The crew's quarters are air-conditioned and heated for the comfort of the crew in all climates. Refer to Chapter 5 for details on the capacities, operation, and maintenance of the ventilating fans, space heaters, and air conditioners.

The sleeping area consists of bunks, lockers, fire station 2, and toilet facilities. They are located on the port side of the crew's quarters.

Accommodations normally provide for six bunks, hung three high on each side of the aft bulkheads. In an emergency, eight bunks can be accommodated, hung four high. Any additional berthing space will require bringing cots aboard.

Lockers are mounted on the outboard bulkhead, from the foot of the bunks to the forward bulkhead.

Fire station 2 is located just forward of the entrance to the shower and toilet.

The crew's head consists of the shower, wash stand, and toilet. The shower and wash stand are standard in their operation. The toilet uses a special inert, nonreactive mineral oil as the flushing vehicle to move the waste from the toilet to the separation tank where the flushing fluid naturally separates from the waste.

For further information on the function, operation, and maintenance of the toilet and the flushing system, refer to Chapter 5.

WARNING: Never pour detergents, soaps, emulsifying agents, or chemicals in the toilet. It will adversely affect the separation of the flush fluid from the waste.

Even with the crane modernization, personal space is at a premium, and consideration for one another is essential. Noise control, personal cleanliness, and good health habits must be maintained.

Located on the starboard side of the crew's quarters, there are enough seats for six crew members to eat at one time. The galley has been completely modernized to include an electric range, 8-cubic-foot refrigerator, potable water system, and drinking fountain. The function, operation, and maintenance of these items are described in Chapter 5.

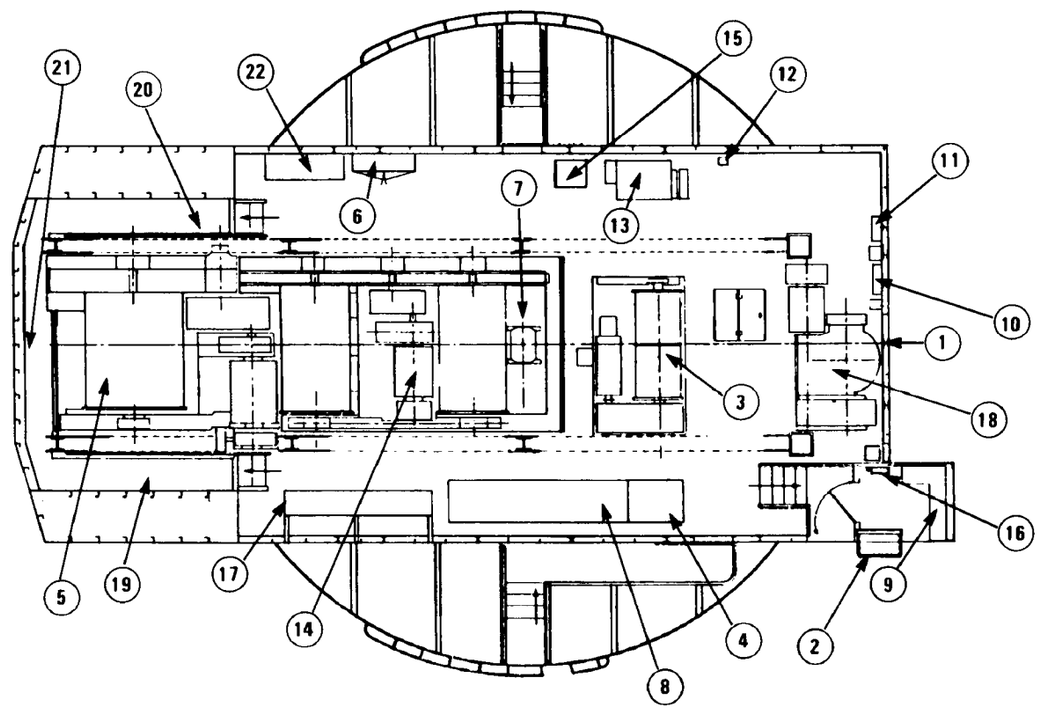
MACHINERY HOUSE

The machinery house is an integral part of the rotating structure of the crane. It houses the main hoist, auxiliary hoist, boom hoist and rotate machinery, the machinery house space heater, and the associated control panels and resistor banks for all of this equip ment. The control panels and resistor banks for all the hoist and rotate machinery are DC-powered. The space heater is located on the port side. The power supply for electrical equipment in the machinery house is distributed from the main engine room switchboard through the rotary collector mounted on the center steadiment of the crane. Each item of the machinery house equipment is described here to acquaint operating personnel with the location and function of each. Operating personnel must become thoroughly familiar with all the various maintenance information before attempting to operate the crane.

Main hoist

The main hoist machinery includes a two-drum, gear-driven hoist unit powered by a General Electric, 100-HP, 240-volt, 420-RPM, DC mill-type motor. Power is transmitted from the motor to the drums through a Pacific

Machinery House



1	CL BARGE	12	DRAVO HEATER BLOWER MOTOR CONTROL
2	AIR CONDITIONER	13	FURNACE
3	AUX HOIST	14	MAIN HOIST
4	AUX HOIST CONT	15	PROTECTIVE PANEL
5	BOOM HOIST	16	RADIO SET
6	CABINET	17	RESISTOR RACK
7	CL	18	SWINGER
8	CONTROL CABINET	19	WALKWAY
9	CONTROL CONSOLE	20	WALKWAY
10	CRANE MACH HSE PWR PNL - 115 VAC	21	WALKWAY
11	CRANE MACH HSE PWR PNL - 230 VAC	22	WORK BENCH

Western reducer, Model S-63, and a set of spur gears. The hoist motor is controlled by a magnetic controller and resistors operated by a master switch in the operator's cab.

Two brakes are provided with the hoist unit. One is a magnetic type, General Electric shoe brake, Type CR 9527-BJ100, that operates with the controller. This brake is designed for magnetic release when the coil is energized. It is automatically set by spring tension when the hoist master switch in the operator's cab is in the neutral (OFF) position or, if for any other reason, power to the motor is discontinued. The brake operating coil is series-wound and is connected in series with the hoist motor.

The other brake is a Wagner, hydraulic mechanical shoe brake, Type H 18 x 8. It is controlled by a hydraulic foot-operated cylinder located in the operator's cab. This brake is spring-released and hydraulic-applied. It is an emergency brake only, to allow manual operation of the hoist.

The main hoist machinery has a General Electric, rotating cam-type limit switch. It is operated through an Ohio Gear Company reduction unit driven by the hoist drum shaft. The limit switch contacts are connected in the hoist controller circuit to provide both upper and lower limit of travel of the main hoist hook block. The upper limit of travel of the main hoist hook block is determined by adjusting the hoist drum limit switch to de-energize the hoisting circuit when the main hook block has reached its safest, highest lift short of contacting the weight suspended from the boom hoist block limit switch. The lower limit of travel of the block is determined with the boom in its highest position by adjusting the limit switch to de-energize the lowering circuit when the main hook block is about 25 feet below the waterline.

The travel limits of the hoist block and adjustment of the two brakes will be carefully checked for satisfactory operation, both before and during initial crane operation. Also, all component units of the hoist machinery will be thoroughly lubricated before operation.

Auxiliary hoist

The auxiliary or whip hoist machinery includes a single-drum gear-driven hoist unit, powered by a General Electric, 175-HP, 240-volt, 1,750-RPM, DC mill-type motor.

Power is transmitted from the motor to the drum through a Horsburgh & Scott Mark II, size 185-T, triple-reduction helical speed reducer. The auxiliary hoist motor is controlled by a magnetic controller and resistors operated by a master switch in the operator's cab.

A magnetic shoe brake is provided with the auxiliary hoist unit. This brake is designed for magnetic release when the coil is energized. It is automatically set by spring tension when the auxiliary hoist master switch is in the neutral (OFF) position or if, for any other reason, power to the motor is disconnected. The brake operating coil is shunt-wound. It requires the use of a series resistor set that is mounted separately on top of the auxiliary hoist control panel.

The auxiliary hoist machinery is provided with a rotating cam-type limit switch that is operated through a gear reduction unit driven by the hoist drum shaft.

The limit switch contacts are connected in the hoist controller circuit. This is to provide both upper and lower limit of travel of the auxiliary hoist hook block in exactly the same circumstances as described for the main hoist. The same precautions, maintenance references, and procedures outlined for the main hoist also apply to the auxiliary hoist machinery.

Boom hoist

The boom hoist machinery includes a single-drum, gear-driven hoist unit powered by a General Electric, 200-HP, 240-volt, 400-RPM, DC mill-type motor. Power is transmitted from the motor to the drum through a Pacific-Western reducer, Model S-67, and a set of spur gears. The boom hoist motor is controlled by a magnetic controller and resistors operated by a master switch in the operator's cab.

Two brakes are provided with the hoist unit. One is a 26-inch, General Electric, mangetic-type shoe brake, Type CR9527-BK100, that operates with the controller. This brake is designed for magnetic release when the coil is energized. It is automatically set by spring tension when the boom hoist master switch is in the neutral (OFF) position or if, for any other reason, power to the motor is discontinued. The brake operating coil is series-wound and is connected in series with the hoist motor.

The other brake is a 27-inch, Clark Controller Company, hydraulic-type mechanical shoe brake, Bulletin 108. It is controlled by a hydraulic, foot-operated cylinder located in the operator's cab. This brake is spring-released and hydraulic-applied, serving as an emergency brake only to allow manual operation of the hoist.

The boom drum has a pawl lock system that ratchets in the hoist direction and, when engaged, locks the boom against lowering.

The boom hoist machinery has a rotating cam-type limit switch that is operated through a gear reduction unit driven by the boom hoist drum shaft. The limit switch contacts are connected in the boom hoist controller circuit to provide both upper and lower limits of boom travel. The lower limit of boom travel can be bypassed by operating the boom-bypass push button.

The upper limit of travel of the boom should occur when the main block is at a 55-foot radius. This places the boom just short of contact with the wooden bumper installed on the "A" frame. The lower limit should be conveniently set to operate just before entering the boom between the forward boom cradle brackets. This prevents accidental lowering of the boom onto the cradle too quickly for safe operation. With the boom properly centered, the boom-bypass push button may then be used to short-circuit the low position of the limit switch action. The boom should then be lowered slowly and carefully onto the cradle, finally allowing the luffing cable to remain taut, but not in full tension, as required to carry the boom.

A main factor in establishing a lower limit of travel of the boom is to prevent dropping the boom which would result in great damage. It would also cause the luffing cable to be torn from its anchorages on the boom hoist drum.

Contacts from two General Electric limit switches are also connected in the boom hoist controller circuits. These switches are mounted on the boom. One is directly adjacent to the boom sheave assembly above the main hook block, and the other adjacent to the boom sheave assembly above the auxiliary hook block. The lever action of each switch is fitted with a suspended weight that will be lifted when contacted by the respective hook block. Such lifting action will open the limit contacts. This prevents the boom hoist controller circuit from operating in the hoisting direction. Lowering direction of boom travel, however, can still be made. The upper limit of travel of the hoist blocks is controlled by the main and auxiliary hoist drum limit switches so that these blocks stop before contact with the boom limit switch weights. A boom limit switch will be activated only when the upper limit of action fails on the respective hoist drum limit switch.

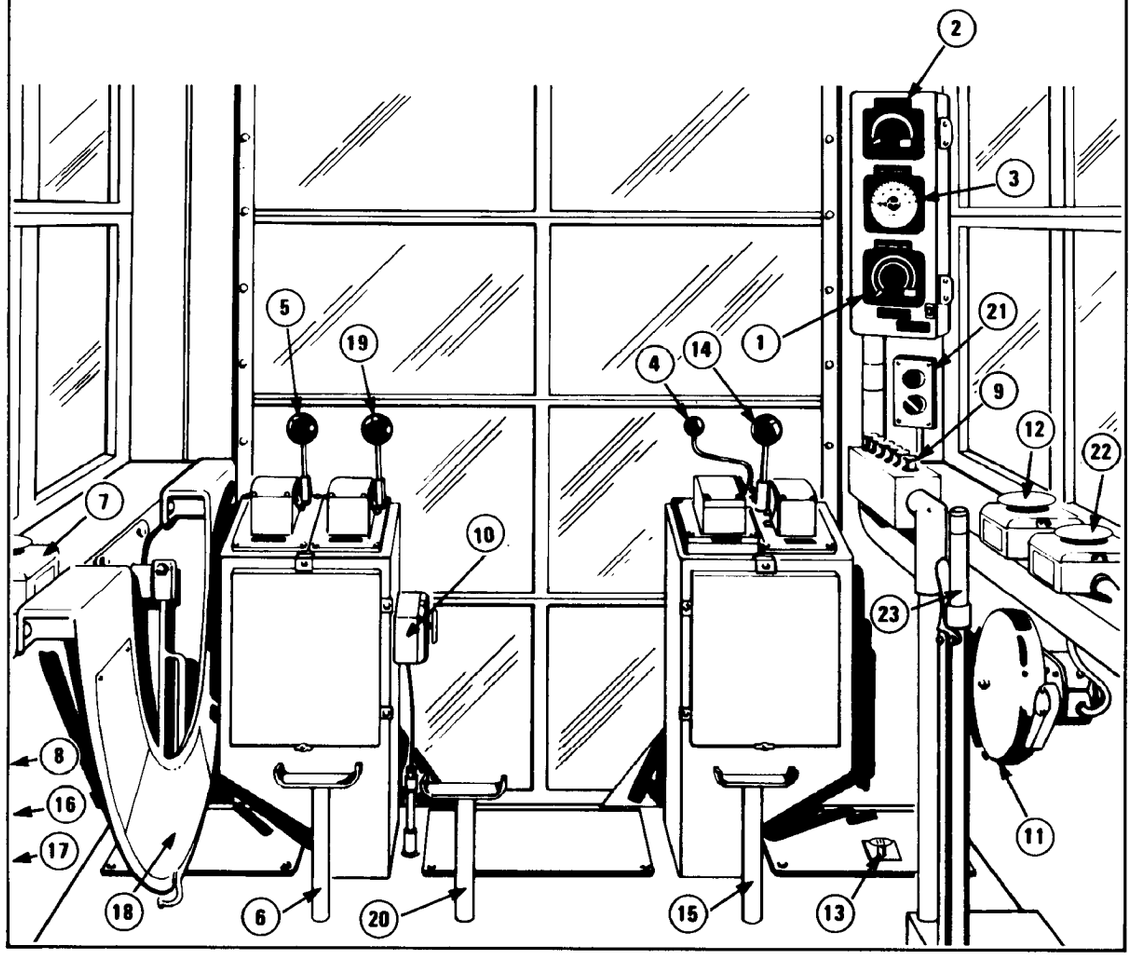
The operator is thus protected by this boom block limit switch feature. Under these circumstances this feature prevents raising the boom and sucking the hoist blocks into the boom sheaves. However, as stated, the upper limit of either the main or auxiliary hoist travel, as determined by the hoist drum limit switch, will have ceased to function. Therefore, the possibility exists of actually over-hoisting the blocks into the boom sheave assembly. The possibility of these circumstances is remote. If they occur, however, repairs to the faulty drum hoist limit switch will be made immediately.

Rotate drive

The rotate machinery, located at the forward end of the machinery house, rotates the crane upon its base. A rotate pinion engages the circular fixed rack on the crane

Controls in Operator's Cab (End-on view)

1 AMMETER BOOM HOIST
2 AMMETER MAIN HOIST
3 AMMETER
4 AUXILIARY HOIST
5 BOOM CONTROL LEVER
6 BOOM HOIST BRAKE
7 BOOM PAWL BYPASS
8 BOOM PAWL BRAKE — OUT OF ILLUSTRATION
9 BYPASS SWITCHES
10 EMERGENCY STOP BUTTON
11 ENGINE ROOM ALARM BELL
12 ENGINE ROOM ALARM BELL SWITCH
13 HOWLER SWITCH PUSH BUTTON
14 MAIN CONTROL HOIST
15 MAIN HOIST BRAKE
16 PAWL IN — OUT OF ILLUSTRATION
17 PAWL OUT — OUT OF ILLUSTRATION
18 RADIUS INDICATOR DIAL
19 ROTATE CONTROL LEVER
20 ROTATE HOIST BRAKE
21 ROTATE PARKING BRAKE CONTROL
22 ROTATE SPUD BYPASS
23 SPUD LOCK FOR ROTATE LOCK



base. It is driven through bevel gearing by a General Electric 65-HP, 240-volt, 500-RPM, DC mill-type motor.

Power is transmitted from the motor to the driven pinion through a Pacific-Western reducer, Model OF-58 and a set of bevel gears. The rotate motor is controlled by a magnetic controller and resistors operated by a master switch in the operator's cab.

On the 100-ton crane there are two brakes: one electric magnetic and one hydraulic with the rotating machinery unit. The electrically operated hydraulic brake is equipped with parking and power failure brake controls. The function of the brake is to stop rotate motion, as well as to hold the rotate platform in a parked position.

WARNING: During a power failure, the brake will not be applied if the crane is rotating and a load is on the hook. Applying the brake suddenly would cause the load to swing in an uncontrolled manner, endangering cargo, crane, and operating personnel.

Center steadiment and rotary collector

The rotary collector is mounted on the center steadiment of the crane and housed in a steel rectangular enclosure located forward of the main hoist drum. The center steadiment contains the kingpin that helps position the rotating structure on the crane base. The rotary collector provides a continuous means of transmitting power from the generator in the engine room to various electrical equipment on deck. This can be done during either a stationary or rotating period of operation of the crane. The collector consists of a shaft with nine collector rings, one of which is a spare, mounted on a common shaft. This shaft is fixed with the crane bass against rotation with the crane, but is flexibly mounted to absorb small deflections. The rings are connected directly to cables leading to the deck equipment. Carbon brushes contact these rings to transmit power supplied from the main switch panel.

Miscellaneous equipment

A 120-VAC *engine alarm system* is installed in both the machinery house and forward engine room. It warns of high water temperatures or low lubricating oil pressures within the main diesel engines. The system is connected to the lighting panel circuit. It consists of a warning horn, signal light, and single-pole disconnect switch. In case of engine trouble, the horn and light operate at the same time to warn the operator to immediate y secure the engine until adjustment or repairs can be made.

A *signal bell* and *push-button system* are installed in the machinery house and forward engine room. They operate in the same circuit as a similar bell and button in the operator's cab. This system may be used by the machinery house or engine room operator to signal the crane operator or vice versa.

A *rotate warning bell* is located under the rotate platform at the forward starboard corner. It is set to operate automatically only when the electric controls for rotation are engaged.

A *trolley* for a 3-to 6-ton hoistis provided. It can be mounted on any one of the several trolley beams installed in the machinery house or the forward engine room.

OPERATOR'S CAB

The various electric controls and hydraulic emergency brake-control master cylinders are arranged in the front of the operator's cab. The foot pedals for the boom hoist, main hoist, and rotate motions of the crane are also located in the cab.

Main hoist controls

The main hoist operates either to raise or lower the main hoist hook block. This is the larger block nearest the machinery house.

The magnetic-type *brake* on the motor shaft automatically engages and holds the load when the master switch is returned to OFF or if, for any other reason, power to the motor is shut off. The hydraulic brake, controlled by the master cylinder, is for emergency use only. The operator, however, will at

all times be ready to use this emergency brake in case the electric brake does not hold. Both brakes should be tested frequently and adjusted as required. When very heavy loads are handled with the main hoist, each one will be lifted only a few inches and then stopped to determine if the braking action of either brake is sufficient to hold the load. If the brake does not hold, crane operation should be secured and authorized personnel notified that the brake shoes should be taken up for wear or replaced.

Never change the brake spring adjustment. This has been set for maximum load. It is necessary only to take up adjustments for brake shoe wear. Be sure the shoes do not drag when released. This dragging action will increase wear on the brake bands.

The main hoist is controlled entirely by the main hoist *master switch* at the front left corner of the cab. The master switch is pulled back toward the operator to hoist the main hoist block and load (as if the operator were pulling the hoisting cable) and is pushed forward for lowering. On each side of the OFF or CENTER position there are five notched positions for the handle. These correspond to five hook speeds, each of which is progressively faster as the handle is moved away from the OFF position. The master switch can be moved as rapidly as desired to any speed, even full speed, without danger to the motor, since acceleration is automatically timed by the control panel for the hoist machinery.

During a hoisting operation (lifting any load from its supporting surface), when vang ropes or guide chains are slack at the start, the master switch should be moved only to the first point and almost immediately returned to OFF. This short operation will be repeated until all slack is taken up and the load begins to rise. Whipping of the cables, caused by tightening them too suddenly, will strain them much more than by any other sudden movement. The load should be lifted only high enough to pass safely over obstacles in its transfer path. Remember that light loads will be lifted at a rate as much as double the hoisting speed of heavy loads.

The first hoisting point on the master switch provides only enough power to lift about 20 percent of full load. Therefore, if the load is heavier than 20 percent and is suspended entirely on the hook (no slack cables), the master switch must be moved quickly to at least the second point. Otherwise the load will drop instead of rise. Similarly, the second point will carry only about 85 percent of full load. Therefore, to get smoother control for accurate spotting of a heavy load, it is best to raise it higher than required, then inch it down as explained in the lowering instructions. Refer to the ammeter panel description later in this chapter regarding the various load operating conditions.

CAUTION: The limit switch geared to the drum shaft will prevent pulling up the hook block against the sheaves on the boom with consequent damage. However, this is a safety feature for emergency use only; the operator will not habitually depend upon it to stop the hook. Such practice is not only dangerous in case of limit switch failure, but it also wears the switch so that it may fail to operate when an emergency arises.

The operation of this limit switch will be tested once daily by running the hookup just below the point of limit switch operation and stopping it, then starting again and approaching the limit switch area at slow speed. If it is evident that the limit switch is not working, the hook will be stopped instantly and the fault reported to personnel authorized to make such repairs or adjustments.

During a lowering operation, remember that heavy loads will go down as much as 30 percent faster than light loads. To start down, move the master switch handle forward only to the desired speed point. Accelerating and braking are automatically controlled with the movement of the switch. The controls are designed so that the motor creates a drag to limit the lowering speed. This eliminates wear on the magnetic-type shoe brake, which stops and holds the load only when the master switch is in the OFF position.

When setting the load down, and especially for accurate spotting of a heavy load, stop it slightly before reaching the final position. Then "inch" down slowly. Inching is a series of short movements in which the master switch is moved back and forth between OFF and the first lowering speed point. Each time allows only a momentary operation of the machinery.

Since the limit switch at the drum shaft stops the hook at the lower limit of travel as well as the upper, it will prevent unwinding the cable completely and rewinding in the opposite direction. This would break the cable at its anchorage on the drum. The limit switch operates when the hook is about 25 feet below water level and the boom is at its highest position. The same precautions will be observed in approaching the lower limit as for the upper limit to check operating condition of the contacts for lower limit of travel.

CAUTION: Prolonged periods of slow-speed operation will be avoided, both in hoisting and lowering. They waste time and power and overheat both the motor and resistors. In other words, the load will be moved as rapidly as safety and other circumstances permit, at the same time allowing ample time for dewing down smoothly beforea the final stop, Quick stops should be avoided for safety and maximum crane life, except in emergencies.

Auxiliary hoist control

The auxiliary hoist operates to either raise or lower the auxiliary hoist block. This is the smaller block furthest away from the machinery house. The auxiliary hoist is controlled by the master switch at the right of the main hoist controls and approximately on the centerline of the operator's cab.

The method of operation and precautions to be observed are exactly the same as for the main hoist. However, remember that the auxiliary hook moves about five and half times as fast as the main hook and will carry only about one fourth as heavy a load. The auxiliary hoist is not fitted with a hydraulic brake.

Boom hoist (luffing) control

The boom master switch and hydraulic emergency brake master cylinder are located at the operator's left and a little behind those for the main hoist. There is also a boom pawl hand lever still further back toward the cab door and protruding from the floor to a height of ab out 33 inches. A boom pawl bypass button is located on the sloping box front just below the boom master switch.

The luffing motion is used to move a load toward or away from the center of the crane. To do this, the boom is raised by pulling back the master switch handle and lowered by pushing it forward. This switch is also arranged with five speeds for either direction of motion. The luffing hydraulic brake is for emergency use, as on the hoists, and the magnetic brake functions automatically when the master switch is in the OFF position. General precautions against improper operation will be observed similar to those outlined for the main hoist. On the 100-ton floating crane, the hoist blocks will move away from the boom as the boom is lowered and will be drawn towards the boom as the boom is raised.

The pawl locking system, found only on the boom hoist, is a locking device in the form of a ratchet and pawl on the cable winding drum. This provides positive locking of the boom in a fixed position when use of the boom motion is not required. Also it provides for securing the boom under load for an extended time.

To disengage this pawl for further luffing, first disengage the latch on the hand lever. Then hold a slight forward pressure against the lever while raising the boom slightly (by pulling the master switch back momentarily). The hand lever will latch in the forward (released) position to prevent accidental re-engagement of the pawl. After the pawl has been thus released, luffing control is the same as main and auxiliary hoist control, with the same precautions to be observed about slack ropes, limit switches, speed, and so forth.

To engage the pawl for additional securing of the boom, proceed as follows: First, stop the boom at the desired height by bringing the master switch to the OFF or center position.

Second, pull the hand lever all the way back and latch it. This tightens a spring in the pawl lever system, permitting the hand lever to be drawn all the way back, even though the pawl may rest against a ratchet tooth top. At the same time, a General Electric limit switch behind the pawl interlocks the pawl with the luffing electrical controls to prevent turning the drum in the lowering direction when the pawl is either partly or fully engaged. Third, hold down the boom pawl bypass button. This permits luffing down in spite of the interlocking limit switch, but only on the lowest speed. Fourth, push the master switch forward to luff down just long enough to fully engage the pawl with a ratchet tooth. Fifth, release the button and return master switch to OFF. The boom will then be safely locked.

The boom limit switch bypass button bypassses the lower limit of boom travel as well as the pawl interlocking limit switch. Guard against completely unwinding the boom hoisting cable, especially if the boom cradle has been removed from the fore deck. The cable is only long enough to allow for lowering the boom onto the cradle.

Rotate control

The rotate master switch and hydraulic brake master cylinder are located at the extreme right side of the operator's cab. Just behind them is the spud lock and lever and its interlocking limit switch on the floor. The spud-bypass push button is on the sloping box front below the master switch. On the front right corner of the wall, just above the master switch, is the rotate parking brake switch and light assembly.

The rotate motion involves the entire crane structure, and it is used to move a load sideways after hoisting it. After releasing the parking brake and spud as explained later, rotation is controlled by the master switch and foot brake. Forward positions of the master switch give rotate movement to the left; backward positions give rotate movement to the right. The operator may remember the directions by recalling that the centerline of the crane is at his left and that the motion of the master switch handle in relation to the center of rotation is the same as that of the entire rotating structure. Motor acceleration is fully automatic, as in the case of the hoists, so that the master switch may be moved rapidly to the desired point. There are five speeds in each direction, as well as two automatically operated accelerating points after the last master switch point is reached.

Two *methods of stopping rotation* are plugging and drifting. The first, "plugging" the motor, is not always the best for smooth operation, there being no automatically operating magnetic brake. "Plugging" a motor means applying reverse power to stop it. The master switch is merely moved in the opposite direction, held there for a short time, and returned to OFF. This may be repeated a few times or the plugging position held until the crane stops. The operator must be careful not to leave the master switch in the reverse position, or the crane will automatically reverse rotation. The electrical controls are designed to eliminate excessive motor currents during plugging, so that plugging beyond the first point on the master switch has no additional effect.

The second and smoothest method of stopping rotation is by letting it drift with the master switch off and using the hydraulic foot brake. Regulate the stopping time as desired by varying foot pressure on the pedal. This is the only hydraulic brake that is not reserved for emergency use.

Load handling during rotation must take into account the swinging of the load. Excessive swinging of the load may be caused by unsteady acceleration or by starting and stopping while the load is slightly swinging. If rotation must be accelerated while the load is swinging, accelerate just after the load swings past the central position and pulls the boom in the direction of the desired rotation. The energy of the swinging load will aid acceleration and somewhat reduce the swinging of the load.

When approaching the desired final position, the boom rotation should be stopped

momentarily a little before the final point is reached. Then, as the load swings ahead, rotation should be started again and stopped just as the load reaches the end of its forward swing. With some practice in timing these movements, the operator can stop with the load and boom in a vertical line over the spot where the load is to be set down. He will also be able to go through the entire rotating motion with a single forward swing of the load.

The *stability of the rotating structure is* secured by two locking devices. The parking brake and spud lock secure the rotate motion of the crane against wind pressure on the boom and also against the list of the hull in the water.

The electric parking brake is used to lock the crane temporarily between operations. To set the parking brake, it is necessary only to turn the two-position switch on the wall. This action de-energizes the magnetic check valve associated with the rotate hydraulic brake. This releases the fluid trapped in the releasing cylinder of that brake and thus allows the brake to be set by spring tension. At the same time, the signal light on the parking brake switch goes out, indicating that the parking brake action is applied. In reality, the parking brake switch and the rotate brake foot pedal operate the same brake shoes. The net result is the same as two independent brakes. Power is restored and the brake is released by pressing down the brake pedal to the floor and then allowing the pedal to return to normal position. The brake pedal can then be used again in rotate operation to slow or stop the crane. Opening of the main contacts in the rotate circuit, or actual power failure in the circuit, also applies the parking action of the rotate brake. This brings the crane to a gradual stop if occurring during actual rotate operation.

The spud lock is used as a positive safety lock when the operator leaves the crane at the end of the working day. The crane can thus be locked only when the boom is over the boom rest on the forward deck.

The spud consists of a heavy steel bar suspended by a lever system to slide vertically in the bottom of the rotating platform. To engage the spud in the catch block that is attached to the crane base, the crane must be rotated until the boom is centered over the boom rest. In this position, the spud is approximately over the catch block. Then the hand lever is released and pushed forward. As it begins to move forward, the spud interlocking limit switch, by internal spring action, breaks the circuit to the rotate controls. This prevents applying power when the spud is down and prevents consequent danger of damage to the motor or mechanical parts. However, the crane is likely to be misaligned slightly so that the spud cannot enter the notch, and the crane must be rotated a little until the spud engages. Power must be restored by pressing the spud-interlock bypass push button with the knee and holding it while the master switch is moved in either direction. The power thus available through the bypass button is only that of the first three master switch points. The catch block is sloped on both ends to raise the spud as it approaches, and the spud is partially counterweighted to aid in lifting it. While the operator has one hand on the lever, he should exert a little forward pressure to feel the spud action and make sure it becomes properly seated.

In lifting the spud, wind pressure or list may cause it to bind. Then the crane must be moved back and forth slightly. Use the bypass button and master switch as described above, at the same time pulling back on the spud lever. The lever must be pulled all the way back and securely latched to ensure against dropping the spud accidentally and to close the limit switch circuit. This permits full control with the master switch.

CAUTION: It is possible to lower **the spud while the crane is in full rotate motion. To do so, however, would place undue strain upon the entire crane structure and perhaps result in damage to some of the crane's equipment or personnel. It should never be attemped therefore, to lower the rotate spud while the crane is in full rotate motion.**

Miscellaneous equipment

In addition to the hoist and rotate controls, several accessory devices are also installed in the operator's cab. These are for the convenience of the operator and for general safety in operating the crane.

A dial-type *radius indicator* is installed in the operator's cab. It shows the operator the actual radius at which the boom is located during normal service. It also shows the maximum safe loading suitable for respective positions of the boom using either the main or auxiliary hoist block. The operator will be fully aware of the weight and required transfer path of any load he is about to handle. This is to make sure that the proposed load transfer is within the limits noted on the radius indicator. There should be no exception to this precaution under any circumstance or condition.

A *generator breaker-trip push button* is located in the operator's cab at the aft left end of the control console. Activating this push button causes the main crane breaker to trip, thus de-energizing all 240-VDC power to the hoist and rotate machinery. This push button will always be used in case emergency shutdown of the crane machinery is needed. It is recommended that this push button also be used after securing the crane at the end of any work period so that the crane controls in the operator's cab cannot be accidentally operated.

After the main breaker is tripped, po wer can be restored by turning the reset handle up to the right and then back to a vertical position. The main breaker panel is located near the port access door to the machinery house.

A *warning horn* installed on top of the operator's cab operates when the floor-mounted push button is engaged by foot pressure. This horn enables the crane operator to warn the deck crew at any time of impending danger from moving loads. It also helps him to signal for a better hookup of the load, or merely to attract attention for further oral or visual signals or instructions. A 120-VAC circuit hookup from the lighting panel supplies power to this horn.

An *ammeter panel,* located in the forward starboard comer of the operator's cab, is fitted with three ammeters that register the amperage of the main, auxiliary, and boom luffing hoist motors during crane operation. Interior lights are installed within this panel to provide better visibility of the dials at any time. A switch located directly below the panel controls these lights.

This ammeter panel provides the crane operator with a relative indication of each load condition through direct motor amperage readings. With a knowledge of normal ampere (amp) readings for the various hoist loads, he will thus be warned of overload conditions at any time. Motor regeneration in lowering of loads will be indicated by the lack of ampere reading. The operator must have some idea of normal ampere loads for the various crane operations to make this panel serve its intended purpose.

The following tables show various average ampere readings of the three hoist motors under several load conditions. Every operator should be especially aware of these readings during his initial operation of the crane to protect both the crane and its personnel. He will note from the tables that certain heavy loads cannot be hoisted on the first or second speed points and that lowering such loads on the fourth or fifth speed points will cause the load to travel faster than the motor. This is indicated by a negative or zero amperage reading.

The control apparatus is protected so that the speed control will be automatically switched to the third speed point on lowering in case of overspeed conditions on the fifth speed point. If, however, this protection fails to operate, or if there is overspeed on the third or lower speed points, the reverse-current relay on the main engine room switchboard will trip the main breaker from the main generators. The operator will avoid overspeed operation and will always note the amperage readings on the ammeter panel for this purpose.

Main Hoist Loading Operating Data

	HOISTING					LOWERING				
SPEED POINT	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
No load, avg 242 V										
Motor, amp	160	100	100	105	110	420	430	600	350	255
Motor, RPM	185	620	690	710	765	10	185	495	585	620
Block Speed, FPM	5.7	20.7	21.7	24.9	27.3	0.6	5.7	16.4	19.3	21.7
50 tons at 80'0" rad Volts, 236 avg										
Motor, amp	210	250	260	280	300	400	365	440	160	130
Motor, RPM	0	175	240	400	530	150	310	545	670	670
Block Speed, FPM	0	5.7	8.1	13.2	17.5	4.9	10.3	18.3	21.8	22.6
100 tons at 80'0" rad Volts, 242 avg										
Motor, amp	260	370	390	415	440	410	335	315	neg	neg
Motor, RPM	0	0	80	315	490	235	420	610	740	820
Block Speed, FPM	0	0	3.0	10.2	16.0	7.9	13.9	20.2	25.0	26.4

Auxiliary Hoist Loading Operating Data

	HOISTING					LOWERING				
SPEED POINT	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
No load, avg 248 V										
Motor, amp	510	730	80	120	720	820	610	350	280	
Motor, RPM	540	770	2858	2941	3006	25	670	1232	1506	1860
Block Speed, FPM	25.5	34.3	127.7	134.1	133.9	1.2	30.1	56.4	69.1	85.2
14 tons at 122'6" rad Volts, 250 avg										
Motor, amp	565	825	315	310	350	720	760	475	180	150
Motor, RPM	320	600	1965	2217	2405	69.5	781.5	1377	1678	2065
Block Speed, FPM	14.9	27.1	87.4	101.9	110.1	3.2	36.1	64.3	78.6	97.9
28 tons at 122'6" rad Volts, 253 avg										
Motor, amp	620	920	550	540	580	730	760	340	30	neg
Motor, RPM	100	425	1072	1493	1805	114	893	1523	1851	2270
Block Speed, FPM	4.3	19.9	47.2	69.8	84.2	5.2	42.2	72.3	88.2	110.6

Boom Luffing Hoist Operating Data
(Fifth speed point)

	HOISTING	LOWERING
No load, Flat to high boom		
Motor, amp	400-210	390-200
Motor, volt	245-222	258-228
Motor, RPM	790-430	610-570
Luffing Time, min	2.25	2.5
100-ton, main block 80′ to 55′ rad		
Motor, amp	600-445	200-Neg
Motor, volt	246	240-235
Motor, RPM	530-480	650-600
Luffing Time, min	1	0.75
84 tons, main block 104′6″ to 55′ rad		
Motor, amp	780-400	260-Neg
Motor, volt	244-242	242-224
Motor, RPM	550-450	760-540
Luffing Time, min	2.0	1.25

Amperage values somewhat higher or lower than those listed in the table can be expected and do not necessarily warrant unsafe conditions. Extremely cold days may cause lower readings, while extremely hot days will cause higher readings. Also, positions of the loads and load increments other than those listed will cause different ammeter readings. Actual operating experience will serve to supplement the values given. Equipment should be repaired immediately as required if amperage values indicate improper operating conditions. Each ammeter in the panel will be given a routine check for satisfactory operation at the regular intervals of the general maintenance program for the crane.

The *air conditioner* (12,000 BTU) is installed in the lower right-hand side of the operator's cab, just behind the operator's stand. For specific information on the 12,000-BTU air conditioner refer to Chapter 5.

The *radio set* (AN/URC-80(V)1/3) is a very high frequency-frequency modulated (VHF-FM) transceiver that provides reliable short-range (35 to 40 miles) voice communications on all channels of the maritime service band. Transmit and receive operation is available on 55 channels between 156.050 and 162.000 megahertz (MHz). In addition, the maritime weather channel can be monitored on 162.550 MHz. The radio set is used on ships, boats, and miscellaneous fixed and mobile shore stations licensed to operate in the maritime VHF band.

NOTE: The only restriction on control settings pertains to channel selection. When operating within the continental United States and/or its territorial waters, **do not transmit** on any of the following unauthorized channels: 01 through 05, 15, and 60 through 64.

Observe the following procedure when operating the radio set:

Step 1. Select the desired operating channel. If the desired operating channel is 06, 16, 22, 23, or W (weather channel, 162.550 MHz), the selection can be made by setting CHANNEL SELECTOR switch S1 to the desired channel. When CHANNEL SELECTOR switch S1 is in any position except SELECT, CHANNEL SELECTOR switches S2 and S3 are inoperative. The transmit function of the radio set is inhibited when CHANNEL SELECTOR switch S1 is set to W. All operating channels of the maritime VHF band may be selected as follows:

ŽRefer to Appendix B, AN/URC-80(V)1/3 Operating Channels.

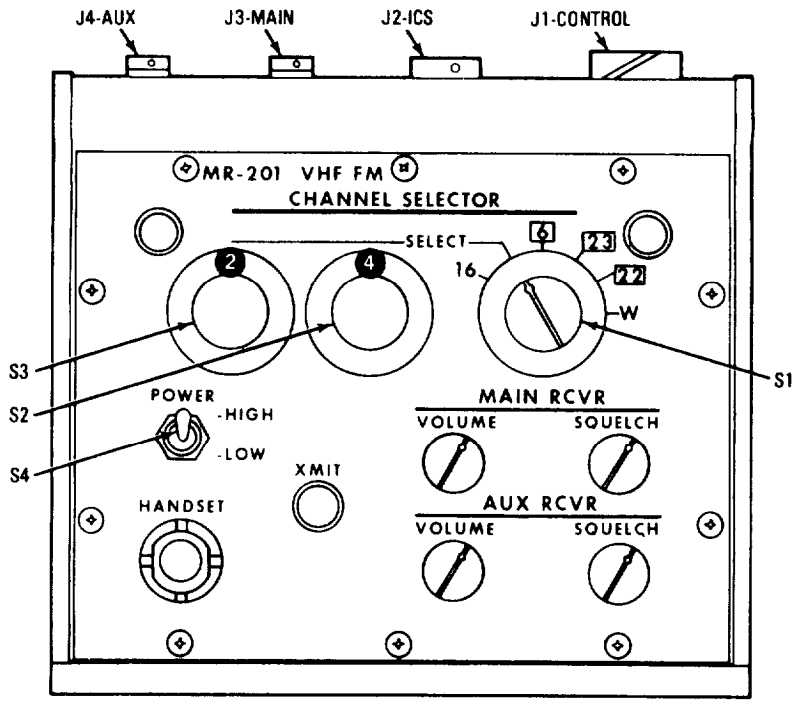
Ž Set CHANNEL SELECTOR switch S1 to SELECT.

Ž Set CHANNEL SELECTOR switches S2 and S3 so that the desired operating channel number is over the black spots of the two switches. For example, if Channel 24 is selected, the number 2 is visible over the black spot of switch S3 and the number 4 is visible over the black spot of switch S2.

Step 2. On the right unit, set power ON-OFF switch 6A7S1 to ON.

Step 3. Set POWER HIGH-LOW switch S4 to either HIGH or LOW, depending upon the power output required. Use the LOW position whenever operating requirements permit. The lower power output will reduce chances of interfering with other stations using the channel.

AN/URC-80(V)1/3 Controls and Indicators



Step 4. Adjust the MAIN RCVR VOLUME control clockwise until background noise or a signal is audible from the loudspeaker.

Step 5. While no signal is being received (just background noise), adjust the MAIN RCVR SQUELCH control clockwise to a point where the noise (squelches) cuts out. Do not adjust the control beyond this point or weak signals may be blocked out.

Step 6. To transmit on the selected operating channel, proceed as follows:

Ž Hold the mouthpiece of the handset about 1/2 inch from your lips.

• Press the PUSH-TO-TALK switch on the handset, and observe that the XMIT indicator on the control unit lights. The lighted indicator shows that the transmitter is operating.

• Speak slowly and clearly across the mouthpiece in a normal-to-loud voice.

Ž When the transmission is completed, release the PUSH-TO-TALK switch.

Step 7. Reception is continuous on the selected operating channel, except when the transmitter is keyed. Adjust the MAIN RCVR VOLUME control as required for the desired audio output from the main receiver loudspeaker. This receive condition is also the condition used for standby operation of the AN/URC-80(V)3.

Step 8. If the radio set is an AN/URC-80(V)1 equipped with an auxiliary receiver, the frequency or operating channel of the auxiliary receiver is preset to Channel 13 (156.650 MHz) and cannot be changed by the operator. Adjust the AUX RCVR VOLUME control, as required, for the desired audio output from the auxiliary receiver loudspeaker.

Step 9. To stop or shut down the radio set under any condition, set POWER ON-OFF switch 6A7S1 to OFF.

For operational maintenance and repair, refer to TM 11-5820-820-12.

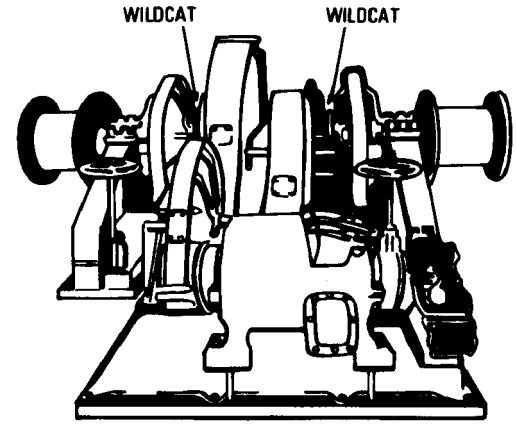
DECK

The location of various items of equipment, including machinery, valves, and switches, are located in the illustration on the following page.

Anchor windlass

The crane is equipped with an electrically operated anchor windlass to handle the anchors and anchor chains. The windlass is mounted on the deck and consists of horizontal drums operated by a 15-HP, 240-VDC motor. The windlass is controlled by a four-point, horizontal, reversing-type switch mounted on top of the windlass controller. The drums, over which the anchor chain passes, are called "wildcats." The raised projections or whelps of the wildcat mesh with the chain links as they move over the drum. The wildcat revolves with the shaft, which is driven by the anchor motor when the clutch is engaged or is free-running when not engaged. Friction brakes control the speed of the wildcat when it is running freely.

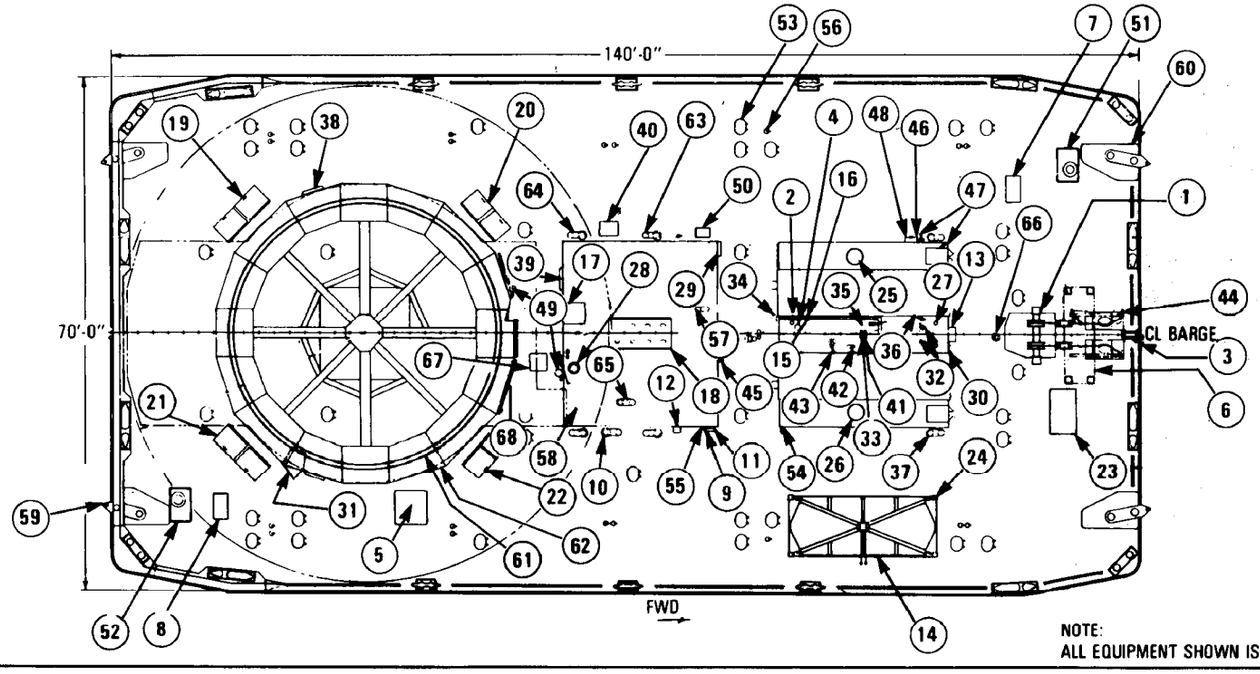
Anchor Windlass



The anchor is dropped by disengaging the clutch and releasing the brake. The weight of the anchor carries out the chain, turning the wildcat as it pays out. The speed of the payout can be controlled by using the friction brake. To hoist the anchor, the clutch is engaged and the wildcat is turned by the power-driven shaft, reeling in the chain over the whelps. To pay out a few links, the engine is walked back

Top View of the 100-Ton Crane (Deck level)

1 ANCHOR WINDLASS
2 AUX ENGINE EXHAUST P/S
3 AUX HOIST BLOCK SUPPORT ASSY
4 BOILER EXHAUST
5 BOLTED WT HATCH
6 BOOM CRADLE SUPPORT
7 CAPSTAN CONTROLLER
8 CAPSTAN CONTROLLER (STBD ONLY)
9 CHT DISCHARGE STATION
10 CHT RM EXHAUST
11 CHT VENT
12 CHT VENT AIR SPLY DN
13 CO_2 CONT STA
14 CONTAINER SPREADER & SLING
15 CONTAM FO DR
16 CONTAM LO DR
17 CREW QTR BOOBY HATCH
18 CREW QTR SKYLIGHT
19 DECK LOCKER
20 DECK LOCKER
21 DECK LOCKER
22 DECK LOCKER
23 DECK LOCKER
24 DECK SOCKET
25 ENG RM SUPPLY VENT
26 ENGINE ROOM EXHAUST VENT
27 EXH P/S
28 EXST VENT MODIFIED
29 FIRE HOSE DISCHARGE
30 FIRE PUMP START/STOP SW
31 FIRE STATION NO 3
32 FO DAY TK VENTS
33 FO DR TK VENT
34 FO & LO OVERFLOW CONTAINER
35 FW FILL ENG
36 FW VENT
37 GOOSE NECK VENT (P/S)
38 LIFE BUOY (P/S)
39 LIFE BUOY (P/S)
40 LIFE PRESERVER LOCKER
41 LO DR TK VENT
42 LO FILL
43 LO TANK VENT
44 MAIN HOIST BLOCK STOWAGE
45 MN AND AUX ENG ALM
46 OIL WTR SEP DISCH
47 OIL WTR SEP DISCH PUMP SW ENGINE RM BOOBY HATCH (P/S)
48 OVERFLOW CONTAINER
49 OVERFLOW CONTAINER
50 PORTABLE BILGE & BALLAST PUMP OVERFLOW CONTAINER STOWAGE (P/S)
51 POWER CAPSTAN
52 POWER CAPSTAN (STBD ONLY)
53 RAISED WT HATCH
54 SHORE CONN BOX
55 SHORE DISCH PUMP SWITCH
56 TANK FILLER CAP
57 TOILET AND SHOWER NATURAL EXH
58 TOP OF CREW QTR
59 TOWING LUG (P/S)
60 TOWING LUG (P/S)
61 TRACK
62 TRACK FDM
63 VENT P/S
64 VENT P/S
65 VENT SPLY CMT AND CRW QTR
66 WINCH CONTROL
67 WT HATCH BOLTED
68 3 FIRE HOSES



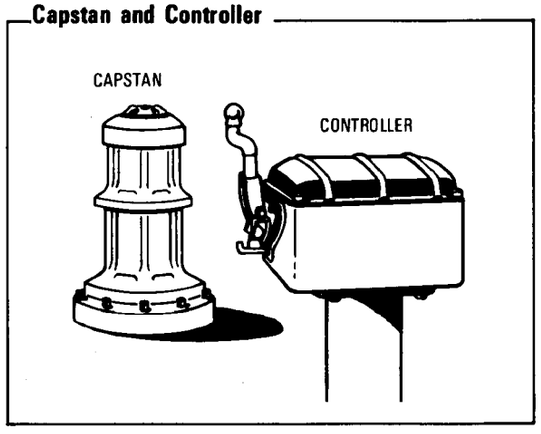
NOTE:
ALL EQUIPMENT SHOWN IS EXISTING UNLESS OTHERWISE NOTED.

or reversed. As a safety precaution, the windlass must be fastened securely to the deck; the structural members below it must be reinforced to provide adequate support. The windlass has a lifting capacity of 4,130 pounds. It can lift two 750-pound anchors from 40 fathoms at the same time or one 750. pound anchor from 150 fathoms. The crane is equipped with two 750-pound anchors and one 350-pound anchor. Each anchor is secured with 75 fathoms of 1 1/2-inch stud link chain. The anchor chains will be marked according to FM 55-501-2, Chapter 6.

Capstans

Two capstans are mounted on the deck of the crane where they will not interfere with the crane's lifting operation. One capstan and its controller are located on the bow on the port side; the other capstand and controller are located on the starboard quarter aft. The controller, a four-point, horizontal, reversing-type, is located near the capstan drum.

Capstan and Controller



Floodlights

Four 750-watt waterproof floodlights are provided—one on the machinery house, two on the boom, and one above the operator's cab. The light above the operator's cab can be rotated and elevated from within the operator's cab.

Fire station number 3

This fixed fire station is located on the starboard side of the rotary platform base. It is fitted with a 50-foot hose, 1 1/2 inches in diameter. Each hose has a combination nozzle attached. For further information on fire-fighting equipment, refer to Chapter 7.

Emergency switches for fire control

A START-STOP switch, another automatic safety device, is found outside on the forward end of the engine room on the main deck. In case of an engine room fire, someone on deck can break the glass on the engine room cutoff switch and then close the three switches. This will automatically shut off fuel pump 1, fuel pump 2, and the engine room supply fan. To the right, and next to the engine room cutoff switches, is the automatic START-STOP switch for the fire pump.

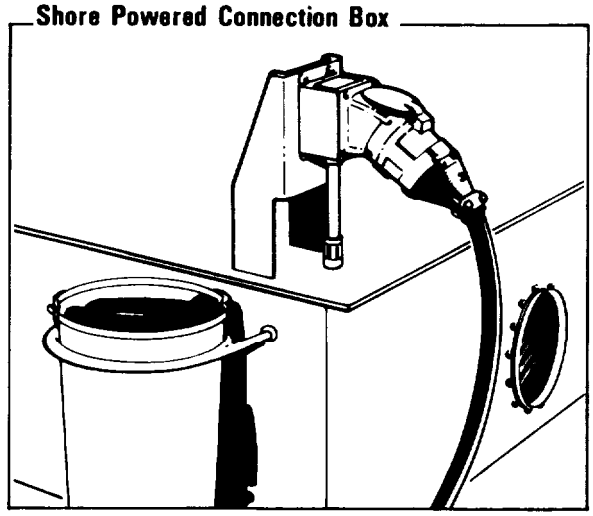
Container spreader bar

The crane carries and maintains its own container spreader bar and lifting sling. The spreader bar weighs 3,897 pounds, and the sling weighs 349 pounds. The container spreader bar and sling have a safe work load (SWL) of 67,200 pounds. The SWL includes the weight of the bar and the sling. The spreader bar is designed to lift only 20-foot containers. When the spreader bar is not in use, it is stored on the forward starboard side of the main deck on installed spreader bar sockets.

Shore power connection box

The shore power connection box is located on the main deck, starboard side, on the aft end of the engine room house. The shore power box is connected to the 240-VAC-load center panel in the engine room. There is also a portable shore power cable that is 100 feet long. When not in use, this cable is stored on a rack located on the port bulkhead of the engine room.

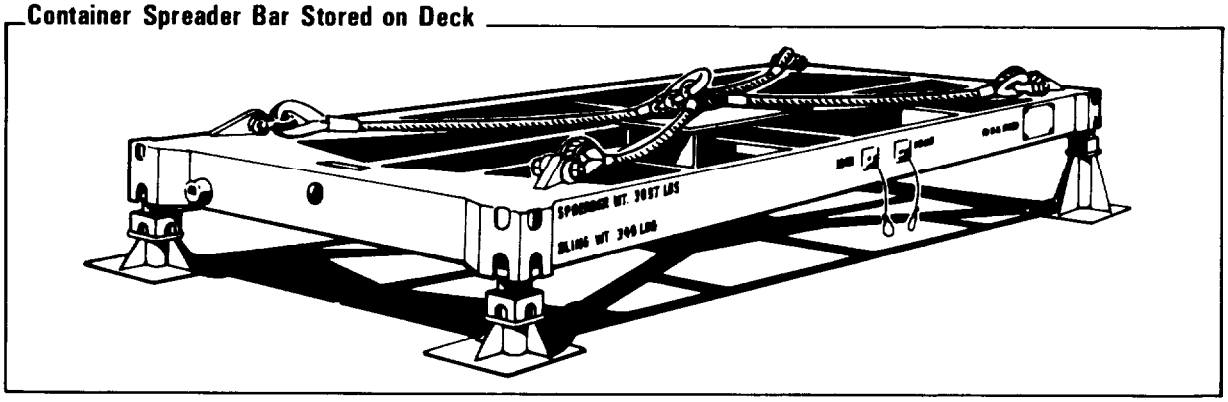
Shore Powered Connection Box



Boom cradle

The boom cradle, installed forward on the main deck of the crane, is provided to support the boom during repairs and when the crane is not in use. Holes are provided in both the cradle and boom for securing the boom to the cradle during a prolonged period of shutdown.

Container Spreader Bar Stored on Deck



Portable bilge and ballast pump

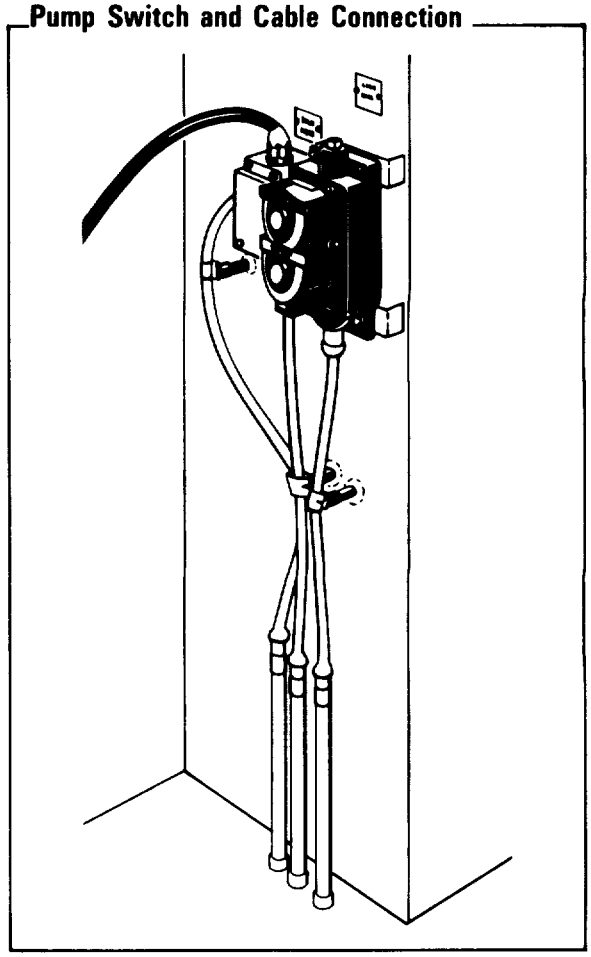
This pump assembly is used to fill or empty the ballast tanks, pump out the engine room bilges, or use as an emergency fire pump. When not in use, it is covered with a canvas cover provided in the barge's equipment. The pump assembly is fitted with a carrier having two U-shaped handles for moving the unit from place to place.

Three 10-foot lengths of 3-inch diameter hoses are stowed on racks located at the forward end of the crane pedestal. These are intended for use with the pump as suction hoses and are fitted with standard hose-thread couplings on either end. One 50-foot section of 1 1/2-inch diameter fire hose, with one 5/8-inch, smooth-bore nozzle, is stowed in a galvanized steel pocket-type hose rack located on the forward end of the crew's quarters. This hose is for use with the pump as a discharge hose.

The pump suction connection (2-inch diameter female pipe thread) is fitted with adapters mounted on the pump itself, which will allow either 3-inch or 1 1/2-inch suction hoses to be used with the pump. A reducing adapter, 3-inch diameter female hose thread tapering to a 1 1/2-inch male hose thread, must be removed from the suction connection to couple a 3-inch suction hose to the pump. The pump discharge connection (2-inch diameter female pipe thread) is fitted with adapters mounted on the pump itself to allow a 1 1/2-inch discharge hose to be used with the pump.

The pump motor is equipped with a male connector and a STOP push button for local emergency stop. A 100-foot electrical cable is used to connect the pump motor to a main deck bulkhead-mounted connection box. The 240-VAC, three-phase power for the motor is supplied from the engine room 240-VAC-load center panel, through a motor controller to the bulkhead-mounted connection box. A remote START-STOP push-button station is wired into the motor controller control circuit. The START-STOP push-button station, bulkhead-mounted connection box, and the 100-foot electrical cable are all located on the starboard side of the fixed base of the crane near the barge centerline. The motor controller is located in the engine room, on the starboard side at the bottom of the stairs. Refer to Chapter 6 for details on operation, preventive maintenance, and trouble-shooting of the portable bilge and ballast pump.

Pump Switch and Cable Connection



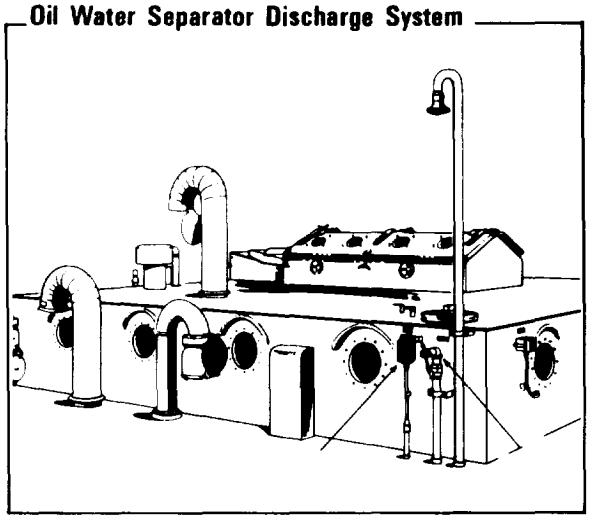
Sewage discharge pump

The push-button station and overboard discharge hose connection are located on the main deck, on the forward end of the crew's quarters house on the starboard side. For operating procedures, refer to Chapter 5 under Collect, Hold, and Transfer System.

Oil-water separator discharge system

The oily water accumulating in the bilges of the engine room is pumped through an oil-water separator, and the lube and fuel waste oils are pumped into a holding tank. The oil-water separator connection and ON-OFF switch for the shoreside discharge of oil waste are located on the main deck, on the starboard side of the engine room. The piping arrangement will permit the oil-water separator pump to take suction from the holding tank and discharge to the deck connection' for transfer to a shore facility.

Oil Water Separator Discharge System



CHAPTER 3

POWER PLANT (AC): GENERATION SYSTEM

This chapter describes the function, operation, and maintenance of the power-generation system located in the engine room. Two 2-cycle auxiliary diesel engines are used to drive the two AC generators that generate power for all AC-operated equipment located on the 100-ton barge crane.

DIESEL ENGINE, 2-CYCLE

SPECIFICATIONS

This section describes the auxiliary diesel engines located in the engine room. The following illustration and table provide engine data.

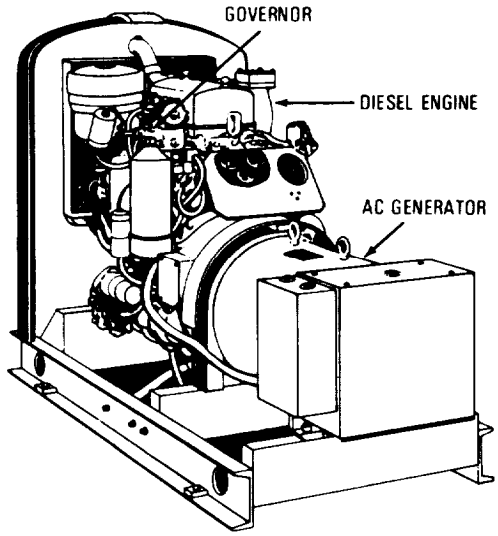
FUNCTIONAL DESCRIPTION

The 2-cycle diesel engine is an internal-combustion power unit in which the heat of fuel is converted into mechanical force and motion inside the cylinder of the engine. Air is compressed to a temperature high enough to ignite fuel sprayed directly into the cylinder where combustion and expansion actuate a piston.

In the 2-cycle engine, intake and exhaust take place during the compression and power strokes respectively. A blower forces air into the cylinders to expel the exhaust gases and supply the cylinders with fresh air for combustion. The cylinder wall contains a row of ports that are above the piston when it is at the bottom of its stroke. These ports admit the air from the blower into the cylinder as soon as the rim of the piston uncovers the ports. The unidirectional flow of air toward the exhaust valves produces a scavenging effect, leaving the cylinders full of clean air when the piston again covers the inlet ports.

As the piston continues on the upward stroke, the exhaust valves close and the

Diesel Engine-Generator Set



ENGINE DATA

Manufacturer	Detroit Diesel Allison
Model	10235100
Type	2-cycle
Bore	4.25 inches
Stroke	5 inches
Cylinders	2 per engine
Compression	17 to 1
Total displacement	142 cubic inches
Fuel	Diesel
Direction of rotation	Right hand (viewed from front end)
Size (engine-generator set)	69 inches long, 32 inches wide, 48 1/2 inches high
Weight	2,110 pounds

charge of fresh air is compressed. Shortly before the piston reaches its highest position, the required amount of fuel is sprayed into the combustion chamber by the unit fuel injector. The intense heat generated during the high compression of the air ignites the fine fuel spray immediately. The combustion continues until the injected fuel has been burned.

The resulting pressure from combustion and expansion forces the piston downward on its power stroke. The exhaust valves are again opened when the piston is about halfway down, allowing the waste gases to escape into the exhaust manifold. Shortly thereafter, the downward-moving piston uncovers the inlet ports and the cylinder is again swept with clean, scavenging air. This entire combustion cycle is completed in each cylinder for each revolution of the crankshaft.

ENGINE COMPONENTS

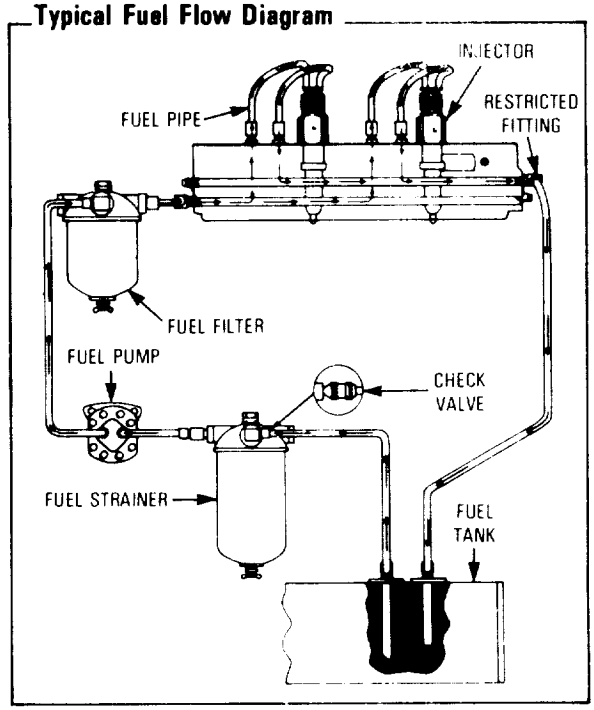
The diesel engine consists of the following basic systems: fuel, air, lubricating, engine cooling, electrical, and exhaust. These are described in detail as follows.

Fuel system

The fuel system consists of fuel injectors, pipes, manifolds, pump, strainer, filter, and necessary fuel lines. A restricted fitting is located in the cylinder-head, fuel-return, manifold outlet to maintain fuel pressure.

Fuel is drawn from the supply tank through the fuel strainer and enters the fuel pump at the inlet side. Upon leaving the pump under pressure, the fuel is forced through the fuel filter and into the fuel inlet manifold. See original inlet side of each fuel injector. The fuel is filtered through elements in the injectors and atomized through small jets into the combustion chamber. Surplus fuel, returning from the injectors, passes through the fuel-return manifold and connecting fuel lines back to the fuel tank. The continuous flow of fuel through the injectors helps to cool the injectors and remove air from the fuel system.

Typical Fuel Flow Diagram



The *fuel injector* combines all the parts necessary to provide complete and independent fuel injection at each cylinder. The injector creates the high pressure necessary for fuel injection, meters the proper amount of fuel, atomizes the fuel, and times the injection into the combustion chamber.

A positive displacement, gear-type *fuel pump* is attached to the cylinder block. It is driven by a helix gear on the engine balance shaft through an adapter and pinion gear.

A spring-loaded relief valve is incorporated in the pump body (normally in the closed position). It operates only when the pressure on the outlet side (to the fuel filter) becomes excessive due to a plugged filter or fuel line.

The fuel pump incorporates two oil seals. Two tapped holes are provided in the underside of the pump body, between the oil seals, to permit a drain tube to be attached. If fuel leakage exceeds one drop per minute, the seals must be replaced.

A replaceable element-type *fuel strainer* and *fuel filter* are used in the fuel system to remove impurities from the fuel. The strainer removes the larger particles, and the filter removes the smaller particles.

The fuel strainer and the fuel filter are basically identical in construction, both consisting of a cover, shell, and replaceable element. The fuel strainer functions under suction; the fuel filter operates under pressure.

Air system

The air system consists of a blower, air cleaner, air box drains, and crankcase ventilation system.

The *blower* supplies fresh air required for combustion and scavenging by forcing a charge of air into the cylinders. The charge of air sweeps all of the waste gases out through the exhaust valve ports. This leaves the cylinder tilled with fresh air for combustion at the end of each downward stroke of the piston. This air also assists in cooling the internal engine parts, particularly the exhaust valves.

Two hollow, three-lobe rotors are closely fitted in the blower housing, which is bolted to the cylinder block. The revolving motion of these rotors pulls fresh air through the air cleaner and provides a continuous and uniform displacement of air in each combustion chamber. The continuous discharge of fresh air from the blower creates a pressure in the air box (air box pressure).

The dry-type *air cleaner* consists of a metal wool cleaning element, saturated with oil and supported inside a housing over a hollow chamber. This serves as a silencer for the incoming air to the blower. Air drawn into the air cleaner by the blower passes through the metal wool, where foreign matter is removed, then down the central duct to the blower.

Air box drains allow drainage of condensate from the air boxes. During normal engine operation, water vapor from the air charge, as well as a slight amount of fuel and lubricating oil vapor, condenses and settles on the bottom of the air box. This condensation is removed by the air box pressure through air box drain tubes mounted on the side of the cylinder block.

The air box drains are to be open at all times. With the engine running, a periodic check is recommended for air flow from the air box drain tubes. Liquid accumulation on the bottom of the air box indicates that a drain tube may be plugged.

Crankcase ventilation is required to remove harmful vapors from the engine. Harmful vapors that can be formed in the engine are removed from the crankcase, gear train, and valve compartments by a continuous, automatic ventilation system.

A slight pressure is maintained in the engine crankcase by the seepage of a small amount of air from the air box past the piston rings. The air sweeps up through the gear train compartment. It is admitted to the valve and injector rocker-arm compartment through a bored passage in the front end of the cylinder block and a mating passage in the cylinder head. Ventilating air in the valve and injector rocker-arm compartment is vented to the atmosphere through a vent pipe which is attached to the governor control housing.

Lubrication system

Lubricating oil is drawn from the engine oil pan into the inlet side of the oil pump. When the oil leaves the pump under pressure, it flows through a vertical front passage in the cylinder block into a bypass valve attached to the side of the block. Oil leaving the bypass valve flows up through a second vertical passage and enters the oil cooler element. From the cooler, the oil continues through a third vertical oil passage where it is diverted in two directions. One portion supplies lubrication to the front crankshaft main bearing and the front cam and balance shaft bearings. The remainder enters a horizontal oil gallery within the cylinder head.

In addition to supplying lubricating oil for the valve and injector rocker-arm assemblies, this oil in the cylinder head flows down

through two vertical passages. This provides lubrication for the center and the rear main crankshaft bearings, in addition to the rear cam and balance shaft bearings. Oil for lubricating the connecting rod bearings flows through drilled passages in the crankshaft that connect with the front and center main bearings.

Drilled passages in the connecting rods provide lubrication for the piston pins. Cooling at the underside of the piston heads is provided by a spray nozzle pressed into the upper end of each connecting rod.

The gear train, including blower gears, and the blower front bearings are lubricated by oil that drains through openings in the front corner of the cylinder head and block onto the camshaft gear.

Lubrication for the blower rear bearing and governor weight assembly is provided by surplus oil returning from the cylinder head through connecting drilled passages in the cylinder block and blower rear end plate. Surplus oil returns to the engine oil pan through connecting passages in the cylinder block and blower rear end plates.

When the oil pressure within the lubricating oil pump exceeds the maximum value of the oil pump relief valve spring, the relief valve is moved off its seat. This permits the excess oil to return to the oil pan.

When the pressure at the inlet side of the bypass valve exceeds the maximum value of the bypass value spring, the ball within the assembly is moved off its seat. This permits the lubricating oil to bypass the oil cooler and enter the third vertical oil passage. This action thereby supplies lubricating oil to the various engine parts during the engine warm-up periods. It also ensures lubrication of engine parts in case the oil cooler becomes stopped up.

A bypass oil filter is attached to the side of the cylinder block to keep the lubricating oil free of dirt particles and sludge. The oil filter consists of an adapter, filter shell, center stud, replaceable-type filter element, retaining spring, and bolt. The oil filter element should be changed every time the engine oil is changed.

Cooling system

The heat exchanger core consists of a series of flat, water strut tubes attached to two round header plates. The core is mounted inside the expansion tank. It is sealed at each end with a seal ring and a flange to prevent the engine coolant from mixing with the raw water. The engine coolant which circulates through the engine cooling system flows around and between the core tubes as it leaves the water tank. The raw water, flowing horizontally through core tubes, lowers the temperature of the engine coolant.

To protect the heat exchanger core from the electrolytic action of the raw water, a zinc electrode is located in a tee fitting at the raw water inlet side of the core on certain engines equipped with this heat exchanger.

That portion of the tank located above the heat exchanger core provides a means of filling the engine coolant system, It also provides space for expansion of the coolant as the temperature rises. A vent tube near the top of the water tank vents the tank to the atmosphere.

The length of time a heat exchanger will function satisfactorily as a cooling unit will be governed largely by two factors. One is the kind of coolant used in the engine and the other the kind of cooling water (salt or fresh) pumped around and through the heat exchanger core by the raw water pump.

Clean water, plus a good commercial rust inhibitor, should be used as a coolant to prevent lime deposits in the heat exchanger core tubes as well as in the engine.

Enough coolant should be maintained in the engine to fill the cylinder block and head and to partially fill the water tank. Allow air space above the coolant in the tank for the increase in volume as the temperature of the coolant rises.

Electrical system

Each engine is equipped with a 24-volt electrical system. This system consists of a starting motor, a battery-charging alter-

nator, a transistor voltage regulator, current regulator, and a cutout relay to protect the electrical system.

Exhaust system

The exhaust pipeline consists of a silencer (one for each engine) and the necessary exhaust line piping. The piping consists of 2 1/2-inch, standard weight, black iron pipe from the engine to the silencer and from the silencer out through the engine room roof. A flexible bellows is located between the engine and the silencer to provide for expansion and to minimize engine vibration. The silencer is a Maxim, Type MUL, which incorporates a nonresonant, side-tube arrangement to allow passage of the exhaust gases from one chamber to another.

INSTRUMENTS AND CONTROLS

The instruments and controls used to operate the engine are located as follows:

- The engine instrument panel is located on the engine.
- The engine control system panel is located on the bulkhead near the engine.
- The voltage control panel is located next to the engine control system panel.
- The AC generator switchboard is located adjacent to the DC switchboard in the engine room,

See Chapter 4 for a complete description of the AC generator switchboard.

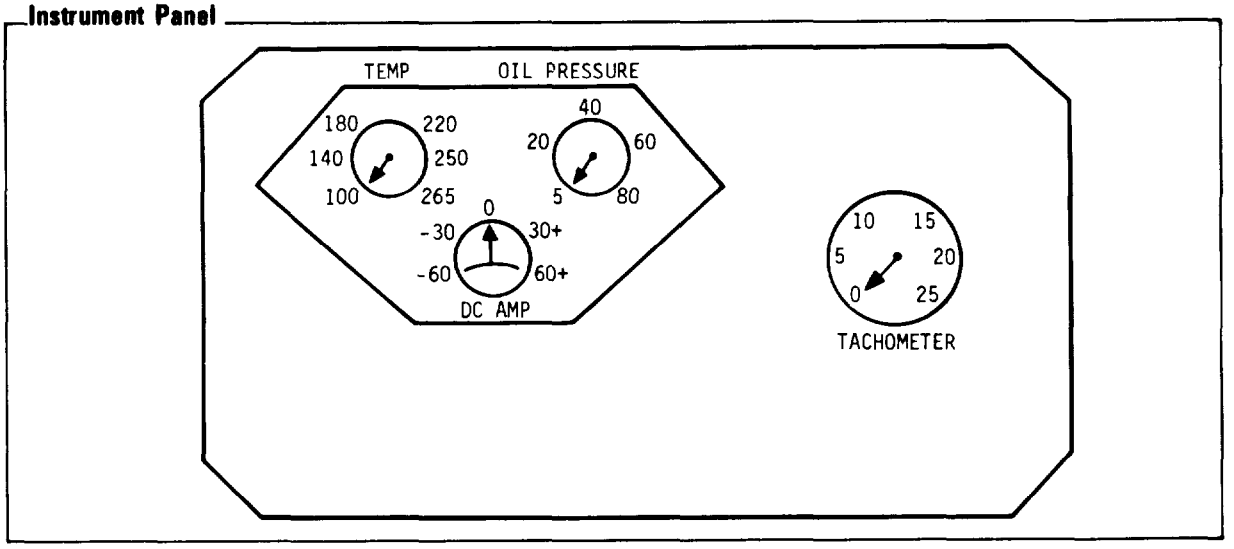
Engine instrument panel

The *oil pressure gage* registers the pressure of the engine lubricating oil. As soon as the engine is started, the gage should start to register. If it does not register at least 18 psi within 10 to 15 seconds from start, the engine should be stopped and the cause determined and corrected before the engine is started again.

The *water temperature gage* registers the engine coolant temperature.

The *DC ammeter* reads the current flow to and from the battery. After starting the engine, the ammeter should register a high charge rate at rated engine speed. This is the rate of charge received by the battery, replenishing the current used to start the engine. As the engine continues to operate, the ammeter should show a decline in charge rate to the battery. The ammeter will not show a zero charge rate, however, since the regulator voltage is set higher than the battery voltage.

The *tachometer* is driven by the engine and registers the speed of the engine in RPM.



Engine control system panel

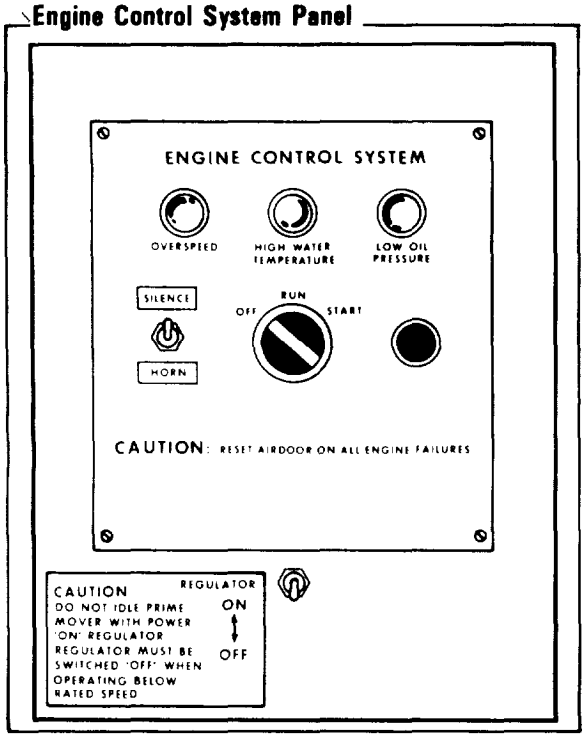
The *OFF-RUN-START switch* is used to start the diesel engine.

The *regulator ON-OFF switch* cuts in or cuts out the voltage regulator. It also allows the regulator to be out when the engine is operating below rated speed to avoid damage to the regulator.

The *SILENCE-HORN switch,* when in HORN position, allows the horn to sound. When placed in SILENCE position, it silences the horn.

The *alarm indicators* light up to indicate that an alarm. identified by the corresponding label, has occurred.

Engine Control System Panel



Voltage control panel

When the *CONTROL VOLTAGE switch* is on MANUAL, this switch allows voltage output of the AC generator to be adjusted using the MANUAL VOLT ADJUST rheostat. When on AUTO, the switch regulates voltage output that was set while in the MANUAL position. It also allows voltage output of AC generator to be adjusted from the AC switchboard.

The *MANUAL VOLT ADJUST rheostat* adjusts output voltage of the AC generator when the CONTROL VOLTAGE switch is in the MANUAL position.

This panel also contains the voltage regulator for the AC generator. Refer to the sections on the generator and the voltage regulator in this chapter.

ELECTRICAL STARTING EQUIPMENT

The electrical engine-starting equipment is listed and described as follows.

The *battery-charging alternator* provides electrical current. This is to keep the storage battery charged and to supply sufficient current to carry any other electrical load requirements up to the rated capacity of the alternator.

The *regulator* is used to regulate the voltage and current output of the battery-charging alternator and to help maintain a fully charged storage battery.

The lead-acid *storage battery* has three major functions. It–

- Provides electrical power to start the engine.
- Stabilizes voltage in the electrical system.
- Furnishes current during failure of the alternator or battery voltage regulator.

The electric *starting motor* is a Bendix drive-type starter. It uses a solenoid for starting the engine when operating the OFF-RUN-START switch on the engine-control system panel. The starter motor becomes energized only when the control switch is in START position. When in START position, the auxiliary solenoid is energized. This causes the starter motor solenoid to energize through the auxiliary solenoid closed contacts. When this solenoid is energized, it in turn connects the batteries to the starter motor through the starter motor solenoid closed contacts. The motor then starts running, engaging the engine flywheel and starting the engine.

The engine automatic shutdown and alarm circuit is energized when the engine control switch is either in the START or RUN position. This circuit is described in the following section.

AUTOMATIC SHUTDOWN AND ALARM SYSTEM

The electrical shutdown mechanism will stop the engine automatically if one of the following conditions occurs:

Ž Lubrication oil pressure drops below a predetermined value.

• Engine coolant overheats.

• Engine overspends.

The shutdown mechanism works in conjunction with the alarm. The alarm sounds a horn to warn the operator that a malfunction has caused the engine to stop running. The horn will continue to sound until the operator moves the alarm toggle switch on the engine-control system panel to SILENCE The shutdown system consists of the following:

•LOW OIL PRESSURE switch connected into the engine oil gallery.

ŽWATER TEMPE RATURE switch connected into the cylinder head.

•FUEL OIL PRESSURE switch installed in the inlet side of the fuel oil filter.

•Hot wire relay.

•Shutdown solenoid attached to the blower air inlet housing and linked to a lever on the air shutoff valve shaft.

ŽGovernor shutdown solenoid.

•Necessary components to automatically trip the AC generator main circuit breaker at the AC switchboard when reverse current is sensed at the AC generator output.

The electrical circuit is de-energized under normal operating conditions. After the engine is started, the LOW OIL PRESSURE switch opens when the lubricating oil pressure reaches approximately 10 psi and the FUEL OIL PRESSURE switch closes at approximately 12 psi fuel pressure. Since the fuel pressure builds up rapidly, the FUEL OIL PRESSURE switch could close before the LUBRICATING OIL PRESSURE switch opens and stops the engine. The hot wire relay, however, will delay the closing of the FUEL OIL PRESSURE switch several seconds. This is to enable the lubricating oil pressure to build up and open the LOW OIL PRESSURE switch contacts.

If the lubricating oil pressure falls below 10±2 psi, the contacts in the LOW OIL PRESSURE switch will close. Current will then flow through the hot wire relay to the shutdown solenoid. When the solenoid is energized, it releases the air shutoff latch, closing the air box door which causes the engine to stop. At the same time the LOW OIL PRESSURE indicator lights up on the engine control system panel, and the horn sounds to warn the operator. However, the few seconds required to heat the hot wire relay will provide sufficient delay to avoid an engine shutdown when the low oil pressure is caused by a temporary condition. Such a condition could be an air bubble or a temporary overlap in the operation of the LOW OIL PRESSURE switch and the FUEL OIL PRESSURE switch when starting or stopping the engine.

Two control relays, located inside the battery charger enclosure, also work in conjunction with the FUEL OIL PRESSURE switch on each engine. The relay for each engine is used to connect the engine batteries to the battery charger when the engine is not running. It is also used to disconnect the batteries from the charger and connect them to the engine alternator while the engine is running.

The watertemperature switch remains open during normal engine operation. When the engine coolant temperature rises to 206±5°F, the switch contacts close and activate the shutdown solenoid. The engine then stops, the HIGH WATER TEMPERATURE indictor lights up on the engine-control system panel, and the horn sounds.

If the engine speed exceeds the high speed setting of the governor (1,980 RMP), the OVERSPEED GOVERNOR switch closes and activates the shutdown solenoid. This

causes the engine to stop, the OVERSPEED indicator to light up on the engine-control system panel, and the horn to sound. When the engine stops, the FUEL OIL PRESSURE switch opens and de-energizes the circuit.

The cause of any one of the abnormal conditions described above must be determined and corrected before the engine is started again. Also, the air shutoff valve must be manually reset in the open position before starting the engine.

If reverse current is sensed at the output of one of the AC generators, the reverse current relay associated with that generator closes. This energizes a shunt trip solenoid which causes the AC generator MAIN CIRCUIT breaker to trip at the AC switchboard.

MAINTENANCE

The remainder of this section discusses maintenance of the engine and its components.

Engine preparation for initial start-up

The following operations should be performed when preparing to start a new *or* overhauled engine or an engine that has been in storage.

Fill the *air cleaner* oil cup to the proper level with engine lubricating oil. Do not overfill.

Prepare the *cooling system* as follows:

- Install all the drain cocks in the cooling system. Drain cocks are removed for shipping.
- Open the cooling system vent.

Ž Remove the filler cap, and fill the cooling system with clean, soft water and a protective solution of high boiling point antifreeze. Keep the liquid level about 2 inches below the filler neck to allow for fluid expansion.

Ž Close the cooling system vent after filling.

Charge the engine *lubrication system* with a pressure prelubricator. The lubricating oil film on the rotating parts and bearings of a new or overhauled engine, or one that has been in storage, may be insufficient for proper lubrication when the engine is started for the first time. The pressure prelubricator should be set to supply a minimum of 25 psi oil pressure for an immediate flow of oil to all bearings at the initial engine start-up. Make sure the oil supply line is attached to the engine before proceeding,

With the oil pan dry, use the prelubricator to prime the engine with sufficient oil to reach all bearing surfaces. Use heavy-duty lubrieating oil, using the dipstick to check the oil level in the oil pan. Add enough oil to bring it to the FULL mark on the dipstick. Do not overfill,

If the pressure prelubricator is not available, fill the crankcase to the proper level with heavy-duty oil.

Preventive maintenance

The following table provides a timetable for engine lubrication and preventive maintenance services.

Engine Lubrication and Preventive Maintenance

ITEM OPERATION	TIME INTERVAL Hours of Operation								
	Daily	8	100	200	300	500	1,000	2,000	
Engine oil	X								
Oil filter							X		
Coolant and filter	X					X	X		

Engine Lubrication and Preventive Maintenance (Continued)

ITEM OPERATION	TIME INTERVAL Hours of Operation								
	Daily	8	100	200	300	500	1,000	2,000	
Hoses						X			
Radiator							X		
Fuel tank	X					X			
Fuel strainer and filter					X				
Air cleaners		X				X			
Air box drains							X		
Ventilating system[1]									
Blower screen							X		
Starting motor[2]									
Battery-charging alternator		X	X		X			X	
Battery		X							
Tachometer drive		X							
Engine tune-up[3]									
Drive belts		X		X					
Overspeed governor						X			
Shutdown system				X					
Power generator		X		X					
Oil change							X		

[1] Clean crankcase breather cap whenever engine oil is changed.

[2] Lubricate oil wicks whenever starting motor is removed or disassembled. Lubricate Bendix drive mechanism when starting motor is removed for servicing.

[3] Tune up engine only as necessary to maintain satisfactory engine performance.

Corrective Maintenance

The following table gives information for exhaust analysis. It lists probable causes and suggested remedies based on the color of smoke being exhausted from the engine. Checks should be made with a minimum water-outlet temperature of 160°F.

Exhaust Smoke Analysis

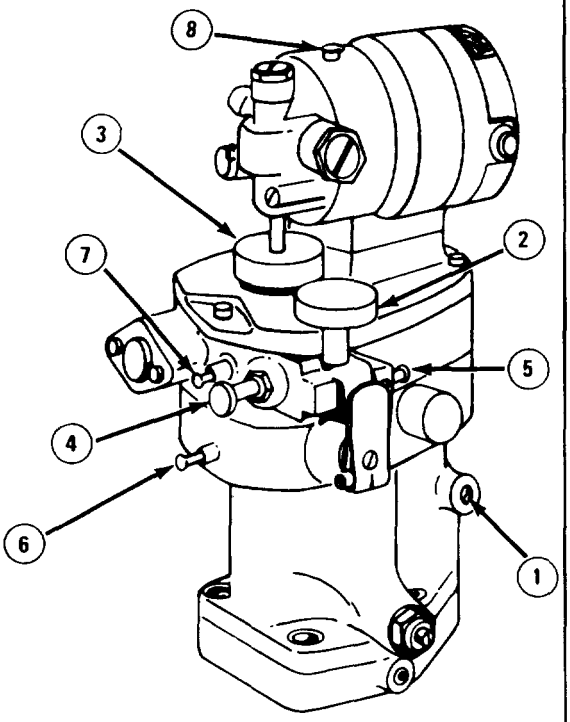
SIGN OF TROUBLE	PROBLEM DESCRIPTION AND PROBABLE CAUSE	REMEDY
Smoke, black or gray.	Incompletely burned fuel. High exhaust back pressure or a restricted air inlet, causing insufficient air for combustion and incompletely burned fuel.	Check for faulty exhaust or silencer obstruction (back pressure can be measured at exhaust manifold outlet with a manometer); replace defective parts.
		Check for clogged cylinder-liner ports, air cleaner, or blower air-inlet screen; clean these items.
		Check emergency stop-air valve to ensure that it is open; readjust if necessary.
	Excessive fuel or irregular fuel distribution.	Check for improperly timed injectors and improperly positioned injector rack control levers; time fuel injectors and governor to correct condition.
		Replace faulty injectors if condition persists after timing and tune-up.
		Check for cracked or broken injection spray tips.
	Improper grade of fuel oil.	Check grade of oil used; refer to fuel oil specification.
Smoke, blue.	Too much lubrication oil in cylinder.	Check for internal lubricating oil leaks.
Smoke, white.	Cylinders misfiring. Use of low-octane fuel.	Check for low compression, octane of fuel used, and water in oil.

GOVERNOR

SPECIFICATIONS

The governor is a variable-speed mechanical device. mounted on the engine and used to maintain a near-constant engine speed during load fluctuations. This is done by providing automatic fuel compensation to the engine during varying load conditions. Since the AC generator is directly coupled to the engine, constant speed is essential to produce constant frequency at the output of the generator. An engine speed of 1,800 RPM produces a generator-output frequency of 60 Hz. The governor is equipped with a speed adjusting motor that enables the operator (at the AC generator switchboard) to match the frequency of one generator to that of the other before synchronizing and to change the load after synchronizing. The following illustration and table provide governor data.

Governor (With synchronizing motor installed)



1 COMPENSATION NEEDLE VALVE
2 DROOP ADJUST KNOB
3 FRICTION DRIVE
4 LOAD LIMIT ADJUST SCREW
5 MAXIMUM DROOP SETTING SCREW
6 MAXIMUM SPEED ADJUST SCREW
7 MINIMUM DROOP SETTING SCREW
8 SYNCHRONIZING MOTOR

GOVERNOR DATA

Manufacturer	Woodward Governor Company
Model	Hydraulic, speed droop-adjusting
Type	SG
Torque output	12 *or* 24 *pounds/inch over* 36° travel of governor output shaft
Operating speed	2,400 or 3,600 RPM
Control	25% of normal speed
Range adjustment	1/2% to 7% over full 36° travel of governor output shaft

FUNCTIONAL DESCRIPTION

The hydraulic, speed-droop-type governor is designed so that the operating speed decreases as the engine load increases. This increases the amount of fuel to the engine and increases its speed. Conversely, the governor operates at a higher speed as the engine load decreases, decreasing the amount of fuel to the engine and decreasing its speed. In this way, stability of the governed system is achieved, and division of load between parallel generators is made possible.

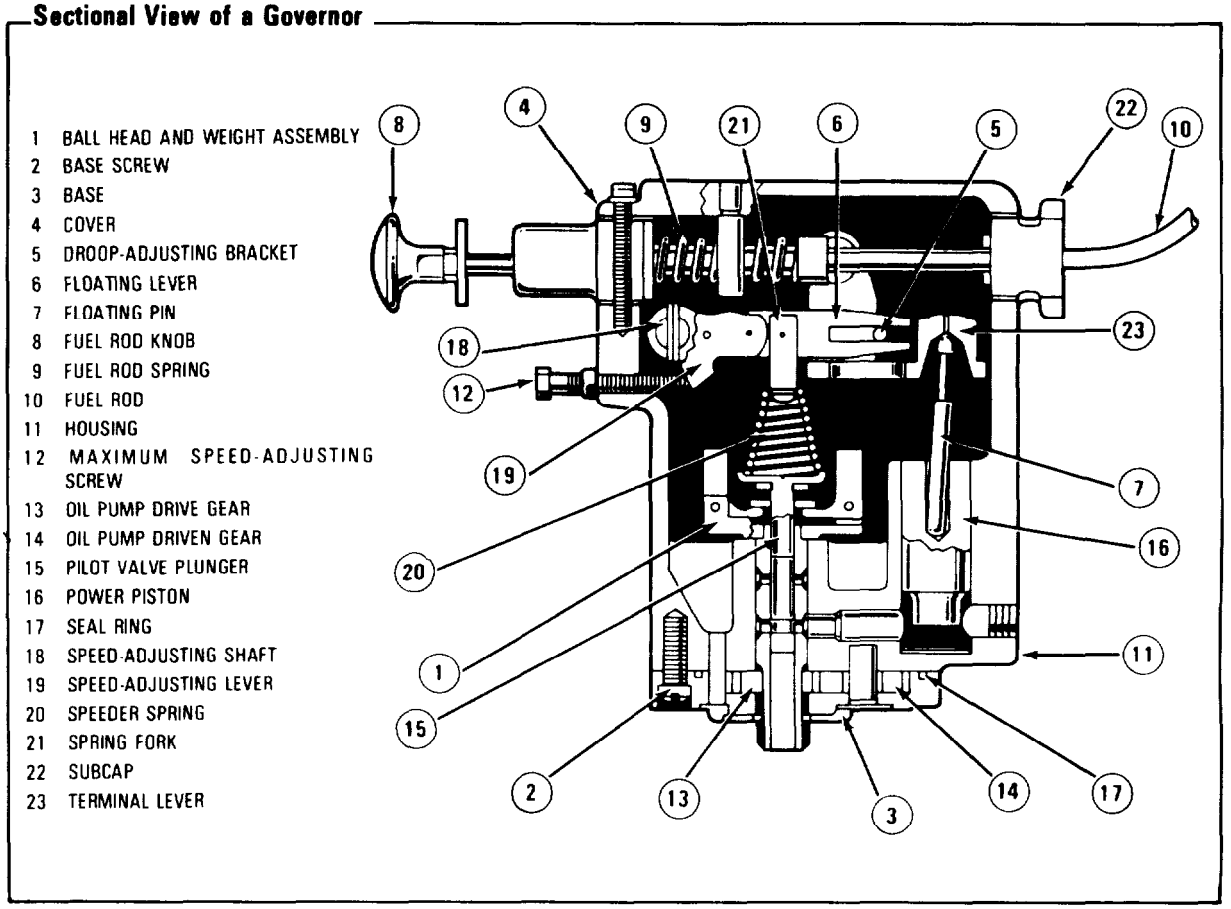
The governor incorporates a speed-stabilizer mechanism. Engine lubricating oil is admitted, under pressure, to an auxiliary oil pump in the governor. The auxiliary pump furnishes the necessary oil pressure to actuate the governor mechanism.

The governor is connected to the fuel injectors by a fuel rod that is attached to a lever on the injector control tube, The amount of fuel to the injectors is decreased by the action of a fuel rod spring and increased by the opposing action of a hydraulic power piston inside a cylinder. Admission of oil to the cylinder is controlled by a pilot valve. The pilot valve, in turn, is controlled by the fly-weights of the governor.

The two flyweights of the governor are mounted on a vertical shaft and driven, through a set of gears, by the upper rotor shaft of the blower. The centrifugal force of the rotating flyweights is opposed by a speeder spring. This spring is located on the vertical shaft between a spring fork at the top and the arms of the flyweights at the bottom. Compression of the speeder spring, which is controlled by the throttle, determines the speed at which the governor will control the engine.

For stability of operation (that is, without hunting), an adjustable, speed-droop mechanism is used in the governing system. Speed-droop adjustment is made through a slotted bracket attached to the terminal lever. Moving the droop-adjusting bracket in toward the engine increases governor droop. Moving it out, away from the engine, decreases the governor droop.

Sectional View of a Governor



When starting a cold engine, several cranking periods may be required for the lubricating oil pressure to become great enough to operate the governor and open the throttle so the engine can start. Since such a delay in starting is considered objectionable, the starting time can be reduced by pulling out on the fuel rod knob. The outward movement of the fuel rod takes control away from the governor.

Since the engine can be stopped by pushing in the fuel rod knob, the fuel rod can also act as a stopping device. Considerable force must be exerted to do this, since the oil pressure against the power piston must be overcome.

In addition to its function of holding the engine speed constant under varying loads, the hydraulic governor acts as an automatic shutdown device in case of lubricating oil pressure failure. Should the engine fail to supply oil to the governor, the servo piston will drop, letting the fuel rod return to the no-fuel position and shutting down the engine.

Governor drive

The governor drive shaft is splined to fit into the engine drive. The governor is mounted vertically and has a 3/8-inch external drain line provided to connect a 1/4-inch pipe-tapped hole in the lower end of the governor cover.

The governor drive shaft is rotated clockwise (when viewed from above). The governor oil inlet and relief valve assembly are on the left, when viewing the governor form the nameplate end.

Synchronizing motor

A synchronizing motor is mounted on the governor to provide a remote speed control. It enables the operator at the AC switchboard to match the frequency of one engine-driven generator to the other generator before synchronizing and to change the load distribution after synchronizing.

The motor is of the split-field, series-wound, reversible type. There is a slip coupling between the motor shaft and synchronizer-adjusting gear. This allows the engine operator to adjust speed by turning the speed-adjusting screw on the governor. A friction coupling is incorporated in the cover assembly to permit overtravel of the motor without damage.

Speed droop

The speed-droop adjustment can be set to automatically divide and balance the load between engines when electrically connected in parallel. Droop is incorporated in the governor through a linkage that varies the compression of the speeder (speed-adjusting) spring as the terminal shaft rotates. Increased fuel reduces spring compression, reducing the governor speed setting accordingly. The unit will also gradually reduce its speed as load is applied. This relationship between load and speed acts as a resistance to load changes when the unit is interconnected with other units, either mechanically or electrically. As droop is reduced toward zero, the unit becomes able to change load without changing speed.

The load is distributed between the two generators by speed and voltage adjustment through operation of the governor speed-control switch and voltage-control rheostat respectively.

Load limit

A load-limit adjustment hydraulically limits the load that can be applied to the engine by restricting the angular, terminal shaft rotation of the governor. This consequently restricts the amount of fuel supplied to the engine.

GOVERNOR ADJUSTMENTS

Three kinds of adjustments need to be made on the governor.

Initial engine start-up

Start the engine. Then position the speed-adjusting shaft for the desired running speed, and allow the engine to warm up. If the engine surges during warm-up, remove the governor cover assembly while engine is running, and adjust the droop bracket and pin toward maximum position (away from governor ball head).

Preliminary speed-droop adjustment

When the engine is warmed up, adjust the droop bracket and pin as much toward minimum as possible while maintaining steady speed.

Manually move the engine fuel linkage to temporarily increase engine speed. If the engine returns to the original steady speed, the adjustment is satisfactory for most single-engine installations. If the engine speed does not settle out, increase the droop slightly (an approximately 1/16-inch movement of bracket) and test again. Continue to increase the droop until operation is satisfactory.

Final speed-droop adjustment

For single-engine operation, set the speed-droop bracket as near minimum as possible (consistent with satisfactory performance) to have the least decrease in speed as load is added to the engine.

For parallel-engine operation, both engine-generator sets are equipped with a speed-droop govenor. Both governors must therefore be set to the same no-load and full-load droop setting. This will allow the load to be balanced on parallel units without changing the system frequency.

Set the droop sufficiently high (towards maximum) to secure satisfactory load division between generator sets. If the load does not divide properly, increase droop on the engine taking too great a portion of the load. Increasing droop setting will also prevent interchange of load between generator sets.

GENERATOR

SPECIFICATIONS

The two AC generators provide AC power to all AC-operated equipment on the floating barge crane. Each generator is driven by a diesel engine, which is speed-controlled through a hydraulically operated governor to provide a constant frequency output. The output voltage of each generator is set by a rheostat at the voltage control panel and regulated by its own voltage regulator. The following table gives detailed data on the generator.

Generator Data

Manufacturer	Kato Engineering Company
Model	30-SX9E
Type	Single-bearing
Power output	30 kw
Voltage	240/277 VAC
Cycles	60 Hz
Speed	1,800 RPM
Phase	3-phase
Windings	Series Delta
Size (generator)	31 inches long, 21 inches wide, and 16 1/2 inches high

FUNCTIONAL DESCRIPTION

The AC generation system consists of a brushless exciter mounted within the generator frame and a saturable transformer voltage regulator mounted in the voltage control panel.

The saturable transformer voltage regulator uses a solid state preamplifier for voltage error detection and control. It includes a series-boost circuit that increases regulator output during periods of high line-current demands such as when motors are started or shorts occur in the load. An automat ic voltage-adjust potentiometer permits the user to change the generator output voltage over a range of ±10 percent of 240 VAC.

The generator output voltage is produced in the generator stationary armature (stator). Voltage is induced into the stator windings by a rotating magnetic field. This field is produced by the turning generator field. For the generator field to become magnetized and produce a rotating magnetic field, a DC voltage (excitation) must be fed to the generator field coils and the generator rotor must be turning. The excitation voltage is supplied by the exciter. The exciter field poles retain some permanent magnetism, thus producing a magnetic field in the exciter. When the generator is started, voltage is induced in the exciter armature windings, fed to the rotating rectifiers, rectified, and fed to the generator field. The generator field then becomes magnetized and produces a rotating magnetic field. Control of the degree of magnetism of the generator field, and thus the voltage induced into the generator stator windings, depends on the voltage from the exciter. The exciter voltage is controlled by the voltage regulator, which supplies and controls the field current fed to the exciter field.

MAINTENANCE

Preventive maintenance

As necessary carry out the following inspection and cleaning procedures:

ŽInspect lead wiring for cracked insulation and loose terminals.

- Inspect control equipment for loose mounting hardware.
- Clean the outside of the generator assembly and ventilating screens.

ŽClean and/or dry the inside of the generator assembly when dust or moisture is present.

When inspection determines that cleaning is necessary, make certain that generators are not running and are tagged OUT OF SERVICE before performing the following procedure:

- Wipe loose dirt from exterior painted surfaces of the generator with a clean cloth. Remove stubborn accumulations of dirt with a detergent or solvent. Clean all ventilating ports with a vacuum cleaner, or use filtered compressed air at a pressure of 25 to 40 psi.

- Clean inside of generator with a vacuum cleaner, or dry filtered compressed air at a pressure of 25 to 40 psi. Remove accumulations of grease and dirt from windings with naptha.
- Clean electrical contacts and terminals with an approved contact cleaner. Do not file contacts.

The generator is equipped with shielded ball bearings. Periodic replenishment of grease is normally not required. A good time to inspect bearings is during major overhaul of the generator or diesel engine. Then either replace or repack the bearings depending on their condition.

If bearings are to be repacked, fill approximately half full. Use a good grade of ball bearing grease recommended for electrical motor service. The grease should be capable of retainng satisfactory lubricating qualities from a temperature of 240°F down to the lowest ambient temperature surrounding the generator.

The generator windings are protected from dampness by strip heaters, one set for each generator. Strip heaters, 120-VAC, 1-phase power, are available at the strip heater distribution box. The heaters for each generator can be turned on by operating the associated switch at the distribution box. Winding resistance can be checked before placing the generator in operation To do this, use the ground-detect system PUSH-TO-TEST push button on the AC switchboard. The GROUND-DETECT SYSTEM lights will reflect the condition of the windings.

Winding insulation resistance can be tested with a hand-cranked megger of not over 500 volts. When meggering any generator winding, remove all connections to associated components, such as the voltage regulator, rectifier bridge, or load. When reconnecting the leads, make sure that all connections are made correctly.

If the insulation fails to meet the test standards (1 megohm minimum), the generator can be heat-dried with a warm air oven, heat lamps, or strip heaters. The temperature should not exceed 150°F.

The generator windings can also be dried with internal heat by using a variable source of direct current. Check for excessive accumulation (pockets) of water on generator windings. Dry as much as possible with compressed air before applying internal heat. Then proceed as follows:

- Remove generator terminal box cover. Disconnect all generator stator leads (1 through 12) from voltage regulator leads and load lines.
- Connect generator stator leads to short-circuit the stator windings.
- In one of the generator leads, insert an ammeter of sufficient size to read full-load generator current.
- Disconnect exciter field leads from F+ and F-terminals on the voltage regulator, and connect a variable source of direct current to the exciter field leads.
- Operate the generator at normal speed. Supply just enough excitation to cause rated current to flow in the generator stator windings.
- Operate for sufficient time to ensure thorough drying of the windings. This can be determined by stopping the generator periodically and checking the insulation resistance of the windings. Check insulation resistance at l-hour intervals. Terminate the drying-out process when measured resistance is within test standards and shows little change over a 2- to 4-hour period of operation.

> *NOTE:* When reconnecting the generator leads, make sure they are connected correctly, otherwise the phase rotation will be affected.

Corrective maintenance

The following chart shows what steps to take in troubleshooting the generator.

Troubleshooting Chart : Generator

SYMPTOM	PROBABLE CAUSE	REMEDY
No voltage output.	Open circuit breaker.	Check and reset circuit breaker.
	Open circuit in exciter field.	Check out continuity of shunt field and leads to voltage control (use ohmmeter or Wheatstone bridge). If open in field coils, remove exciter field field assembly and return assembly to factory for repair.
	Loss of residual magnetism in the exciter field poles.	Adjust manual-adjust potentiometer to full resistance. Flash field by making a flash connection of DC across terminals F1 to F2.
	Open circuit in stator winding.	Check for continuity in windings. Return to factory for repair if open.
	Malfunction of automatic voltage regulator.	See troubleshooting of voltage regulator in this chapter.
	Short-circuited generator output leads.	Clear lead to restore voltage buildup.
	Open in rotating rectifiers.	Check rotating rectifiers; replace if open.
	Open in alternator field.	Check for continuity; return rotor to factory for repair if field coils are open.
	Shorted rotating rectifiers.	Check for shorts; replace if faulty.
	Shorted exciter armature.	Check for short; if faulty replace.
	Shorted leads between exciter armature and generator field.	Test and repair.
Low voltage output.	REGULATOR ON-OFF switch in OFF position.	Position to ON.
	Improper adjustment of VOLTAGE ADJUST rheostat.	Adjust rheostat. (See Voltage Regulator in this chapter.)
	High-resistance connection; connections will be warm.	Tighten connections.
	Shorted field.	Test field coils for possible short by checking resistance with an ohmmeter or resistance bridge. Return rotor assembly to factory for repair if alternator field coils are shorted.
	Weak field due to operating in warm temperature.	Improve the ventilation of generator. Field current can be increased, providing the generator temperature rating is not exceeded.
	Improper speed of engine-driven generator set due to defective governor, ignition system, or carburetor.	Check and correct deficiencies. (See Diesel Engine or Governor in this chapter.)

Troubleshooting Chart : Generator (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Fluctuating voltage.	Voltage regulator not operating properly.	Check regulator. (See Voltage Regulator in this chapter.)
	Engine speed fluctuating.	Check engine governor. (See Governor in this chapter.)
	Loose terminal or load connections.	Tighten connections.
	DC excitation voltage fluctuating.	Check DC excitation circuit. Correct any defects.
High voltage output.	Overspeed.	Correct speed of engine by adjusting governor. (Refer to Governor in this chapter.)
	Improper connection of generator.	Reconnect generator correctly.
	Improper adjustment of VOLTAGE ADJUST rheostat.	Adjust rheostat. (See Voltage Regulator in this chapter.)
Overheating.	Clogged ventilating screens and air passages.	Clean all screens and air passages.
	Dry or defective bearings.	Lubricate dry bearings; replace if defective.
	Generator field coils shorted or grounded.	Test field coils for shorts; replace if rotor is shorted or return to factory for repair.
Vibration.	Defective or dry bearings.	Lubricate dry bearings; replace if defective.
	Misalignment of generator and engine.	Align generator set.
	Generator not properly mounted.	Check mounting; correct defective mounting.

VOLTAGE REGULATOR

SPECIFICATIONS

The voltage regulator is used with the AC generator to maintain the generator output voltage within ±2% of the preset value, from no-load to full-rated load. It is also capable of providing more than 200 percent rated short-circuit current for starting loads. The regulator obtains its power from the generator output voltage. The following table gives detailed data on the voltage regulator.

Voltage Regulator Data

Manufacturer	Kato Engineering Company
Type	Kamag No 13683
Sensing	120/240-volt, 50- to 60-Hz, 1-phase
Power output	100-VDC, 2-amp
Current boost	200%
Regulation	±2%
Size (voltage control panel)	24 inches high, 20 inches wide, and 9 1/4 inches deep
Weight	About 60 lb

FUNCTIONAL DESCRIPTION

The voltage regulator consists of a highly saturable transformer and a solid state pre-amplifier. The regulator also incorporates voltage rheostat multiterminal switch (RMS) sensing and current boost. This latter feature provides short circuit current boost to ensure good starting characteristics. Shown is the closed loop control diagram of the generator-regulator system into basic blocks.

The generator provides a means of converting mechanical energy from an engine to electrical energy. To increase the generator ability to perform as an infinite bus, a voltage regulator is used as a generator field exciter. With external constant field excitation, the generator terminal voltage would be the inherent regulation, ranging from 10 to 50 percent. The voltage regulator improves regulation to ±2 percent or better under rated, full-load conditions.

Voltage and current are combined magnetically in a saturable transformer. The saturable transformer has a control winding (C1, C2) to vary the output as an inversely proportional power amplifier. For example, increasing control signal results in reduced output.

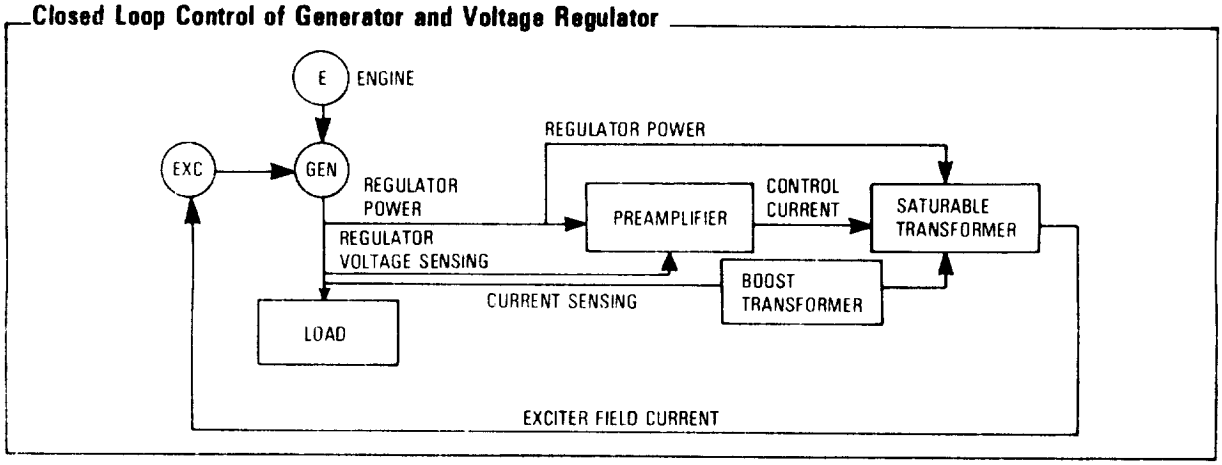
Winding (H1, H3) provides the power to TS1. Power is obtained from the generator output. Linear reactor (LI) is a series, current-limiting reactor that supplies reasonably constant current to TS1 under no-load conditions.

Current boost winding (E, F) is the load current boost. Since generator field excitation is nearly proportional to load current, an increasing load will provide additional current to TS1. This results in nearly the exact increase in field excitation.

Control winding (C1, C2) provides a means for voltage adjustment and compensation for circuit tolerance and increases in field power due to thermal effects.

Winding (X1, X3) is the output AC, which is rectified by a full-wave diode bridge (BR1). The DC output of the rectifier bridge provides field excitation.

Closed Loop Control of Generator and Voltage Regulator



Voltage output adjustment

The generator output voltage level can be adjusted as follows:

Step 1. With the generator running at rated speed (1,800 RPM) and the CONTROL VOLTAGE switch on the voltage control panel positioned to AUTO, adjust the VOLTAGE ADJUST rheostat (R18) for 240-VAC output. If that voltage level cannot be obtained, adjust R18 to halfway range; then proceed to the following step.

Step 2. Adjust VOLTAGE RANGE ADJUST potentiometer R19 for 240-VAC output. Adjustment of potentiometers R18 and R19 back and forth may be necessary for the correct 240-VAC output level.

Voltage stability adjustment

If, during operation, voltage output oscillates or poor response occurs when the load is varied, adjust for stability as follows:

Step 1. With voltage output adjusted to 240 VAC, adjust STABILITY ADJUST potentiometer R8 (located on the circuit card) until voltage output is stable at both no-load and full load.

Step 2. Refer to Generator in this chapter for frequency setting and load application.

MAINTENANCE

Preventive maintenance

Preventive maintenance consists of periodic inspecting and cleaning. The voltage regulator should be inspected and cleaned approximately four times a year as follows:

Step 1. Make sure that the generator is shut down; then remove the five clamps and open panel door.

Step 2. Inspect lead wires and terminal connections. Repair any frayed or worn lead wire insulation. Tighten any loose terminal connectors. Clean excessive dirt from the lead wires with clean cloth.

Step 3. Clean dirt from the voltage regulator with a vacuum cleaner or with filtered, compressed air at a pressure of 25 to 40 psi.

Step 4. Check the regulator for loose mounting bolts or nuts. Tighten any loose connections.

Step 6. Close the door and replace the five clamps before starting the generator.

WARNING: Avoid exposure to dangerous voltage. Do not attempt to repair or clean parts within the terminal box when generator is running.

Corrective maintenance

The following troubleshooting chart pinpoints specific problems, probable causes, and corrective actions. Refer to diagrams at the end of this chapter for schematics of the voltage regulator and preamplifier assemblies (pages 3-25 through 3-28).

Troubleshooting Chart Voltage Regulator

SYMPTOM	PROBABLE CAUSE	REMEDY
No generator output voltage.	No residual magnetism in exciter field.	Disconnect F+, F- leads at regulator and flash field with about 12 VDC.
	Shorted or open exciter armature, generator field or generator armature windings.	Measure resistance of windings as check for open windings. Check resistance to ground as check for shorted windings. If windings are open or shorted, return defective part to factory or authorized local repair shop.
	REGULATOR ON-OFF switch in OFF position.	Position switch to ON.
	Exciter rectifiers open.	Test; replace defective rectifiers.
Generator output voltage low.	VOLTAGE ADJUST (R18) not properly adjusted.	Adjust potentiometer. Refer to procedures outlined in operating instructions.
Generator output voltage low but controllable at no-load.	Regulator or generator not connected correctly.	Connect as shown on generator set wiring diagram.
	Diesel engine under speed.	Increase speed to generator set.
	Defective voltage regulator.	Check sensing, error detector, and amplifier circuits.

Troubleshooting Chart : Voltage Regulator (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Generator output voltage low at no-load. No voltage control and exciter residual at about 25 percent of nominal.	Exciter field defective or regulator disconnected or defective.	Check connections to voltage regulator. (Refer to generator set wiring diagram.) If connections are correct, disconnect F+, F- leads at regulator and flash field with 12 VDC. If voltage rises to nearly normal, regulator is probably defective and should be repaired or replaced. If voltage does not rise when field is flashed, check exciter field resistance. Repair defective exciter field.
Generator output voltage low (50 to 90 percent rated no-load) and no regulator control.	Low engine speed.	Check engine speed. Increase to rated value of generator.
	Generator or regulator not connected correctly.	Check connections. (Refer to generator set wrong diagram.)
	Defective regu!ator.	Excite separately with 12 VDC connected to exciter field leads F+, F-. If voltage rises, regulator is probably defective. lest regulator components: repair or replace regulator.
	Open VOLTAGE ADJUST (R18) or VOLTAGE RANGE ADJUST (R19) potentiometers.	Test; replace if defective.
Generator output voltage high but controllable at no-load.	Engine speed high.	Reduce speed of generator.
	Open sensing or shorted VOLTAGE ADJUST (R 18) or VOLTAGE RANGE ADJUST (R19) potentiometers. Defective error detector or amplifier.	Check sensing circuit for poor connections. Check sensing transformer for open or shorted windings. Check VOLTAGE ADJUST potentiometers; replace defective components. Test components located on printed circuit board.
Poor regulation. Generator output voltage normal at no-load, but collapses or drops under load. Load removal results in nominal voltage.	Engine speed drops due to governor not functioning properly.	Adjust governor.
	Generator or regulator disconnected.	Check generator set wiring diagram; reconnect if disconnected.
	Unbalanced load.	Balance load (see Generator in this chapter).
	Regulator defective.	Test by connecting separate excitation voltage to terminals F+, F-, about 30 to 60 VDC depending on kw load and power factor. If voltage is nearly normal, voltage regulator is probably defective. Replace or repair.

Troubleshooting Chart : Voltage Regulator (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Poor regulation. Generator output voltage normal at no-load, but collapses or drops under load. Load removal results in nominal voltage (Continued).	Generator defective.	Test as described above. If near-normal power does not result when unit is separately excited, check generator connections and test winding resistance. Also test rotating rectifiers in exciter assembly.
Poor response on load application.	Same as "poor regulation" above.	Same as "poor regulation" above.
	REGULATOR STABILITY ADJUST (R8) requires adjustment.	Adjust as described in operating instructions for voltage stability adjustment. Normally a regulator that is stable at no-load will remain stable when steady-state load is applied.
Voltage fluctuates, oscillates, or hunts.	Engine speed fluctuating.	Check repair defective governor.
	Regulator STABILITY ADJUST (R8) requires adjustment.	Adjust as described in operating instructions for voltage stability adjustment. Normally a regulator that is stable at no-load will remain stable when steady-state load is applied.

Voltage regulator assembly removal

The voltage regulator assembly can be removed from the voltage control panel as follows:

Step 1. Remove the five clamps from the panel door, and open door.

Step 2. Free the electrical cable by removing the two clamps.

Step 3. Disconnect the cable from the terminals on the back of the door.

Step 4. Remove the four nuts and washers; then remove regulator assembly from panel.

Step 5. Disconnect the reactor cable from the transformer.

Step 6. Disconnect wiring from the terminals on the side of the preamplifier subassembly.

Step 7. Remove four nuts, washers, and screws; then remove the preamplifier subassembly.

Voltage regulator components testing

Follow these procedures for testing the various components of the voltage regulator. When testing components connected in a circuit, care should be taken that other components in the circuit do not affect readings.

CAUTIONS: Meggers and high-potential test equipment should be used with care. Incorrect use of such equipment could destroy the rectifiers, transistors, and capacitors in the regulator.

When testing insulation resistance of generator windings with the megger, first disconnect leads between regulator and generator.

During normal operation, the *rectifier* sometimes develops small brown surface marks. These usually do not affect rectifier operation. To test the rectifier, follow these steps:

Step 1. Connect an ohmmeter or 3-volt test light across the rectifier. Observe the ohmmeter reading or, if a test light is used, observe if bulb lights.

Step 2. Reverse the leads. Again, observe the ohmmeter reading or, if a test light is used, observe if bulb lights.

Step 3. A good rectifier will have high resistance in one direction and low resistance in the opposite direction. If a test lamp is used, the bulb should light in the direction of low resistance and should not light in the direction of high resistance. If a low resistance is indicated in both Steps 1 and 2, the rectifier is probably shorted. High resistance in both Steps 1 and 2 indicates an open rectifier.

Capacitors can be checked on a capacitor bridge to measure capacitance and leakage. Capacitance should not vary more than ±10 percent from rated values.

If an ohmmeter is used, connect across the capacitor and set to a high-resistance scale. The meter should initially indicate low resistance and should then gradually increase until capacitor is fully charged.

Typical defects of the *saturable transformer* are open or shorted windings. Open windings can be determined by disconnecting the transformer from the circuit and then testing continuity of the windings. Shorted windings generally can be detected by checking resistance of the transformer windings with the winding resistance of an identical transformer known to be in good condition.

Check the secondary voltages of the power *transformer* with rated voltage on the primary winding. Measured voltages, taken when a transformer is unloaded, run up to about 10 percent higher than those taken when the transformer is wired into its circuit. Typical transformer defects are shorts between windings, open windings, and shorted turns. These usually can be detected by checking resistances and voltages. When the transformer overheats and the existence of shorted turns cannot be proved by resistance measurement, check the no-load alternating current in the primary winding. This excitation current will be excessive if there are shorted turns.

Current transformers have a fixed ratio of current between primary and secondary currents. The ratio between these currents is determined by the turns ratio. The following test can be made for shorted turns:

Step 1. Load the generator to produce primary current in the transformer.

Step 2. Measure the secondary current.

CAUTION: Do not open the secondary current of a current transformer while the circuit is energized.

The ratio of primary to secondary current is approximately the same as the ratio of secondary turns to primary turns. If the secondary current is considerably less than it should be, shorted turns are indicated.

Check the resistance values of *potentiometers* and *resistors* with an ohmmeter. Potentiometers and adjustable resistors should be checked over their full range. Take care to avoid damage to the fine wire when setting adjustment bands on ajustable resistors. The adjustment band should be loosened until it slides freely on the resistor tube. Typical defects are open or short-circuited resistors.

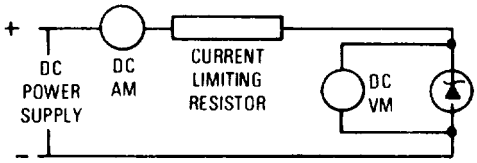
Silicon transistors can be tested with a 3. volt test light as detailed in the following transistor test chart. The test-by-test light method will normally indicate if a transistor is open or short-circuited. Remove the transistor from the circuit to prevent other components in the circuit from affecting the readings. The light indications listed in the following table will be observed if the transistor is not shorted or open. The following illustrations show the location of base, emitter, and collector lead.

Transistor Test

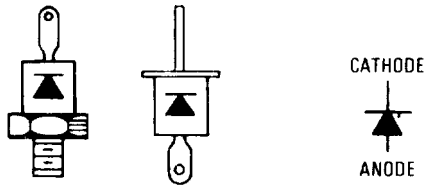
TYPE TRANSISTOR	TEST LAMP NEGATIVE LEAD CONNECTED TO-	TEST LAMP POSITIVE LEAD CONNECTED TO-	LIGHT INDICATION
NPN	Base	Emitter	No light
NPN	Base	Collector	No light
NPN	Emitter	Base	Light
NPN	Collector	Base	Light
PNP	Base	Emitter	Light
PNP	Base	Collector	Light
PNP	Emitter	Base	No light
PNP	Collector	Base	No light

A *zener diode* can be checked with an ohmmeter in much the same way as for a normal rectifier, or a battery check can be performed. If a DC power supply having a low ripple is available, the actual operation of the zener can be checked. Referring to the test setup illustrated in the figure showing the zener diode test, the voltage across the diode will increase until it reaches the zener voltage. As the DC input voltage is increased, the voltage across the diode will remain constant and the current through the diode will increase rapidly. Do not exceed the current rating of the diode.

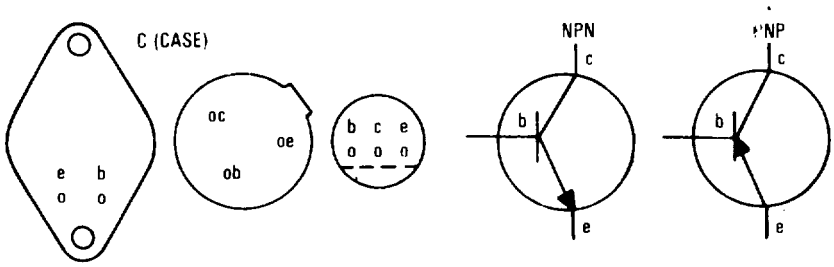
Zener Diode Test



Silicon Rectifier



Silicon Transistor (Physical and electrical diagrams)



Voltage and resistance measurements

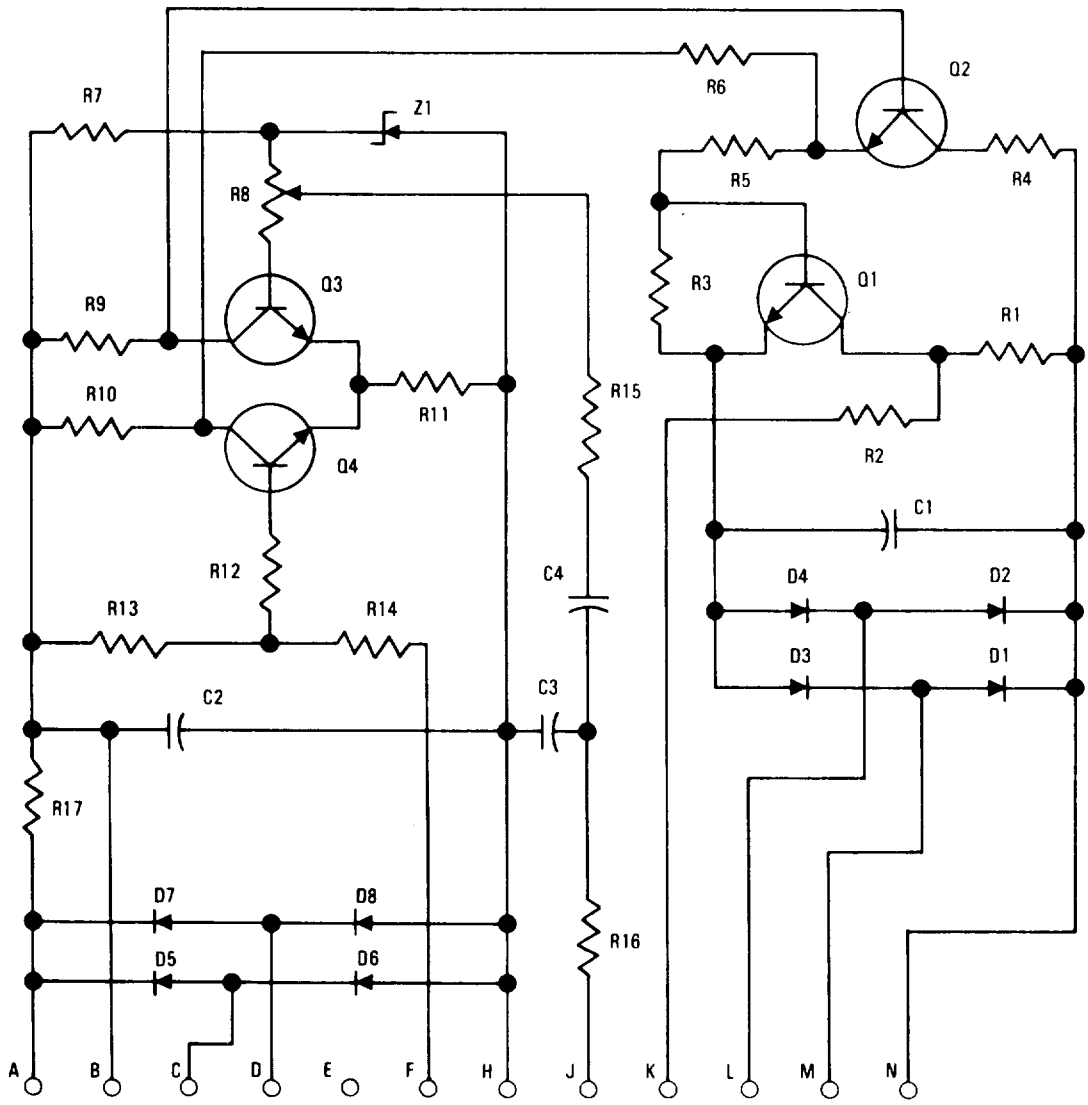
Voltage and resistance values across the voltage regulator circuits are outlined in the following table of regulator voltage and resistance measurements. The measurements are taken with a Multimeter. Voltage measurements will be taken with no-load on the generator and generator output voltage so adjusted that 135 VAC will appear between regulator terminals L and N (Saturable Transformer, Schematic 3). To take resistance measurements, disconnect wires to regulator terminals F+, F-, L, N, T1, T2, T3, and T4. Leave wires on terminals 7 and 8.

Mechanical assemblies of the voltage regulator are illustrated on the following pages.

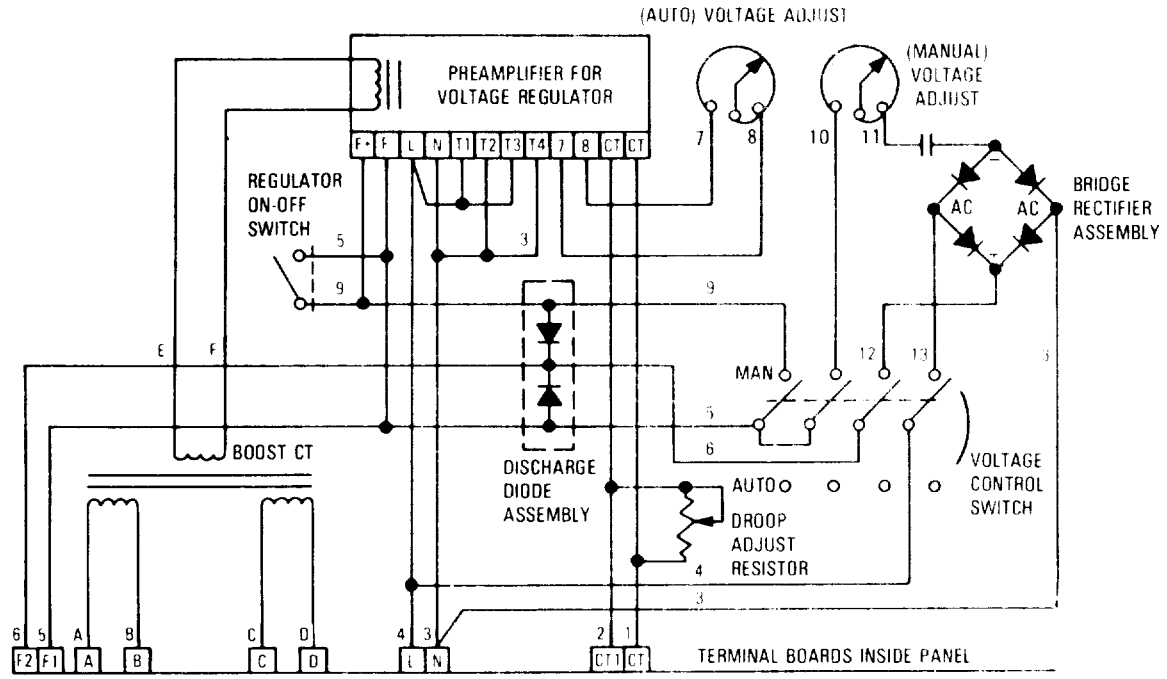
REGULATOR VOLTAGE AND RESISTANCE MEASUREMENTS

STEP	POINT OF MEASUREMENT	TYPICAL READING
	(Refer to Schematic 1)	(May vary slightly)
1.	Printed circuit board terminals A to B	260 ohms
2.	Printed circuit board terminals F to H	0-1500 ohms depending on voltage adjustment setting
3.	Printed circuit board terminals C and D	30 VAC, 6.5 ohms
4.	Printed circuit board terminals L to M	30 VAC, 6.5 ohms
5.	Printed circuit board terminals K (C-) 10 N (c+)	3.5 VDC
6.	Printed circuit board across Z1	Zener voltage 8.2 VDC
7.	Printed circuit board, junction of resistors R13, R14 to printed circuit board terminal H (Refer to Schematic 2)	8.2 VDC nominal; varies with changes in sensing and setting of voltage adjustment
8.	Regulator terminal board, terminals L TO N	135 VAC
9.	Regulator terminal board, terminals T1 to T2	120 VAC
10.	Regulator terminal board, terminals T3 to T4	120 VAC
11.	Regulator terminal board, terminals F+ to F- (Refer to Schematic 3)	13 VDC
12.	Saturable transformer TS1, terminals H1 to H3	28 VAC, 6.5 ohms
13.	Saturable transformer TS1, terminal H1 to regulator terminal L	107 VAC
14.	Saturable transformer TS1, terminals X1 to X3	20 VAC, 6.5 ohms

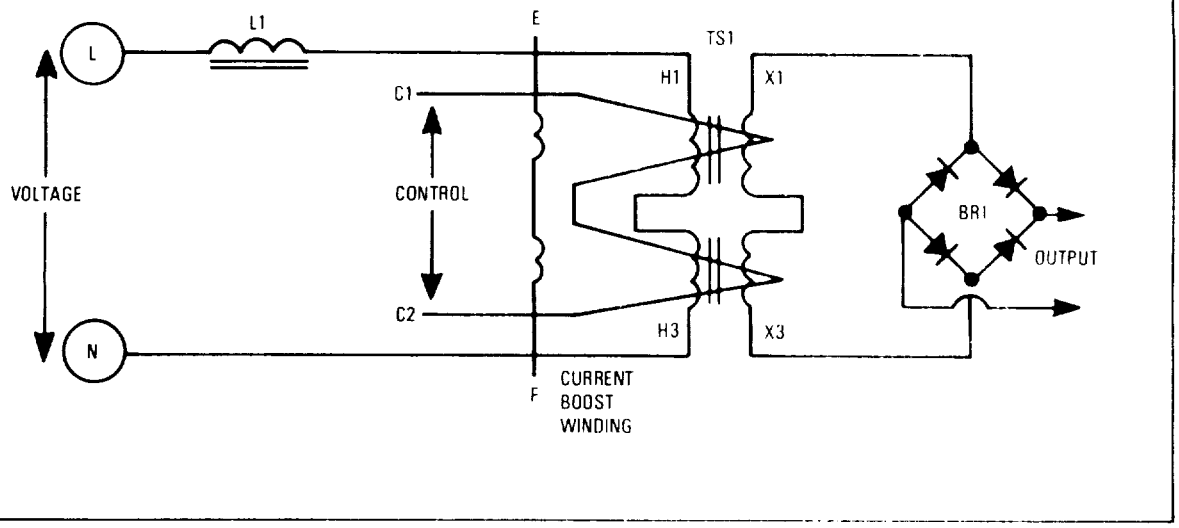
Preamplifier of Voltage Regulator (Schematic 1)



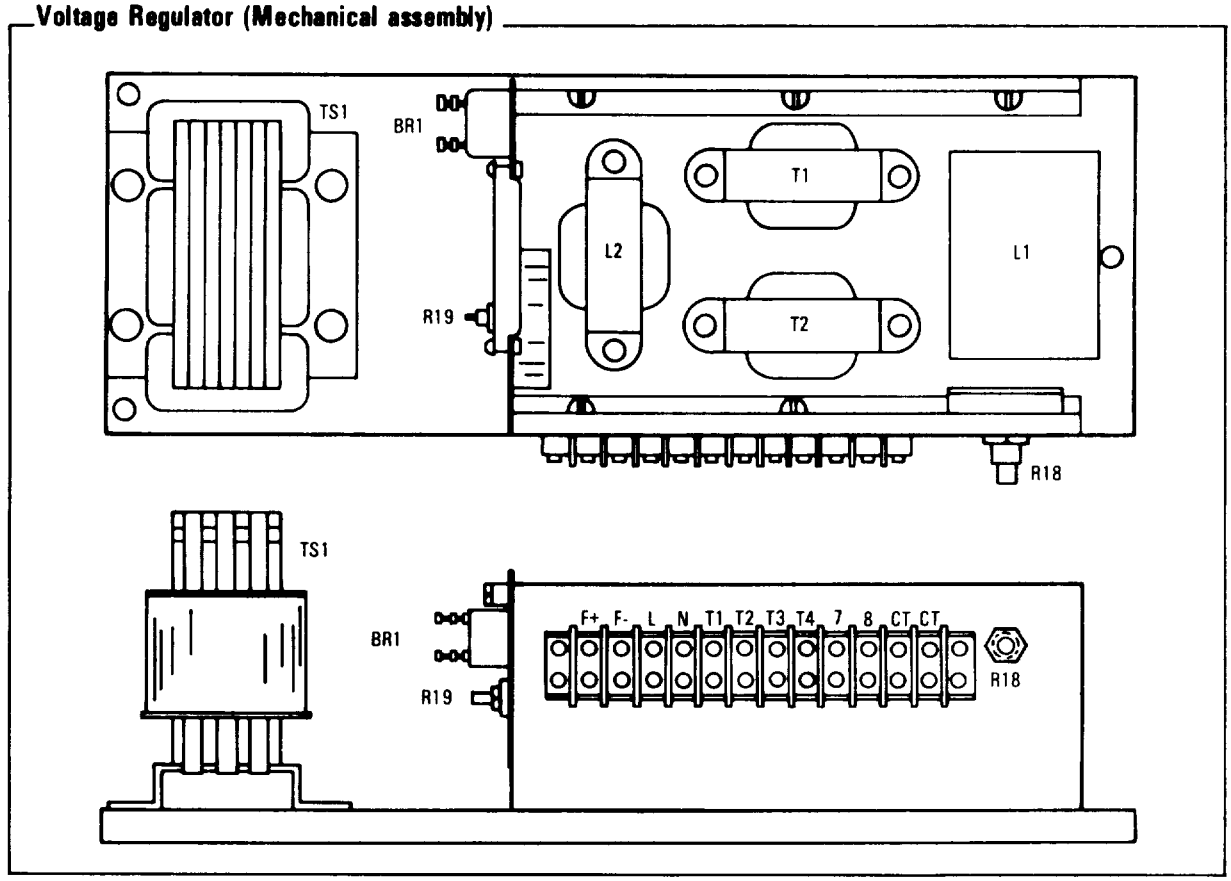
Voltage Regulator (Schematic 2)



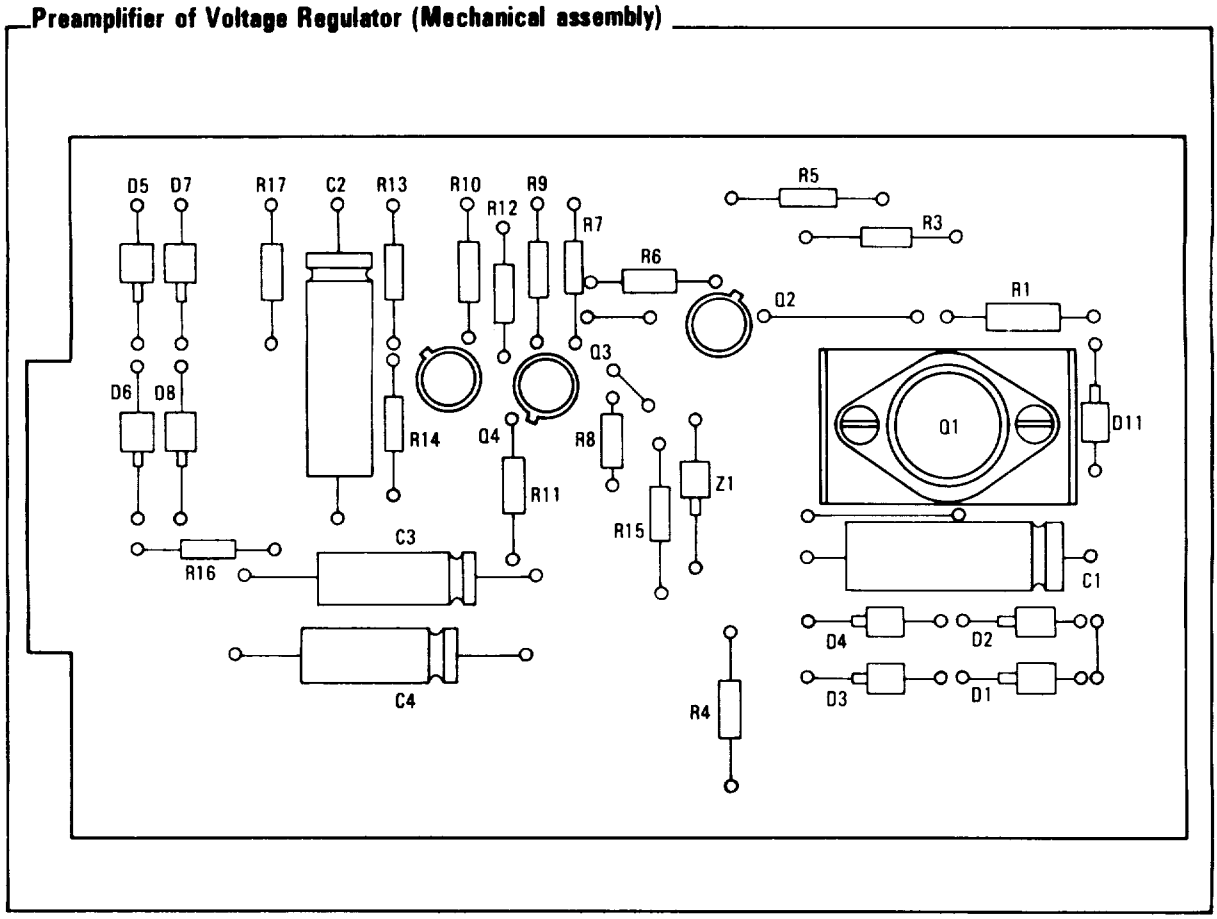
Saturable Transformer (Schematic 3)



Voltage Regulator (Mechanical assembly)



Preamplifier of Voltage Regulator (Mechanical assembly)



CHAPTER 4

POWER PLANT (AC): DISTRIBUTION SYSTEM

The AC generator switchboard controls and monitors the output of the two AC generators and supplies AC power to the power distribution panels. These panels receive power through main circuit breakers and distribute this power to all AC-operated equipment located on the barge.

GENERATOR SWITCHBOARD SPECIFICATIONS

This section describes the AC generator switchboard, hereafter referred to as the AC switchboard. The following table and illustration present data on the switchboard front panel and its components.

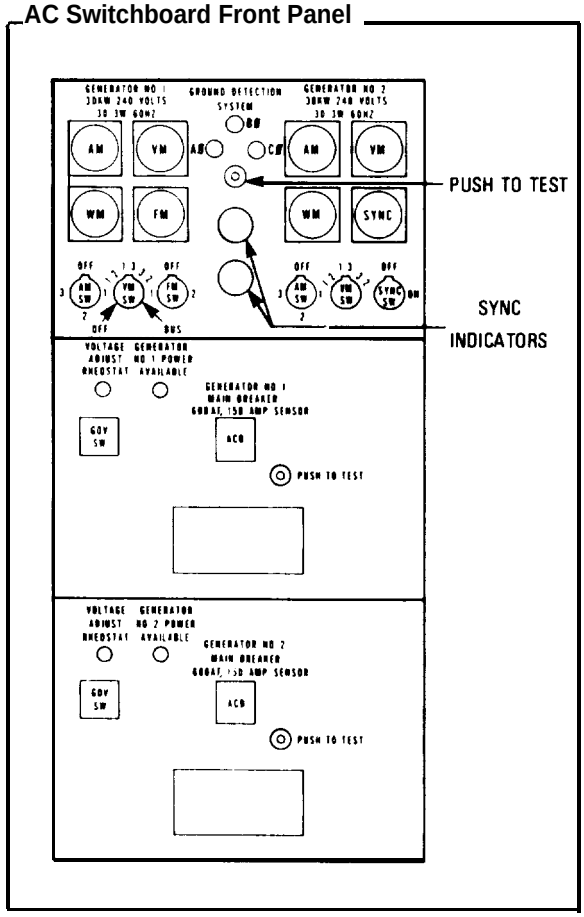
AC Switchboard Data

CONTROL METER, OR INDICATOR	FUNCTION
Air circuit breaker, Type TJ53601, 600-amp frame breaker (one for each generator), has 100-amp long-time delay, 800-amp short-time delay, and 1,200-amp instantaneous tripping, with 120-VAC undervoltage release, SPOT auxiliary switch, and manually operated breaker drawout.	Makes 240-VAC, 3-phase, 60-Hz power from AC generator available to engine room, 240-VAC-load center panel.
PUSH-TO-TEST push button.	Permits mechanical simulation of overcurrent tripping for test purposes and acts as a means of tripping the breaker m an emergency situation.
Reverse power relay.	Automatically shuts off 240-VAC power to the engine room, 240-VAC-load center panel {by opening main circuit breaker) when the relay senses load-current reversal.
VOLTAGE ADJUST rheostat (one for each generator).	Varies the AC generator output voltage (by varying sensing voltage circuit at voltage regulator unit).
GOVERNOR switch (one for each engine).	Drives the governor motor to increase or decrease the speed of the diesel engine. This increases or decreases the speed of the AC generator, consequently increasing or decreasing the output frequency.
Voltmeter, 0- to 300-V scale (one for each generator).	Indicates AC generator output voltage.
Voltmeter swttch (one for each voltmeter).	Connects voltmeter to associated AC generator output circuit. Switch has five positions OFF, “1-2," “2-3,” “3-1” (corresponding to A phase, B phase, and C phase respectively), and “BUS.”

AC Switchboard Data (Continued)

CONTROL, METER, OR INDICATOR	FUNCTION
Ammeter, 0- to 200-amp scale (one for each generator.)	Indicates AC generator output current.
Ammeter switch (one for each ammeter).	Connects ammeter to associated AC generator output circuit. Switch has four positions “OFF,” “1,” “2," and “3’ (corresponding to A phase, B phase, and C phase respectively)
Wattmeter, 0- to 80-kw scale (one for each generator).	Indicates load at associated AC generator output.
Frequency meter, 55- to 65-Hz scale.	Indicates frequency of selected AC generators.
Frequency meter switch.	Connects frequency meter to AC generator load circuit; selects generator 1 or 2.
Synchroscope.	Used to synchronize frequency of one AC generator with the other and to divide load between the two generators.
Synchroscope switch.	Allows selection of engine-generator set to be synchronized (should be set to synchronize oncoming generator set).
Synchroscope lights.	Work m conjuction with synchroscope when synchronizing generator loads. One light is connected to A phase of generator 1 and the other to A phase of generator 2.
GENERATOR NO 1 (or NO 2) POWER AVAIL-BLE indicator.	Lights to indicate that associated AC generator is operating and output voltage is available.
Ground fault detect lights.	When PUSH- TO-TEST is depressed, all three indicators will light. If no ground is present, all three indicators will show same brightness. If a ground is present in a particular phase, indicator for that phase will be dim, other two indicators will be bright.
PUST-TO-TEST switch.	Connects a ground fault detector circuit indicator to each phase of AC generator output.

AC Switchboard Front Panel



FUNCTIONAL DESCRIPTION

The following paragraphs describe the operation of the synchroscope, generator reverse-current relay, and air circuit breaker drawout assembly.

Synchroscope

The synchroscope is of the rotatable, polarized iron-vane type. The stator, operating in conjunction with the moving iron vane, has an independent exciting coil. The winding is connected to one phase of the incoming machine through a phase-splitting network that produces a rotating field. The exciting coil is connected to the corresponding phase of the running machine. The moving vanes are thus polarized by the resulting field. The action of these two fields is such that the vane will indicate the phase difference.

To indicate synchronism between two systems correctly, the synchroscope must be connected to corresponding phases of the two systems; for example, to phase A of both generators 1 and 2. The field coil with its impedor is connected through a potential transformer to the system or bus already energized. The polarizing coil is connected through another potential transformer to the generator which is to be synchronized with the system.

If the pointer remains in the vertical position, the two sources are in synchronism. If the needle remains in a position other than vertical, the two sources are operating at the same frequency, but with a phase angle between them proportional to the angle the pointer takes from the vertical. A rotating pointer indicates a difference in frequency between the two sources equal to the frequency of the rotation of the pointer. The markings on the synchroscope dial will indicate whether the oncoming generator is running faster or slower than the bus. The scale has a synchronism mark at "12o'clock" with a “fast” arrow pointing clockwise and a “slow” arrow pointing counterclockwise. The speed of the generator must be varied to synchronize it with the bus.

The calibration of the instrument can be checked by connecting both windings to the same source. The pointer should then indicate synchronism. If the pointer does not indicate synchronism, it should be shifted to the vertical position.

Generator reverse-current relay

When a generator is operating in parallel with another and its prime mover (diesel engine) fails, the generator will take power from the system, run as a motor, and drive the prime mover. This could damage the prime mover. To prevent this, the reverse-current relay will trip the generator circuit breaker and take the generator off the bus when the reverse power exceeds the relay setting. The setting is chosen according to the particular requirements of each generator set.

Air circuit breaker drawout assembly

The drawout mechanism is designed for heavy-duty applications. It permits rapid examination and maintenance of the circuit breaker without having to de-energize the switchboard bus structure. The drawout has four discrete positions: engaged, test, disengaged, and fully withdrawn. Mechanical interlocking is built in to prevent the movement of a closed breaker into or out of the engaged or test position.

The racking handle is an integral part of the drawout frame. All main and secondary contacts are self-aligning. The carriage can be hand-rotated 180 degrees on the rails for contact inspection or maintenance.

MAINTENANCE

Preventive maintenance

The following suggested inspection schedule is based on average operating conditions. The actual frequency should be adjusted according to operating conditions as experience dictates.

Monthly Inspection Schedule

WHAT TO INSPECT	WHAT TO INSPECT, FOR
Magnetically operated devices contractors, relays, and solenoids	- Control-circuit voltage - Collections of dirt or gum - Excessive heating of parts indicated by discoloration of metal parts, charred insulation, or odor - Freedom of moving parts (no binding or sticking) - Corrosion of metal parts - Remainng wear allowance on contacts - Loose connections - Condition of flexible shunts - Worn or broken mechanical parts - Excessive arcing in opening circuits - Excessive noise in AC magnets - Evidence of dripping liquid falling on control
Thermally operated devices	- Collections of dirt or gum - Excessive heating of parts indicated by discoloration of metal parts, charred insulation, or odor - Freedom of moving parts (no binding or sticking) - Corrosion of metal parts - Proper contact pressure - Loose connections - Condition of flexible shunts - Worn or broken mechanical parts - Excessive arcing in opening circuits - Evidence of dripping liquid falling on control - Condition of heating element - No binding of contacts when latching mechanism trips
Static accessories resisiors, rectifiers, capacitors, transformers, fuses, wrong, and bus and cable work	- Collections of dirt or gum - Excessive heating of parts indicated by discoloration of metal parts, charred insulation, or odor - Corrosion of metal parts - Loose connections

Semiannual Inspection Schedule

WHAT TO INSPECT	WHAT TO INSPECT FOR
Mechanically operated devices master witches, pushbuttons, selector switches, manual starters, and rheostats	- Collections of dirt or gum - Excessive heating of parts indicated by discoloration of metal parts, charred insulation, or odor - Freedom of moving parts (no binding or sticking) - Corrosion of metal parts - Remaining wear allowance eon contacts - Proper contact pressure - Loose connections - Condition of flexible shunts - Condition of arc chutes or barriers - Worn or broken mechanical parts - Excessive arcing reopening circuits - Condition and level of oil (if oil-immersed); presence of sludge - Condition of gaskets (for oil-immersed, dust-tight, or watertight units) - Evidence of dripping liquid falling on control - Condition of control-circuit contacts - Wear or roughness on sliding contacts - Lubrication of contacts where recommended
Arc chutes or barriers	- Corrosion if almost burned through, replace to prevent arc heat from burning out pole pieces or shorting the next phase
Flexible shunts	- Corrosion - Damage from wear - Condition flex or twist slighly to check
Interlocks	- Adjustment according to manufacturer's instruction book
Push button, overload relay, contacts, and so forth	- Freedom of function to provide protection in an emergency

Corrective maintenance

The following paragraphs describe the cleaning and care of fuse clips, ferrules, and silver contacts. Refer also to Distribution Panels in this chapter for inspecting and cleaning of electrical components.

Dry dust and dirt should be blown off with dry compressed air. This is important since dust may not only prevent the control devices from operating normally but may also contain conducting material that will ultimately form a short circuit between points of different potentials. Dust on the surfaces of interlocks may prevent a circuit from being completed, even when the contacts are in the closed position. *Grease, oil, or sticky dirt* is removed with a cleaning fluid. Do not soak the parts, particularly the coils, with the cleaner. Use just enough to loosen and wipe off the grease. For cleaning small parts, a small paintbrush dipped into the cleaning solution is good for getting into corners and crevices.

Most *fuse clips* and *fuse ferrules* are plated to resist corrosion. However, it is well to remove the fuse from the clip occasionally and polish the contact surfaces. In replacing

the fuses, be sure that they fit snugly into the clips.

Contractors, up to 100-amp capacity, as well as small relays, use *silver contacts*. These oxidize more slowly than copper contacts. Any silver oxide formation on the contact is self-reducing. Therefore, it is not necessary, or recommended. to file fine silver contacts to remove the oxide. It takes very little filing to destroy the contact's usefulness completely.

If any sulphur gas is present in the atmost sphere, a sulp hide may form on the silver. If the contact pressures are light and the voltage low, this condition may prevent the flow of current when the contacts close. The sulphide, darker in color than the oxide, should be cleaned off if it causes trouble.

The following tables present trouble-shooting remedies for the electrical com- - ponents of the generator switchboard.

Troubleshooting Chart : Air Circuit Breakers

SYMPTOM	PROBABLE CAUSE	REMEDY
Premature tripping.	Setting too low for motor starting current.	Increase trip setting slightly.
	Repetitive closing or logging of motor starting currents.	Check type of load and current peaks with trip setting.
	Undervoltage device control circuit and auxiliary pilot devices affected by open circuit or loss of voltage.	Same as above.
	Incorrect trip rating.	Adjust trip rating.
Failure to latch in, open, or reset.	Incorrect adjustment of trip mechanism.	Refer to breaker instructions and adjust.
	Worn parts such as pins, links, or broken springs.	Check and adjust all operating parts and Control circuits.
	Excessive currents causing contact wear.	Check to see that current rating is not exceeded; adjust as necessary.
	Fault in remote control circuit.	Check operation of reverse. current relay.
	Trip element or mechanism damaged due to excessive current.	Repair or replace, then check current rating and adjust if necessary.
	Excessive corrosion or accumulation of foreign material.	Check environmental conditions and clean unit.
	Arc chutes damaged due to excessive currents.	Check to see that current rating is not exceeded.
	Binding in attachments preventing resetting of latch.	Realign and adjust attachments.
	Chipped or worn latch.	Replace latch.
	Latch out of adjustment.	Adjust latch.
	latch return spring too weak or broken.	Replace spring.
	Hardened or gummy lubricant.	Clean bearing and latch surfaces.

Troubleshooting Chart : Air Circuit Breakers (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
False tripping.	Binds in overload device.	Replace overload device.
Failure to trip.	Travel of tripping device does not permit positive release of tripping latch.	Readjust or replace device.
	Worn or damaged trip unit parts.	Replace trip unit.
Short contact life.	Corrosion on contacts.	Check motor starting current.
	Excessive currents and frequent closing and opening of circuit.	Check motor starting current; reduce duty cycle.
	Short circuits, loose connections.	Check circuit operation; tighten connections.
	Misapplication.	Check current rating.
	Excessive filing or dressing.	Replace contacts.

Troubleshooting Chart :Contacts

SYMPTOM	PROBABLE CAUSE	REMEDY
Welding of contacts.	Abnormal inrush motor starting currents.	Reduce currents.
	Rapid jogging.	Use suitable contactor to switch circuit to normal duty.
	Incomplete manual closure.	Frequent inspection of contacts.
	Inadequate maintenance for renewal of contacts.	Renew contacts.
Contact chatter.	Poor contact in control pickup circuit.	Improve the contact or use holding interlock.
	Excessive jogging.	Find out whether device is recommended for jogging service. If it is not, caution operator.
	Broken pole shade.	Replace, or order new magnet assembly.
	Contactor slams, thus opeing interlock in coil circuit.	Increase wipe and pressure on interlock.
Overheating of contacts.	Copper oxide on contacts.	Install silver-faced contacts.
		If copper contacts, file with fine file. (CAUTION excess filing wears out the contacts Never file silver. faced contacts.)
	Carrying load continuously for a long time.	Install silver-faced contacts.
	High reductive loads such as DC fields.	Install silver-faced contacts.
	Sustained overload.	Reduce current or install a larger device.
	Insufficient contact pressure.	Clean, adjust.

Troubleshooting Chart : Contacts (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Overheating of contacts (Continued).	Loose connection.	Clean and tighten. (Measurement of the milivolt drop across the current-carrying connections will indicate where excessive heating originated.)
	Contacts not aligned.	Adjust contacts.
	Contacts dirty, greasy, or coated with dark film.	Clean contacts.
	Contacts badly burned or pitted.	Replace contacts.
	Current-carrying surfaces dirty.	Clean surfaces of current-carrying parts.
	Bolts and nuts of points at terminals.	Tighten, but do not exceed limits of bolts or fittings.
	Current in excess of breaker rating.	Decrease load, rearrange circuit, or Install larger breaker.
	Excessive ambient temperature.	Provide adequate ventilation.
Wear contact pressure.	Wear allowance gone.	Replace and adjust.
	Poor contact adjustment.	Adjust gap and "wipe."
	Low voltage preventing magnet seal.	Correct voltage condition (possible line regulation).
Welding or freezing of contacts.	Abnormal inrush of currents of more or less than 10 times continuous rating. (this will vary depending on the type of device.)	Reduce currents.
		Substitute special nonweld contacts.
		Install larger deivce.
		Install copper contacts (CAUTION Check for overheating of copper contacts).
	Rapid jogging.	Install copper contacts if otherwise suitable.
Overheating of sliding contacts.	Overcurrent; weak contact pressure; oxidation; high ambient; rough contacts.	For very heavy service, use special alloy contacts lubricate periodically as manufacturer recommends.
Abrasion and roughening of sliding contacts.	lack of maintenance and lubrication, very heavy service, arcing; oxidation; abrasive dirt.	Sliding contacts usually require lubrication. (Use lubricant recommended by manufacturer) Special alloy contacts should be specified for extra heavy service.
Arc chutes pitted, worn, or broken.	Abnormal interrupting duty (inductive loads); excess vibration or shock.	Check application.
	Moisture.	Eliminate moisture. or keep several chutes on hand for replacement.
	Improper assembly.	Replace with correct assembly.
	Rough handling.	Handle more carefully.

Troubleshooting Chart : Contacts (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Insulation failure.	Overvoltage, voltage transients, high Induced voltages.	Correct system voltage.
	Mechanical damage.	Replace damaged parts.
	Moisture, dirt, and fumes, overheating (carbonizing).	Keep controls clean and dry. Get special coil for application.

Troubleshooting Chart : Coils
(Includes series and blowout coils)

SYMPTOM	PROBABLE CAUSE	REMEDY
Coil failure.	Moisture, corrosive atmosphere.	Relocate coils or use special resistant coils.
Open circuit, not "roasted."	Mechanical damage.	Do not handle coils by the leads.
	Excess vibration or shock; coil movement causing insulation failure or broken wire.	Relocate and provide a special mounting. Coils should be held firmly in place.
Overheated, "roasted."	Overvoltage or high ambient.	Check application and circuit.
	Wrong cod, short.time-rated cod energized too long.	Check manufacturer's instructions.
	Shorted turns caused by mechanical damage, corrosion, or conducting of dust.	Replace coil and correct conditions if practical to practical to do so.
	Too frequent operation (very rapid jogging of AC Coils)	Check application.
	Undervoltage, failure of magnet to seal in.	Check circuit Interlock.
Series or blowout coils overheated.	Excessive current rating used.	Install larger coil, or reduce current.
	High ambient temperature.	Relocate or regulate temperature.
	loose connection, corrosion, or oxidation on connection surfaces.	If connection is hot, clean before tightening.

Troubleshooting Chart : Shunts, Magnets, and Other Mechanical Parts

SYMPTOM	PROBABLE CAUSE	REMEDY
Flexible shunt failure.	Improper installation.	See manufacturer's instructions.
	Large number of operations; worn out mechanitally.	Replace shunt.
	Corrosive atmosphere or moisture.	Incorrect application.
	Burned by arcing, oxidized connection.	Check application and system voltage.
Worn or broken pans.	Heavy slamming caused by overvoltage, underload, or wrong coil. Chattering caused by broken pole shader or poor contact in control circuit. heavy duty cycle, too much jogging.	Replace part, and correct cause of damage.
	Abrasive dust, mechanical abuse.	Clean; use correctly.
Noisy magnet.	Broken pole shader, magnet faces not true as result of wear or mounting strains.	Replace.
	Dirt or rust on magnet faces.	Clean.
	Low voltage.	Check system voltage.
	Improper adjustment, magnet overloaded.	Check manufacturer's instruction sheet.
Broken pole shade.	Heavy slamming caused by overvoltage, magnet underloaded, weak tip pressure, or wrong coil.	Replace and correct the cause.
Failure to pick up.	Low voltage on coil.	Check system voltage.
	Coil open, wiring of coil, or shorted turns.	Replace.
	Wrong coil.	Replace with correct type.
	Excessive magnet gap; magnet overloaded.	Check instruction sheet.
Failure to drop out.	Mechanical binding.	Check instruction sheet and adjust.
	Gummy substance on magnet faces.	Clean.
	Worn bearings.	Replace the part.
	Nonmagnetic gap m magnet circuit destroyed.	Replace magnet.
	Voltage not removed.	Check coil voltage.
	Not enough mechanical load on magnet, Improper adjustment.	Check instruction sheet and adjust.

Troubleshooting Chart : Capacitors, Resistors, Transformers, and Fuses

SYMPTOM	PROBABLE CAUSE	REMEDY
Breakdown or failure of dielectric in capacitor.	Overvoltage.	Check system voltage.
	Voltage surges caused by switching or lightening.	Install protective equipment.
	Some types not usable with AC.	Check application.
	Moisture, corrosion, or high temperature.	Correct condition, or install special unit.
	Continuous voltage on intermittent-rated unit.	Install proper unit.
	Mechanical damage.	Replace capacitor.
Insulation failure of resistor, overheating.	Rating too low.	Install larger resistor.
	Running on starting resistor.	Check the timer to make sure it operates.
	Restricted ventilation.	Relocate.
Insulation failure of resistor, open circuit.	Burned out from overheating.	Replace resistor and see above.
	Corrosion, moisture, or acid fumes.	Relocate or correct atmospheric conditions.
	Mechanical damage.	Replace worn or broken parts.
Overheating of transformer.	Overcurrent or overvoltage.	Check load on transformer and system voltage.
	Intermittent-rated unit left on continuously.	Check circuit operation and correct accordingly.
	High ambient temperature.	Relocate transformer or reduce load.
	Shorted turns.	Replace coil.
Premature blowing of fuse.	Wrong fuse for application.	Replace fuse with correct rating.
	Heating at ferrule contacts; corrosion or oxidation of ferrules and clips.	Keep ferrutes and clips clean.
		Use plated clips and ferrules, replace annealed clips.
	Weak contact pressure.	Provide adequate pressure.
Delayed blowing of fuse.	Wrong fuse for application.	Replace fuse with correct rating.

DISTRIBUTION PANELS

FUNCTIONAL DESCRIPTION

The power distribution panels receive AC generator power from the AC switchboard through main circuit breakers. They distribute this power to all AC-operated equipment on the barge. Shore power can be selected at the engine room 240-VAC-load center panel in place of the AC generators. These circuit breakers for shore power are mechanically interlocked so only one source of power can be selected at a time.

The following power distribution panels are covered in this section and each is described in the order listed:

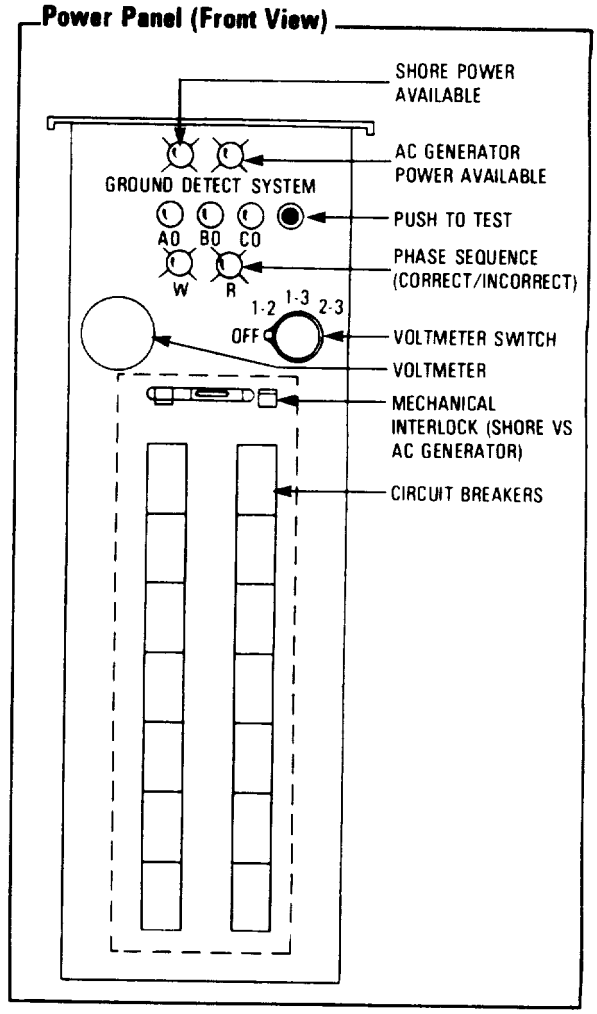
- Engine room, 240-VAC-load center power panel (P-0203)
- Engine room, 120-VAC-load center panel (P-01 10)
- (Galley, 240-VAC power panel (P-205)
- CHT room, 240-VAC power panel (P-207)
- Crane machinery house, 240-VAC power panel (P-209)
- Crane machinery house, 120-VAC power panel (P- 109A)
- Galley and quarters, 120-VAC power panel (P-104)
- Engine room, 120-VAC power panel (P-101)
- Galley and quarters, 120-VAC lighting distribution box (P-105)
- Engine room, 120-VAC strip heater distribution box (P-103)
- Engine room, 120-VAC light distribution box (P-102)
- Operator's cab, 120-VAC light distribution box (P-0109F)

Engine room, 240-VAC-load center power panel (P-0203)

This power panel (see following illustration and table) receives 240-VAC, 3-phase power from the AC switchboard or shore power. It distributes power throughout the barge for all AC-operated equipment. The P-0203 power panel performs the following functions in addition to power distribution:

- Selects a source of power, either the AC generators through the AC switchboard or shore power through the shore power connection box. A mechanical interlock prevents simultaneous connection to the AC generators and to shore power.
- Detects ground fault on all 3-phase lines by using a PUSH-TO-TEST push button and a set of indicators, one indicator for each phase.
- Phase monitors shore power, using a set of panel lights working in conjunction with equipment installed aboard.

Engine Room, 240-VAC-Load Center Power Panel (Front View)



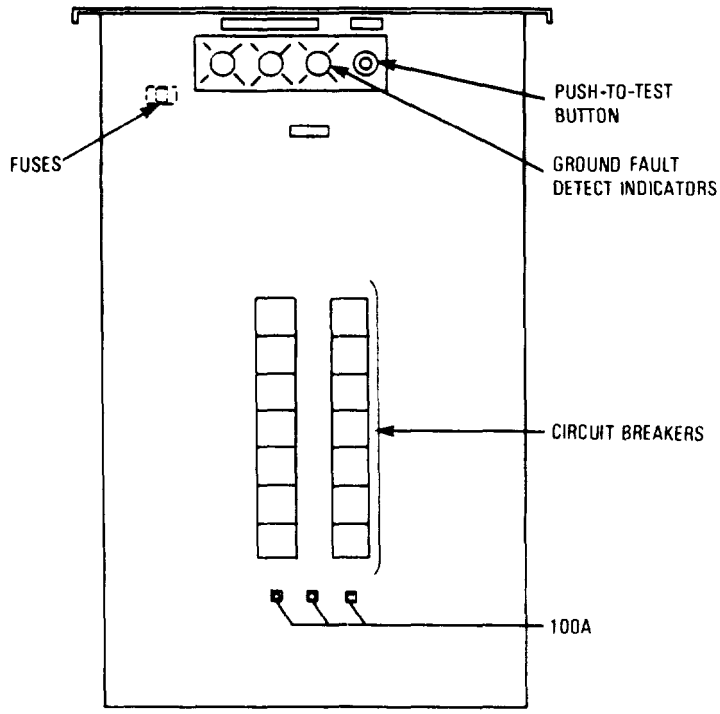
Engine Room, 240-VAC-Load Canter Power Panel Data

GENERATOR NO 1 (or NO 2) POWER AVAILABLE indicator.	Indicates AC generator(s) is (are) available to supply power, indicates AC switchboard bus is energized by one or both AC indicator. generators and this power is available for use at AC switchboard.
Voltmeter.	Monitors voltage input on shore power.
Voltmeter switch.	Connects voltmeter to shore power Switch has four positions "OFF," "1 ," "2," and "3," corresponding to A phase, B phase, and C phase respectively.
Mechanical interlock.	Interlock function prevents AC generator power to be connected in parallel with shore power.
Phase sequence correct switch.	lights to indicate that shore power phase sequence is correct with equipment installed aboard, so that motors will run with correct rotation.
Phase sequence incorrect switch.	Lights to indicate that shore power phase sequence is not correct with equip ment installed aboard.
Ground detect system indicators (one for each phase).	When PUSH-TO-TEST push button is depressed, all three indicators will light brightly if no ground is present on any one of the three phases. If ground is present on any one phase, the light for that phase will be only dimly lit.
Circuit breaker, 15 amp.	Supplies 240-VAC, 3-phase power to the portable bilge and ballast pump motor through a motor controller (Refer to section on motor controllers in this chapter)
Circuit breaker, 30-amp.	Supplies 240-VAC, 3-phase power to the air compressor motor through a motor controller, which is interlocked with the fire pump.
Circuit breaker, 50-amp.	Supplies 240-VAC, 3-phase power to the fire pump motor through a motor controller, which is interlocked with the air compressor to prevent the air compressor from running when the fire pump is in use.
Circuit breaker, 30-amp.	Supplies 240-VAC, 3-phase power to raw-water pump number 2 through low voltage release (LVR) motor controller.
Circuit breaker, 40-amp.	Supplies 240-VAC, 3-phase power to the galley power panel (P-205).
Circuit breaker, 15-amp.	Supplies 240-VAC, 3-phase power to the supply fan in engine room through a motor controller.
Circuit breaker, 30-amp.	Supplies 240-VAC, 3-phase power to the CHT room power panel (P-207).
Circuit breaker, 15-amp.	Supplies 240-VAC, 3-phase power to raw-water pump number 1 through LVR motor controller.
Circuit breaker, 40-amp.	Supplies 240-VAC, 3-phase power to the crane machinery house 240-VAC power panel (P-209) through rotary collector rings.
Circuit breaker, 90-amp.	Supplies 240-VAC, 3-phase power to the engine room 120-VAC, 3-phase, load center panel (P-0110) through a step-down 240/1 20-VAC transformer.
Circuit breaker, 15-amp.	Supplies 240-VAC, 3-phase power to the oil-water separator pump through its own control panel.
Two circuit breakers, 15-amp.	Spares.

Engine room, 120- VAC-load center panel (P-0110)

This power panel (see following illustration and table) receives 120-VAC, 3-phase power from the 240-VAC-load center panel through 240/ 120-VAC transformers and distributes 120-VAC, l-phase power through circuit breakers to the equipment as listed. This panel is equipped with a 3-phase ground-fault detection circuit.

Engine Room, 120-VAC-Load Center Front Panel



Engine Room, 120-VAC Load Center Front Panel Data

Circuit breaker. 50-amp.	Supplies 120-VAC power to the engine room, 120-VAC power panel (P-101)
Circuit breaker. 30-amp.	Supplies 120-VAC power to the engine room, 120-VAC lighting distribution box (existing).
Circuit breaker, 30-amp.	Supplies 120-VAC power to the engine room, 120-VAC strip- heater distribution box (existing).
Circurit breaker, 50-amp.	Supplies 120-VAC power to the galley and quarters 120-VAC power panel.
Circuit breaker, 30-amp.	Supplies the galley and quarters 12 D-VAC lighting distribution box.
Circuit breaker, 15-amp.	Supplies the engine alarm panel for the DC-system diesel engines.
Two circuit breakers, 15-amp and 30-amp.	Spares.

Galley, 240-VAC power panel (P-205)

This power panel receives 240-VAC, 3-phase power through a 40-amp circuit breaker at the 240-VAC-load center panel. It distributes this power through circuit breakers to operate the equipment as listed in the following table.

Galley, 240-VAC Power Panel Data

Circuit breaker, 15-amp.	Energizes the galley and CHT room supply fan motor through low voltage protection (LVP) motor controller.
Circuit breaker, 30-amp.	Provides 240-VAC, 3-phase power to the galley range.
Two circuit breakers, 15-amp.	Spares.

CHT room, 240-VAC power panel (P-207)

This power panel receives 240-VAC, 3-phase power through a 30-amp circuit breaker at the engine room, 240-VAC-load center panel (P-0203). It distributes this power through circuit breakers to operate the equipment as listed in the following table.

CHT Room, 240-VAC Power Panal Data

Circuit breaker, 15-amp.	Energizes the transfer pump through LVP motor controller.
Circuit breaker, 15-amp.	Energizes the flushing pump through IVR motor controller.
Circuit breaker, 15-amp.	Energizes the aeration blower through LVP motor controller.
Circuit breaker, 15-amp.	Energizes the shore discharge pump through LVP motor controller.
Two circuit breakers, 15-amp.	Spares.

Crane machinery house, 240-VAC power panel (P-209)

This power panel receives 240-VAC, 3-phase power from the 240-VAC-load center panel through rotary collector rings. It distributes this power through circuit breakers to the equipment as listed in the following table.

Crane Machinery House, 240-VAC Power Panel Data

Circuit breaker, 25-amp.	Supplies 240-VAC to the crane machinery house, 120-VAC power panel (P-109A) through a 240/120-VAC, step-down transformer.
Circuit breaker, 15-amp.	Supplies 240-VAC to the air-conditioning unit in the operator's cab.
Circuit breaker, 15-amp.	Energizes the blower motor for the Dravo heater through LVR motor controller.
Circuit breaker, 25-amp.	Provides 120-VAC to the existing operator's cab, lighting-distribution panel through a 240/ 120-VAC, step-down transformer.
Two circuit breakers, 15-amp.	Spares

Crane machinery house, 120-VAC power panel (P-109A)

This power panel receives 120-VAC, 1-phase power from the crane machinery house, 240-VAC power panel (P-209) through a 240/120-VAC step-down transformer. It distributes 120-VAC, l-phase power through circuit breakers to equipment as listed in the following table. This panel is equipped with a ground-fault detection circuit.

Crane Machinery House, 120-VAC Power Panel Data

Circuit breaker, 15-amp.	Supplies 120-VAC to the machinery house and operator's cab receptacles isolated through a 2-kva (kilovolt-ampere) isolation transformer, which is used for shock protection (lamps, radios, razors) of personnel.
Circuit breaker, 15-amp.	Supplies 120-VAC to the AN/ URC-80 radio set.
Circuit breaker, 15-amp.	Supplies 120-VAC to a terminal box, which in turn supplies power to the fuel pump motor for the Dravo heater unit (existing).
Circuit breaker, 15-amp.	Supplies 120-VAC to hydraulic brake-svstem bleeder-valve solenoid.
Two circuit breakers, 15-amp.	Spares.

Galley and quarters, 120-VAC power panel (P-104)

This power panel receives 120-VAC, 3-phase power from the engine room, 120-VAC-load center panel (P-0110). It distributes 120-VAC, 1-phase power through circuit breakers to the equipment as listed in the following table. This panel is equipped with a 3-phase ground-fault detection circuit.

Galley and Quarters, 120-VAC Power Panel Data

Circuit breaker, 15-amp.	Supplies the range hood exhaust fan.
Circuit breaker, 15-amp.	Supplies the refrigerator.
Circuit breaker, 30-amp.	Supplies a 2-circuit breaker box in the galley and crew's quarters through an isolation transformer for shock protection (lamps, radios, razors) of personnel.
Circuit breaker, 20-amp.	Supplies power for one air-conditioning unit in the crew's quarters.
Circuit breaker. 15-amp.	Supplies power to seawater pump m the engine room for cooling of air-conditioning compressor in the crew's quarters.
Circuit breaker, 20-amp.	Supplies power to one air-conditioning unit in the crew's quarters.
Circuit breaker, 15-amp.	Supplies power to a seawater pump for crew quarters' air-conditioning unit.
Circuit breaker, 15-amp.	Supplies power to the summary alarm panel.
Circuit breaker, 15-amp.	Supplies power to freshwater pump (potable water).
Circuit breaker, 15-amp.	Supplies power to water cooler.
Two circuit breakers, 15-amp.	Spares

Engine room, 120-VAC power panel (P-101)

This power panel receives 120-VAC, 3-phase power from the engine room, 120-VAC-load center panel (P-0110). It distributes 120-VAC, l-phase power through circuit breakers to the equipment as listed in the following table. This panel is equipped with a 3-phase ground-f ault detection circuit.

Engine Room, 120-VAC Power Panel Data

Circuit breaker, 50-amp.	Supplies 120-VAC to the engine room, 120-VAC power panel.
Circuit breaker, 30-amp	Supplies 120-VAC to the engine room, 120-VAC lighting distribution box (existing).
Circuit breaker, 30-amp.	Supplies 120-VAC to the engine room, 120-VAC strip heater distribution box (existing).
Circuit breaker, 50-amp	Supplies 120-VAC to the galley and quarters, 120-VAC power panel.
Circuit breaker, 30-amp.	Supplies the galley and quarters, 120-VAC lighting distribution box.
Circuit breaker, 15-amp.	Supplies the engine alarm panel for DC-system diesel engines.
Two circuit breakers, 15-amp and 30-amp.	Spares.

Galley and quarters, 120-VAC lighting distribution box (P-105)

This distribution box is an existing DC panel that was reconnected to the AC system (see table below). It receives 120-VAC, 1-phase power from the engine room, 120-VAC-load center panel and distributes this power to the new unit heater fans. The other switches are not covered since they supply existing circuits.

Galley and Quarters, 120-VAC Lighting Distribution Box Data

Switch, 30-amp.	Supplies 120-VAC to two unit heater fans through its associated control relay; thermostatically controlled.
Switch, 30-amp.	Supples 120-VAC to the other two unit heater fans through its associated control relay; thermostatically controlled.
Other switches.	Existing switches.

Engine room, 120-VAC strip heater distribution box (P-103)

This distribution box is an existing DC panel that was reconnected to the AC system. It receives 120-VAC, 1-phase power from the engine room, 120-VAC-load center panel and distributes this power to the DC and AC generators strip heaters through associated switches.

Engine room, 120-VAC light distribution box (P-102)

This distribution box is identical to that described above except that it distributes 120-VAC power to the engine room lighting circuit and to isolated receptacles used by the crew. These receptacles are connected to the distribution box through isolation transformers to provide the crew with shock protection.

Operator's cab, 120-VAC light distribution box (P-0109F)

This distribution box is an existing DC panel that was reconnected to the AC system. It receives 120-VAC, 1-phase power from the crane machinery house, 240-VAC power panel through a 5-kva, 240/120-volt, 1-phase transformer. It distributes this power to (existing lighting circuits for the crane machinery house, operator's cab, rotating platform, and boom.

MOTOR CONTROLLERS

AC power is applied to motors through controllers that provide LVP, LVR, and overload (OL) features. A table listing motors and associated motor controllers is given on page 4-20. The operation of Class 2510, 8536, and 8606 motor controllers is discussed as follows.

Class 2510

The Class 2510 motor controller acts as a manual starter, providing both OL and LVP features. The LVP is provided by a continuous-duty solenoid that is energized when line voltage is present. The starter contacts can be closed (by positioning the ON-OFF switch to ON) only when the solenoid is energized. If a loss of power occurs while the motor is operating, the solenoid will de-energize, opening the starter contacts and allowing the spring pressure to return the handle to a "center off' position (between ON and OFF). The motor is kept disconnected from the power lines after voltage is returned to operating level until the operator positions the ON-OFF switch back to ON.

An OL relay in each main power line provides OL protection for this motor controller. The OL relay consists of a heater winding through which the load current flows, a solder pot, and a ratchet wheel. A current OL condition will melt the alloy in its solder pot, allowing the ratchet wheel to rotate. This activates a trip mechanism which opens the starter contacts, allowing the handle to go to the "center off' position. After the solder has cooled, the mechanism can be reset by pushing the handle to its extreme OFF position. The motor can then be started by moving the switch to the ON position.

Class 8536

The Class 8536 motor controller acts as a magnetic starter and has LVP or LVR and OL features. The motor is started by either depressing the START push button or through a sustained-contact switch (such as a pressure switch) located in the circuit. This switch allows power to be applied to the motor when closed. The magnetic starter is used when full-starting torque and the resulting current inrush are not objectionable. When the START button is depressed or the associated sustained-contact switch is closed, the magnetic starter coil is energized. This closes a contact in each main line and connects the 3-phase power to the motor.

LVP is obtained by a normally open, momentary-contact START push button in parallel with a normally open interlock on the magnetic starter. When the START push button is depressed, the main contactor coil is energized. This causes the contacts of the main contactor to close and connects the motor to the power lines. It also closes a

contact in parallel with the START push button for the holding interlock. The holding interlock assures that the main coil continues to be energized after the START button is released. When a reduction or loss of line voltage occurs, the main contactor coil is de-energized. This causes the contacts of the main contactor to open (thus stopping the motor) and breaks the holding interlock. When the line voltage returns to operating level, the START push button must be depressed to start the motor.

LVR provides for disconnecting the motor from the power lines on reduction or loss of power and keeping it disconnected until power returns. Then it automatically reconnects the motor to the power lines to restart the motor. LVR is obtained by the use of a sustained-cont switch in series with the main contactor coil. When the START switch is closed, a circuit is completed through the coil of the main contactor and the main contactor closes. on reduction or loss of voltage, the coil is de-energized and the main contactor opens. On restoration of power, the coil is energized again and the motor restarts automatically.

The OL protection feature is similar to that described in the 2510 class. The exception is that the main line overload relays operate a separate set of contacts in series with the magnetic coil, rather than operating directly on the main power line contacts. When the overload relay contacts are opened, the magnetic coil is de-energized. This then allows the main contacts to open. The overload relay mechanisms can be reset after the solder cools by depressing the RESET push button on the front of the motor controller. The motor can there be started normally.

Class 8606

The Class 8606 motor controller is the autotransformer type that includes transition-start, OL protection, and LVP or LVR. The autotransformer starting function provides reduced voltage, starting at the motor terminals, through the use of a tapped, 3-phase autotransformer. On initiation, a 2-pole contactor and a 3-pole contactor close to connect the motor to the preselected autotransformer taps. A timing relay causes the transfer of the motor from the reduced-Voltage Start to full line Voltage Operation without disconnecting the motor from the power source. This is known as closed transition-starting. Autotransformers with transition-start controllers are used to provide maximum torque available with minimum line current, with taps to permit both of these factors to be varied.

Class 8606 motor controllers are used to control the operation of the fire pump and the air compressor on the 100-ton crane barge. The fire pump controller has a LOCAL-OFF-REMOTE selector switch and START-STOP push buttons. It is connected to a remote START-STOP push-button station located on the main deck. When the selector switch is on LOCAL, the fire pump can be started either locally or remotely, but it can be stopped at the local station only. When the selector switch is on REMOTE, the fire pump can be started either locally or remotely, but can be stopped at the remote station only.

The air compressor motor controller has a HAND-OFF-AUTO selector switch and START-STOP push buttons. It is connected to a pressure switch in the air compressor discharge line. When the selector switch is on HAND, the air compressor can be controlled manually using the START-STOP push buttons. When the selector switch is on AUTO, the air compressor operation is controlled automatically by the pressure switch.

The LVP or LVR and OL features for the Class 8606 motor controllers are as described for the 8536 class. The fire pump controller provides LVP. The air compressor controller provides LVP when the selector switch is on HAND, and LVR when the switch is on AUTO.

Motor Controller/Motor Data

MOTOR	MOTOR CONTROLLER TYPE/CHARACTERISTICS
Hot water boiler circulation pump motor.	Square D, Type MCA-21, Class 2510; has ON-OFF manual starter with 120-VAC, 60-Hz LVP coil with one thermal overload relay.
Potable water pump motor.	Same as above
Fuel oil transfer pump motors (2).	Same as above.
Seawater (AC cooling) motors (2).	Same as above.
Aeration blower motor.	Square D, Type MBA-22, Class 2510; has ON-OFF switch manual starter with 240-VAC, 60-Hz LVP coil with three thermal overload relays.
Sewage transfer pump motor.	Square D, Type SBA-2, Class 8536; has START push-button magnetic starter with 240-VAC, 60-Hz LVP coil with three thermal overload ralays.
Raw-water pump motors (2).	Square D, Type SBA- 2, Class 8536; has magnetic starter with a 240/120-VAC, step-down transformer for internal control with a 120-VAC, 60-Hz LVR coil with three thermal overload relays; has no START-STOP push buttons. The start-stop motor operation is through a pressure switch in DC generator lube oil line.
Portable bilge and ballast pump moto.r	Same as raw-water pump motors except start-stop operation is from START-STOP push buttons located on the starboard side of the fixed base of the crane; it is LVP.
Sewage flushing pump motor.	Same as raw-water pump motors but has no START-STOP push buttons. Motor operation IS controlled by a pressure switch in the flushing fluid line; it is LVR.
Shore-discharge pump motor.	Same as raw-water pump motors except start-stop operation is from START-STOP push buttons on main deck; it is LVP.
Galley and CHT room supply fan motor.	Same as raw-water pump motor except it has START-STOP push buttons and is LVP.
Engine room supply fan motor.	Same as raw-water pump motor except type is SCA- 3. It has START-STOP push buttons and is LVP.
Dravo heater blower motor.	Same as raw-water pump motor except it has a three-position selector switch and is LVR.
Fire pump motor.	Square D, Type SOA-1, Class 8606; has magnetic reduced-voltage autotransformer starter with local START-STOP push buttons. LOCAL-OFF-REMOTE switch has a 240/ 120-VAC step- down transformer for internal control and a 120-VAC, 60-Hz LVP coil with three thermal overload relays. (Main contactor has one normally closed auxiliary contact for interlock with air compressor.)
Air compressor motor.	Same as above except for HAND-OFF-AUTO switch instead of LOCAL-OFF-REMOTE switch. Acts as LVP when in HAND position and as LVR when in AUTO position. When in AUTO position, compressor operation is controlled by a pressure switch located in air supply line.

MAINTENANCE

The following tables present maintenance procedures and troubleshooting charts for power distribution equipment.

Preventive maintenance

Before beginning maintenance procedures on the power panels. notify operators that power will he de-energized.

WARNING: Ensure that—

- **AC generators are not running.**
- **Shore power is not selected.**
- **Generators are tagged "Out of Service."**
- **Power circuit breakers are open and tagged "Out of Service."**
- **Rubber matting is placed on deck around the working areas.**

Once these precautions have been taken, set mechanical interlock to ensure that the shore-power circuit cannot be closed.

The following procedure is used to clean and inspect the power panels.

WARNING: Remove rings, watches, **chains, and** other metallic articles before working in the power panels.

Step 1. Open or remove access covers. (WARNING: Wear rubber test gloves.)

Step 2. Test all bus bars, circuit breakers, and cable connections with voltage tester to ensure that areas/components are not energized. (WARNING: Use only insulated tools.)

Step 3. Vacuum accessible components and surface areas. Use dusting brush to loosen dirt.

Step 4. Wipe components and surface areas with lint-free rags.

Step 5. Operate switchboard disconnect links to ensure freedom from mechanical binding and proper alignment.

Step 6. Inspect contact surfaces to ensure that they are free of deep pitting and projections.

Step 7. Inspect electrical and mechanical connections for tightness. Tighten loose connections; as necessary, use jam nuts or lock washers to keep connections tight.

Step 8. Inspect bus bar supports; ensure that supports will prevent grounding or short circuiting of bus work during periods of shock.

Step 9. Inspect wiring for evidence of over-heating and chafing and frayed or chipped insulation.

Step 10. Clean components and surface areas with clean, lint-free rags.

Step 11. Clean electronic components and vicinity with camel-hair brush.

Step 12. Inspect electronic components for discoloration, blistering, bulging of containers, and leakage of insulating compounds.

Step 13. Reinstall dust covers where applicable.

Step 14. Inspect resistors, rheostats, and potentiometers, as applicable, for evidence of overheating.

Step 15. Inspect contact surfaces for sharp projections, pitting, misalignment, and evidence of overheating.

> ***NOTE:*** The brown discoloration found on silver and silver-plated contacts is harmless Silver or silver-plated contacts should not be dressed unless sharp projections extend beyond contact surfaces.

Step 16. Ensure that plug-type connectors are clean, tight, and straight.

The following procedure is used to clean and inspect the circuit breakers.

Step 1. Test with voltage tester to ensure that circuits are de-energized.

Step 2. Gain access to and remove arc chutes.

Step 3. Vacuum accessible components. Use dusting brush to loosen dirt.

Step 4. Inspect wiring for evidence of overheating and chafing and frayed or chipped insulation.

Step 5. Inspect electrical and mechanical connections for tightness. Tighten loose connections, as required; use jam nuts or lock washers to keep connections tight.

Step 6. Inspect contact surfaces for sharp projections, pitting, misalignment, and evidence of overheating.

NOTE: The brown discoloration found on silver and silver-plated contacts is harmless. Silver or silver-plated contacts should not be dressed unless sharp projections extend beyond contact surfaces.

Step 7. Inspect chutes for breaks, burns, and evidence of carbonizing.

Step 8. Reinstall arc chutes.

Step 9. Operate circuit breaker manually through three cycles of operation to detect erratic operation or mechanical binding.

Step 10. Reinstall circuit breakers as applicable.

Step 11. Remove work materials from switchboard.

Step 12. Close or reinstall access covers.

Step 13. Remove safety tags, and return equipment to normal readiness condition.

Step 14. Notify operators that power is restored.

Corrective maintenance

The following tables apply to maintenance of power distribution equipment.

Troubleshooting Chart : Contacts on Motor Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Contact chatter (also see "noisy magnet")	Poor contact m control circuit.	Replace the contact device, or use holding circuit interlock (3-wire control).
	Low voltage.	Check coil terminal voltage and voltage dips during starting.
Welding and freezing.	Abnormal inrush of current.	Check for grounds, shorts, or excessive motor load current, or use larger contactor.
	Insufficient tip pressure.	Replace contacts and springs; check contact carrier for deformation or damage
	Low voltage preventing magnet from sealing.	Check coil terminal voltage and voltage dips during starting.
	Foreign matter preventing contacts from closing.	Clean contacts with solvent. Contacts, starters, and control accessories used with very small current or low voltage should be cleaned with Freon.

Troubleshooting Chart : Contacts on Motor Controller (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Welding and freezing (Continued).	Short circuit or ground fault.	Remove fault, and check to be sure fuse or breaker rating is correct.
Short tip life or overheating of tips.	Filing or dressing.	Do not file silver tips. Rough spots or discoloration tips, will not harm tips or impair their efficiency.
	Interrupting excessively high currents.	Install larger device, or check for grounds, shorts, or excessive motor currents.
	Weak tip pressure.	Replace contacts and springs; check contact carrier for deformation or damage
	Dirt or foreign matter on contact surface.	Clean contacts with solvent. Take steps to reduce entry of foreign matter into enclosure.
	Short circuit or ground fault.	Remove fault and check to be sure fuse or breaker rating is correct.
	Loose connection in power circuit.	Clean and tighten.
	Sustained overload.	Check for excessive motor load current.

Troubleshooting Chart : Coils on Motor Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Open circui.t	Mechanical damage.	Handle and store coils carefully.
Overheated coil.	Overvoltage or high ambient temperature.	Check coil terminal voltage which should not exceed 110 percent of coil rating.
	Incorrect cod Shorted turns caused by mechanical damage or corrosion.	Install correct coil. Replace coil
	Undervoltage, failure of magnet to seal in.	Check coil terminal voltage which should be at least 85 percent of coil rating.
	Dirt or rust on pole faces.	Clean pole faces.
	Mechanical obstruction.	With power on OFF, check for free movement of contact and armature assembly.

Troubleshooting Chart : Overload Relays on Motor Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Tripping.	Sustained overload.	Check for excessive motor currents or current unbalance between phases; correct cause.
	Loose or corroded connection m power circuit.	Clean and tighten.
	Excessive coil voltage.	Voltage should not exceed 110 percent of coil rating.
Failure to trip.	Mechanical binding, dirt, corrosion, and so forth.	Replace relay and thermal units.
	Relay previously damaged by short circuit.	Replace relay and thermal units.
	Relay contact welded or not in series with contractor coil.	Check circuit for a fault, correct condition. Replace contact or entire relay as required.

Troubleshooting Chart: Magnetic and Mechanical Parts on Motor Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Noisy magnet.	Broken shading coil.	Replace magnet and armature.
	Dirt or rust on magnet faces.	Clean.
	low voltage.	Check coil terminal voltage and voltage dips during starting.
Failure to pickup and seal.	No control voltage.	Check control circuit for loose connection or poor continuity of contacts.
	Low voltage.	Check cod terminal voltage and voltage dips during starting.
	Mechanical obstruction.	With power on OFF, check for free movement of contact and armature assembly.
	Coil open or overheated.	Replace.
	Wrong coil.	Replace.
Failure to dropout.	Gummy surfaces on pole faces.	Clean pole faces.
	Voltage not removed.	Check coil terminal voltage and control circuit.
	Worn or corroded parts causing binding.	Replace parts.
	Residual magnetism due to lack of air gap in magnet path.	Replace magnet and armature.
	Contacts welded.	Replace contacts.

Troubleshooting Chart : Manual Starters on Motor Controllers

SYMPTOM	PROBABLE CAUSE	REMEDY
Faliure to reset.	Latching mechanism worn or broken.	Replace starter.
Burnouts.	Short circuits or grounds.	Remove grounds or shorted conditions.
	Overheating.	Increase low contact pressure; remove dirt, oil, or grease, remove oxides or sulfides.
	Slow "breaking."	Eliminate bred.
	Low lead dimension.	Increase lead dimension.
	Excessive lead dimension.	Reduce lead dimension.
Excessive wear.	Excessive jogging or inching.	Do not jog or inch controllers unnecessarily.
	Faulty blowout assembly or arc shield.	Replace or repair blowout coil; eliminate shorted turns.
	Excessive overloads.	Eliminate cause; check current readings.
	Slow "breaking."	Remove bind of parts.
	Excessive filing.	Do not dress or file the contacts unnecessary.
Overheating.	Oil or grease.	Remove with a cloth moistened with methyl chloroform.
	Copper oxides.	Remove with a fine file or 00-grade sandpaper.
	Low spring pressure.	Increase pressure or replace spring.
	Loose contacts.	Tighten.
Welding or sticking.	Ground or excesslve overload.	Eliminate cause; check current readings.
	High spring pressure.	Reduce pressure.
	Low voltage.	Increase voltage.
	Slow "making" or bred.	Remove bind.
Excessive arcing or sputtering.	Short circuit or ground.	Remove grounded or shorted circuit.
	Binding parts.	Eliminate bind of parts.
	Faulty blowout assembly.	Replace or repair blowout coil; eliminate shorted turns.
	Excessive lead dimension.	Reduce to increase contact gap.

CHAPTER 5

SERVICE SYSTEMS

The PIP modernization installed an AC electrical system to power the following ship's services:

- Ž Ventilating system
- Ž Heating system
- Ž Air-conditioning system
- Ž Hot water system
- Ž Galley equipment
- Ž Potable water system
- Ž Collect, hold, and transfer system

Technical information on these services is provided in this chapter. For anything beyond operator's maintenance, refer to the appropriate TM or manufacturer's manual.

VENTILATING SYSTEM

SPECIFICATIONS FOR AXIAL FANS

Three axial fans are used in the crane barge. They ventilate the engine room, the sewage CHT area, and the crew's quarters. The following table gives detailed data on the fans.

FUNCTIONAL DESCRIPTION

Axial fans are used to move large volumes of ambient air for cooling of equipment and for ventilation. The 3,000-CFM axial fan forces ambient air into the engine room. The 2,000-CFM axial fan blows fresh air to the crew's quarters and CHT room through ducting. The airflow is controlled by manually operated dampers. The motors that drive the two axial fans require 240-volt, 3-phase, 60-Hz power.

The 400-CFM axial fan in the galley range hood exhausts heat and cooking odors from the galley. This exhaust fan requires 120-volt. single-phase, 60-Hz power.

> CAUTION: Before operating any of the axial fans, certain precautions must be observed. Ensure that the intake vents and outlets are not obstructed and the ventilation system goose-neck are open.

Fan Data

2,000-CFM Axial Fan

Mow

Power requirements	240-VAC, 3-phase, 60-Hz
Power output	3/4HP
Speed of rotation	3,450 RPM
Capacity	2,000 CFM
Size	21 inches long. 17 5/8 inches dia
Unit weight	170 lb

3,000-CFM AXIAL FAN

Motor

Power requirements	240-VAC, 3-phase, 60-HZ
Power output	1 HP
Speed of rotation	1,750 RPM
Capacity	3,000 CFM
Size	24 inches long. 22 1/8 inches dia
Unit weight	24 lb

400-CFM Axial Fan

Motor

Inlet/outlet	Inlet bell, 10 1/2 inches dia
Power requirements	120-VAC, 1 -phase, 60-HZ
Power output	1/I2 HP
Speed of rotation	11,750RPM
Capacity	400 CFM
Size	10 1/4 inches long, 10 1/2 inches dia
Unit weight	24 lb

Engine room, 3,000 -CFM axial fan

This fan is turned on and off by pressing the START-STOP push button **on the** associated motor controller. It is located on the engine room bulkhead just below the outlet duct of the fan. The flow of air can be controlled by manually operating a damper in the outlet duct on the starboard side of the engine room.

The motor controller has three push buttons: START, STOP, and RESET. Overload and low-voltage protection features are provided by the controller. For an overload or low voltage condition, depressing the RESET and START push buttons will restore the fan motor operation after the overload or low voltage condition is removed.

The operation of this fan is also controlled by a pressure switch in the CO_2 system. In the event of a fire in the engine room, the CO_2 system will come on, spraying the engine room with CO_2 and activating the pressure switch in the CO_2 line. This causes the engine room fan to turn off via the motor controller. A red indicator will light on the C O_2 alarm panel. The fan's normal operation is indicated by a white indicator on the panel.

Crew's quarters and CHT room, 2,000-CFM axial fan

This fan is turned on and off by pressing the START and STOP button on the assocated motor controller. It is located on the aft, starboard bulkhead of the crew's quarters galley area. The flow of air can be controlled by manually operating dampers installed in the ventilation ducting. One damper, located near the outlet in the berthing area, can be used to manually control the flow of ventilating air to that area. A damper near the galley outlet can control the flow of air to the galley and mess area.

The motor controller operates as previously described for the 3,000-CFM fan.

Galley range, 400-CFM axial fan

The exhaust fan in the range hood is turned on and off by operating the ON-OFF toggle switch. It is located on the bulkhead near the range.

MAINTENANCE

Certain precautions must be taken before any maintenance is done on the ventilation system. High voltage supplies the axial fans.

WARNING: Be sure that—
- Controllers and circuit breakers have been shut off.
- Breaker on controller has been tagged, advising that the unit has been shut off for maintenance and warning against unauthorized removal of the tag.

Failure to observe the above warning could cause injury or death to personnel and/or damage to equipment.

Preventive maintenance

Certain inspections must be conducted on the ventilation system as follows:

Ž Every 90 days, inspect the wire mesh screens on the fan ducts for accumulated oil, grease, lint, fibers, or other foreign matter.

- Every six months, remove the fans from the attaching foundations, and inspect the fan blades for accumulated oil, grease, or other foreign matter. Check the shafts for tightness and wear.

Clean the fan blades with a hose, scraper, compressed air, or a brush. If oil or grease has accumulated on the blades, use a soft, clean cloth with a petroleum distillate solvent.

Fan motors have sealed bearings that have been prelubricated at the factory for the life of the bearing. No lubrication is required during service.

Corrective maintenance

If the fan or motor should become noisy, vibrate excessively, or overheat, the following corrective maintenance will be performed:

- Check to see that shaft is not bent.
- Check alignment.

Ž Check wheel on shaft for tightness.

- Check motor bearings for wear, alignment, or lack of lubrication.

Ž Check foundation bolts for tightness.

Ž Check wheel for cleanliness.

Check fan for unbalance. If the conditions listed above are satisfactory, then the fan should be vibration-tested as follows:

Step 1. Attach vibration sensors to the fan housing forward and aft of the motor bearings.

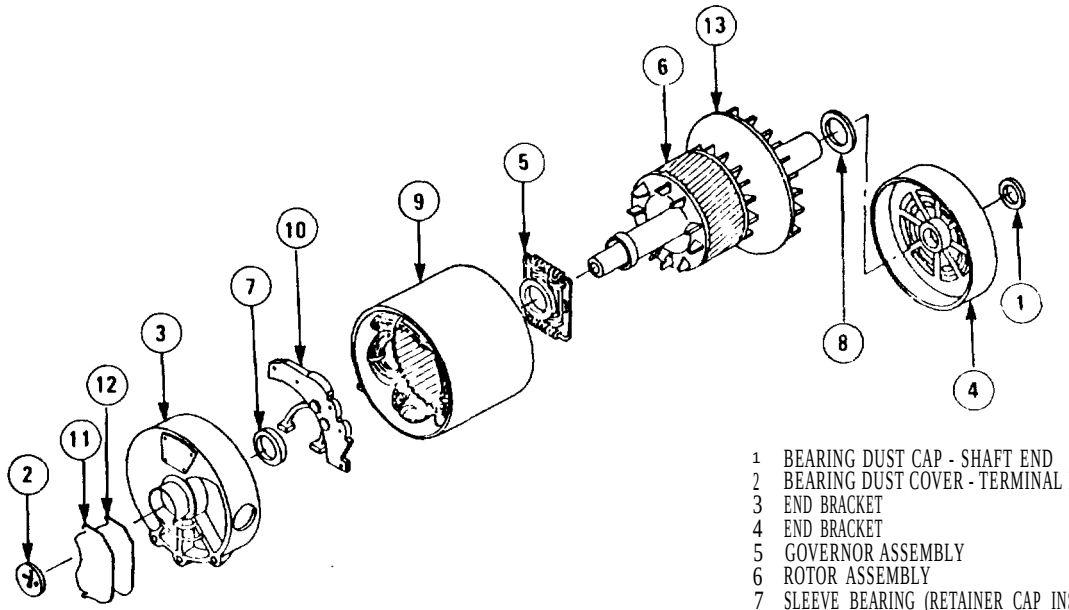
Step 2. Turn the motor on and observe the vibration meter. The following values indicate the fan's unbalance condition. Vibration is given in roils, double amplitude, at the motor bearings.

RPM	SMOOTH	FAIR	ROUGH	VERY ROUGH
1,750	0.75	1.5	3.5	5 to 7
3,450	0.50	1.0	2.5	3 to 5

The fan should not be operated if its condition on the foregoing scale is less than "fair." If the condition is less the "fair," the fan should be rebalanced. Disassemble and inspect all parts for wear and damage. Repair or replace parts as required. The motors for the 3,000-CFM and 2,000-CFM axial fans are different only in size. For the 400-CFM axial fan motor, the manufacturer recommends replacing the entire motor unit in case of unsatisfactory operation due to motor wear or damage.

The following illustration gives an exploded view of the motor on these fans. Refer to the following pages for troubleshooting remedies for the axial fans.

3,000-CFM/2,000-CFM Axial Fan Motor



1 BEARING DUST CAP - SHAFT END
2 BEARING DUST COVER - TERMINAL END
3 END BRACKET
4 END BRACKET
5 GOVERNOR ASSEMBLY
6 ROTOR ASSEMBLY
7 SLEEVE BEARING (RETAINER CAP INSIDE)
8 SLEEVE BEARING (RETAINER CAP INSIDE)
9 STATOR ASSEMBLY
10 SWITCH ASSEMBLY
11 TERMINAL COVER
12 TERMINAL COVER GASKET
13 VENTILATING FAN

Troubloshooting Chart: Axial Fans

SYMPTOM	PROBABLE CAUSE	REMEDY
Low air delivery.	Reversed rotation of fan	Reverse any two connections.
	Excessive system resistance.	Clean system, removing any obstructions.
	Dirty fan blades.	Clean Fan blades and interior of fan casing.
Excessive noise and rough operation.	Dirty fan blades.	Clean blades and casing.
	Excessive resistance.	See "low air delivery" above.
		Check for unstable fan operation.
	Mechanical unbalance	Balance fan impeller and motor rotor. Straighten shaft or correct faulty seating of bearings.
	Loose mounting bolts.	Tighten bolts.
	Word or defective bearings	Replace bearings.
Will not run, but motor hums.	Jammed impeller.	Restore casing roundness. Clean fan blades and casing interior. Correct face mounting of motor to provide equal tip clearance around casing.
Motor will not start (no hum).	loss of power.	Check fuse. Reset thermal overload protector.
	Open connection.	Check for broken wiring, improper connection.
Motor hums, but fails to start.	Excessive overload.	Check for jamming, clogging, or freezing.
	Open in starting circuit.	Check starting capacitors (where applicable) for open or short.
	Open in running circuit.	Check winding contin uity.
	Grounded windings.	Check starting and running windings for grounds.
	Switch contacts not closing.	Check switch operation.
Motor fails to accelerate normal load to running speed.	Starting winding remains in circuit.	Switch contact points may be struck together. switch actuator may be defective.
	Defective starting capacitors.	Check for open, leaking or dried-out capacitors.
	Improper value of placement capactors.	Check capacitor value Replace with capacitor of correct value.

Troubleshooting Chart Axial Fans (Continued)

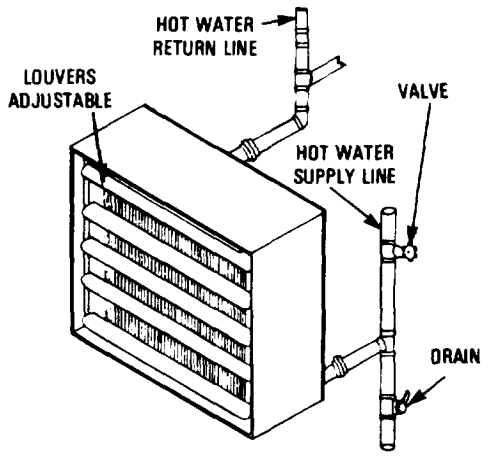
SYMPTOM	PROBABLE CAUSE	REMEDY
Motor starts arid accelerates load, but is rough and noisy, draws high current	Faulty rotating switch actuator.	Check rotating switch actuator operation.
	Faulty switch.	Check switch operations.
Motor starts properly, but will not come up to full speed. Motor speed cycles between the switch dropout and cut in speed.	Switching speed too low because of faulty or improperly located rotating switch actuator.	Check rotating switch-actuator operation.
Bearing overheating.	Improper lubrication.	Relubricate motor.
	Worn bearings.	Inspect bearings and replace if necessary.
Vibration.	Misalignment with fan.	Check alignment of motor fan and realign if required.

HEATING SYSTEM

SPECIFICATIONS FOR SPACE HEATERS

Four space heaters provide heat for the crew's quarters. Two heaters are located in the berthing area and two in the galley and mess area. Each heater is rated to deliver 815 CFM of air heated to 129° F for a distance up to 27 feet. The following graphic presents data on the space heaters.

Space Heater Data



Motor:
- Power requirements 120-VAC, 1-phase, 60-Hz
- Capacity 22,500-BTU, 815-CFM

Thermostat:
- Electrical rating 120-VAC, 1-phase, 60-Hz
- Temperature-setting range .... 56° to 94°F

Size ..... 23 7/8 inches long, 17 inches wide, 14 5/8 inches high

Unit weight ..... 55 lb

FUNCTIONAL DESCRIPTION

The four space heaters are used to heat the crew's quarters. Water at 212°F is pumped from the hot water supply system by the hot water circulating pump through piping to the heaters. The water runs through coils, heating the coils. Electric fans blow ambient air across the hot coils into the air space to be heated. One thermostat is provided for both units in each of the areas. The thermostats are connected to the control relays. When ambient air is cooler than desired, the thermostat causes the control relay to energize. This turns on the circulating pump in the hot water supply system and pumps hot water through the supply pipes. The fan motors turn on, circulating air across the coils. The hot water, after passing through the coils, is returned to the hot water boiler through the return pipes. See the following illustration for installation of a space heater. The hot water is obtained from the hot water supply system, described in this chapter.

The operation of the space heaters is automatically controlled by the thermostats. Before checking the operation of the space heaters, be sure that—

- The hot water boiler is operating, that is, providing hot water to the system.
- The hot water circulating pump is running (15-amp circuit breaker closed at the engine room, 120-VAC power panel (P-101)).
- The power switch energizing the associated control relay is positioned to ON at the galley and quarters, 120-VAC lighting distribution box (P-105).

Beginning with the berthing area heaters, follow this procedure to operate the system:

Step 1. Set thermostat to desired temperature, and turn switch to AUTO.

Step 2. Open the valve in the hot water supply pipe.

Step 3. Check to see that the valve in the return line is open.

Step 4. Check to see that power is available to the system.

Step 5. Move thermostat control lever to 10° F above room temperature; heating fan should start.

Step 6. Move thermostat control lever to below room temperature; heating fan should stop.

Step 7. Set the thermostat at the desired temperature setting, and let the system operate one complete cycle to make certain the thermostat and all other associated equipment are functioning properly.

Step 8. Repeat the procedure with the galley area space heaters.

The thermostats are calibrated at the factory under controlled conditions. If field calibration appears necessary, proceed as follows:

CAUTION: Disconnect power source from thermostat before removing cover.

Step 1. Remove cover and place as close as possible to the thermostat. Allow thermometer temperature to stabilize.

Step 2. Turn calibration screw clockwise until snug.

Step 3. Set temperature control lever on scale mark that corresponds to thermometer reading.

Step 4. Turn calibration screw counterclockwise very slowly until contact is made. Keep in mind that the thermostat is a very sensitive device. Turning the calibration screw I/4 turn changes the temperature control point about 9°F.

Step 5. Check calibration by moving temperature control lever to the left (opening the contacts) and returning it slowly to the right until contact is made. Check the indication *on* the scale; it should correspond to the reading on the thermometer. If the two readings do not correspond, recalibrate until they do.

MAINTENANCE

Preventive maintenance

Preventive maintenance includes inspection, cleaning, and lubrication.

INSPECTING. The space heaters should be inspected periodically as indicated.

Cleaniness: fan blades, coils, louvers	Annually; every 90 days with constant operation.
Overheating: motors (very hot to the touch or smoking)	Every 90 days.
Quiet operation: entire unit	Annually; every 90 days with constant operation.
Alignment: motor and fan	Annually; every 90 days with constant operation.

CLEANING. The unit casing, fan, diffuser, and coil should be cleaned thoroughly once a year or when dirty. Heating efficiency depends on cleanliness. Certain procedures should be performed when lubricating the motor and cleaning the coil.

WARNING: Before cleaning—
- Disconnect power source.
- Tag "Out of Service."

Wipe any excess lubricant from the motor, fan, and casing. Clean the motor thoroughly. A dirty motor will run hot and eventually cause internal damage.

To clean the coil, loosen the dirt with a brush on the fan side of the coil. Operate the motor, allowing the fan to blow the loosened dirt through the unit, use high pressure air or steam on the side of the coil away from the fan.

NOTE: A piece of cheesecloth or burlap bag over the fan outlet can be used to collect the large particles during the cleaning process.

Clean the casing, fan blades, fan guard, and diffuser with a damp cloth. Any rust spots on the casing should be cleaned off and any bare metal repainted. Tighten the fan guard, motor frame, and fan bolts. Check the fan for clearance and free rotation.

The thermostat also requires periodic cleaning.

WARNING: Remove the power source from the thermostat before removing the cover; failure to do so could result in serious electrical shock.

Turn off the power to the thermostat, and remove cover. Blow or brush away any accumulated dust or dirt, and inspect the device for external or internal damage. If the contacts are oxidized, clean them by manually closing the contacts upon a piece of hard-finish cardboard (similar to a postcard) and drawing the cardboard from between contacts. Repeat the operation several times to ensure a good clean surface.

LUBRICATING. Motors with oil holes are lubricated before shipment and do not require further lubrication for one year unless the motors have been operated under extreme conditions or constant fan operation. In the latter case, the fan motors should be lubricated every 90 days. Lubricate with SAE 20W oil if motors are operated in ambient temperatures between 32° and 100°F. Above 100°F, use an SAE 30W to 50W oil; below 32°F, use an SAE 10W oil.

Corrective maintenance

The following table presents remedies for space heater malfunctions.

Troubleshooting Chart: Space Heater

SYMPTOM	PROBABLE CAUSE	REMEDY
No heat from unit.	Hot water supply system malfunction.	Troubleshoot hot water supply system (see Hot Water System in this chapter).
	Supply valve and/or return valve might be closed.	Open valve.
Heat inadequate.	Dirty coils.	Clean coils.
	Hot water supply failure.	Troubleshoot hot water supply system (see Hot Water System in this chapter).
	Supply and/or return valve only partly open.	Open valve fully.
Fan motor fails to start.	Electrical circuit open.	Check circuits for loose connections, plugs not properly seated, circuit breakers open, overload relays open.
	Thermostat set low or malfunctioning.	Set thermostat, or repair.
Fan motor overheats.	Motor defective.	Replace motor.
	Lack of lubrication.	Lubricate.
	Too much lubrication.	Stop motor: remove all excess lubrication.
Motor vibrates excessively.	Lack of lubrication.	Lubricate.
	Bent fan shaft.	Replace motor.
	Dirt on fan blades.	Clean blades.

AIR-CONDITIONING SYSTEM

SPECIFICATIONS FOR AIR CONDITIONERS

The air-conditioning system consists of three units. Two 9,400-BTU air conditioners are located in the crew's quarters, one in the berthing area and the other in the galley and mess area. One 12,000-BTU air conditioner is located in the operator's cab.

Two seawater pumps provide cooling to the air-conditioner coils, one pump for each 9,400-BTU air conditioner. The 12,000-BTU air conditioner is air-cooled. The following table gives data on the air conditioners.

Air-Conditioner Data

9,400-BTU AIR CONDITIONER

Capacity	9,400 BTUs/hr
Type	Console
Power requirements	120-VAC, 1-phase, 60-Hz
Wattage	1.49 kw (17.2 amp)
Size	19 1/4 inches long, 16 inches wide, and 28 1/8 inches high
Weight	150 lb

Air Conditioner Data (Continued)

12,000-BTU AIR CONDITIONER

Capacity	12,000 BTUs/hr
Type	Window unit
Power requirements	240-VAC, 3-phase, 60-Hz
Wattage	1.96 kw
Size	25 inches long, 28 7/8 inches wide, and 15 1/4 inches high
Weight	120 lb

AIR-CONDITIONING COOLING (SEAWATER) PUMP

Capacity	3 GPM @ 40 ft total displacement height (TDH)
Motor:	
Power requirements	120-VAC, 1-phase, 60-Hz
Speed of rotation	1,750 RPM
Current	7 amp
Power output	1/3 HP

FUNCTIONAL DESCRIPTION

The two 9,400-BTU air-conditioning units located in the crew's quarters use seawater to cool the condenser coils and speed up cooling of the ambient air. Two seawater pumps in the engine room pump seawater to the air-conditioning units. The seawater pumps are turned on and off automatically by thermostats located in the air-conditioning units. The motors for the unit fans and condensers are connected to electrical receptacles. The motor operation for each air conditioner is controlled by a relay which, in turn, is controlled by a motor controller.

The air-conditioning units in the crew's quarters are thermostatically controlled. The thermostat setting knob is located in an opening on the right side of the unit and can be set to the desired temperature. The operation of each unit is entirely automatic and separate. Each unit, along with its seawater pump, turns on and off as the room temperature changes from that set on the thermostat. Refer to manufacturer's manual.

The 12,000-BTU air conditioner, a window unit in the operator's cab, is temperature-controlled and allows for a variety of outputs. The operator can select fan only, various degrees of cooling, and air-exchange operation. In the latter configuration, air in the cab can be vented, exhausted, or cooled. The normal position of the VENT-SHUT-EXHAUST control is SHUT. In VENT position, ambient air is drawn into the area; in EXHAUST position, internal air is removed from the area. The fan control has five positions: fan, low-, medium-, and high-cooling, and off.

The directional louvers which control the direction of air flow are adjustable to direct the air upward, horizontally, or downward.

The 12,000-BTU air-conditioning unit is operated as follows:

- Adjust coolness control to the desired setting for maximum comfort.
- Ensure that motor controller for seawater pump is switched ON.
- Press fan control switch to desired setting.
- If fan only is desired, press only FAN button.
- To shut off conditioner, press OFF button.

MAINTENANCE

Preventive maintenance

For the 9,400-BTU units, refer to the manufacturer's manual.

The 12,000-BTU unit requires routine cleaning and lubricating. To clean, perform the following steps every 30 days:

Step 1. Press down on top corners of grille and pull outward. Lift grille from bottom-retaining clips.

***Step* 2.** Remove filter from plastic pins. Vacuum or wash filter in warm water. Shake filter vigorously to remove excess water, and replace on plastic pins. Be sure that the filter completely covers the coil face.

Step 3. Place the slots in the bottom edge of the grille on the spring clips attached to the base pan. Push top of grille firmly to the cabinet. Be certain filter attaches to pins on back of grille.

The fan motor is factory-lubricated and requires no lubrication under normal operating conditions for a period of five years. The fan motor should be oiled at the beginning of each cooling season thereafter. If the unit is subjected to heavy use, dusty atmosphere, or other abnormal conditions, oil the-motor at the beginning of the first cooling season and each cooling season thereafter. An oil port is located on each side of the motor. Remove the dust plugs from oil ports, and add 4 drops of SAE 20W oil through each port. Be sure to replace the plugs after oiling.

Corrective maintenance

Refer to the troubleshooting chart to determine both the probable cause and corrective maintenance for the majority of the minor air-conditioning problems. For major repair, consult the applicable manufacturer's manual or TM.

Troubleshooting Chart: Air-Conditioning Units

SYMPTOM	PROBABLE CAUSE	REMEDY
Compressor does not run.	Burned out capacitor.	Replace.
	Motor line open.	Close start or disconnect switch.
	Unit cord unplugged.	Plug into receptacle.
	Tripped circuit breaker.	Reset.
	Control stuck open.	Repair or replace.
	Frozen compressor or motor bearings.	Repair or replace.
	Control thermostat off due to cold location.	Move control to warmer location.
	Control thermostat will not operate at temperature below 70°F.	Warm thermostat and bulb.
Unit short cycles.	Compressor overload cutting out.	Check for high head pressure, tight bearings, clogged air, or water-cooled condenser shut off.
Unit operates long or continuously without lowering temperature.	Slight shortage of gas.	Repair lead and recharge.
	Control contacts frozen.	Clean points or replace control.
	location too warm for thermostat.	Move thermostat to cooler location.
	Air in system.	Evacuate and recharge.
	Compressor inefficient.	Check valves and pistons.
	Defective insulation.	Correct or replace.
	Unit too small.	Add unit or replace.

Troubleshooting Chart Air Conditioning Units (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Head pressure too high.	Refrigerant overcharge.	Purge.
	Air in system.	Evacuate and recharge.
	Dirty condenser.	Clean.
	location too hot for unit.	Relocate unit.
Head pressure too high.	Refrigerant undercharge.	Repair leak and recharge.
	Compressor suction or discharge valve ineffective.	Clean or replace leaky valve plates.
Noisy unit.	Insufficient compressor oil.	Add oil.
	Tubing rattles.	Bend tubes away.
	Mountings loose.	Tighten slightly.
	Compressor still bolted down for shipping.	Loosen nuts.
Compressor loses oil.	Shortage of refrigerant.	Repair leak and recharge.
	Oil getting trapped in lines.	Drain tubing toward compressor.
	Short cycling.	Reduce number of starts per hour.
Hot liquid line.	Shortage of refrigerant.	Repair leak and recharge.
Frosted liquid line.	Restriction in liquid.	Remove restriction in line.
Top condenser coils cool when unit is in operation.	Refrigerant undercharged.	Repair lead and recharge.
	Compressor inefficient.	Check and correct compressor.
	Air lock and recharge.	Check for leak; evacuate.
Coils ice up.	Loose or worn fan belts.	Replace or tighten fan belt.
	Dirty filters.	Clean or replace filters.
	Insufficient CFM.	Increase speed of blower.
Compressor will not start; no hum.	Open line circuit.	Check wiring, circuit breaker, receptacle.
	Overload kicked out.	Check current rating.
	Control contacts open.	Check pressure control; check line pressure.
	Open circuit in compressor.	Replace compressor.
	Thermostat contacts open.	Warm thermostat.

Troubleshoothrg Chart: Air Conditioning Units (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Compressor will not start; hums intermittently (cycling on thermal overload).	Improperly wired.	Check wiring against diagram.
	Low line voltage.	Check main line voltage; determine location of voltage drop.
	Open starting capacitor.	Replace starting capacitor.
	Relay contacts not closing.	Replace relay if defective.
	Open circuit in starting winding.	Check stator leads; if leads are in good condition, replace compressor.
	Stator winding grounded.	Same as above.
	Tight compressor.	Check oil level; check binding.
Compressor starts; motor will not get off starting winding.	Low line voltage.	Bring up voltage.
	Improperly wired.	Check wiring against diagram.
	Defective relay.	Check operation manually; replace relay if defective.
	Running capacitor shorted.	Replace capacitor.
	Starting and running windings shorted.	Check resistance. Replace compressor it defective.
	Starting capacitor weak.	Check capacitance, replace if low.
	Tight compressor.	Check oil level. Check binding.
Compressor starts and runs but cycles on overload.	Low line voltage.	Bring up voltage.
	Additional current passing through overload protector.	Check for added fan motors, pumps, and so forth, connected to wrong side of overload protector.
	Overload protector weak.	Check current; replace overload protector if defective.
	Running capacitor defective.	Check capacitance; replace if defective.
	Stator partially grounded or shorted.	Check resistance ground; replace if defective.
	Inadequate motor cooling.	Correct cooling system.
	Compressor tight.	Check oil level. Check forbidding.
	Unbalanced line on 12,000 -BTU unit.	Check voltage of each phase. If not equal, correct condition of unbalance.

Trouhleshooting Chart: Air Conditioning Units (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Starting capacitors burn out.	Short cycling.	Replace starting capacitor.
	Prolonged operation on starting winding.	Reduce starting load (install suction-regulating valve); increase voltage if low.
	Relay contacts sticking.	Clean contacts or replace relay.
Running capacitors burn out.	Excessive line voltage.	Reduce line voltage to no more than 10 percent over rating of motor.
	High line voltage and light load.	Reduce voltage if over 10 percent. Check voltage imposed on capacitor, and select one equivalent to this in voltage rating.
Relays burn out.	Low tine voltage.	Increase voltage.
	Excessive line voltage.	Reduce line voltage to no more than 10 percent over rating of motor.
	High line voltage and light load.	Reduce voltage if over 10 percent. Check voltage imposed on capacitor, and select one equivalent to this in voltage rating.
Relays burn out.	Low line voltage.	Increase voltage.
	Excessive line voltage.	Reduce voltage.
	Short cycling.	Reduce number of starts par hour.

HOT WATER SUPPLY SYSTEM

SPECIFICATIONS

The hot water boiler is an oil-fired, fully automatic central heating unit. It supplies hot water by means of a circulating pump to the space heaters (see Heating System in this chapter) and for eneral use.The system as a whole consists of the following components:

- Hot water boiler having a hot water control, stack switch, temperature and pressure gage, and a boiler safety relief valve.
- Oil-burner assembly having an oil-burner motor and blower, burner nozzle, strainer, ignition transformer, pressure gage, vacuum gage, and solenoid valve.
- 40-gallon combination tank and heater with a heating element, water-temperature control, temperature gage, and auxiliary electric heater.
- 25-gallon compression tank.
- Hot water circulating pump.
- Oil filter.

The automatic oil burner assembly is located on the boiler. The following table provides more information on the various components.

Hot Water Supply System Data

Hot water boiler:	
Capability	150 GPH @ 212°F
Capacity	210,000 BTUs/hr
Compression tank:	
Capacity	25 gal, 125 psi
Dimensions	52 inches long, 12 inches dia
Combination tank heater:	
Capacity	40 gal
Dimensions	58 inches long, 16 inches dia
Oil-burner motor:	
Power requirements	120-VAC, 1-phase, 60-Hz
Power output	1/6 HP
Current	3 amp
Burner nozzle	3 1/2 inches long, 3/4 inches wide
Stack switch, power requirements	120-VAC, 1-phase, 60-Hz
Ignition transformer:	
Rated power	120-VAC, 60-Hz, 2.2-amp
Dimensions	5 5/16 inches high, 4 3/8 inches wide
Circulation pump, capacity	15 GPM @ 14 ft TDH
Pump motor:	
Capacity	3,530 GPM
Rotation	1,725 RPM
Power requirements	120-VAC, 1-phase, 60-Hz
Power output	1/6 HP
Current	3.3 amp
Solenoid valve:	
Power requirements	120-VAC, 1-phase, 60-Hz
Maximum water temperature	180°F
Auxiliary electric heater:	
Power requirements	120-VAC, 1-phase, 60-Hz
Power used	1,500 w
Pressure gage	2 inches dia
Vacuum gage	2 inches dia

FUNCTIONAL DESCRIPTION

The hot water boiler is of the vertical fire-tube, two-pass, top-fired design. The center combustion chamber compresses the first pass, and the return fire tubes the second pass. The base of the boiler is insulated from the deck by means of an air space and wet bottom section. The top cover on which the oil burner is mounted is insulated from the boiler. The cover can be removed for periodic cleaning and inspection of boiler tubes and combustion chamber. A cleanout and inspection port is also provided in the base of the boiler. Suitable openings are provided for the convenient mounting and connection of the safety stack control, water-operating temperature control, temperature and pressure gage, and safety pressure-relief valve. Boiler outlet and return connections may be made at the rear or at the side of the boiler.

The oil burner is a fully automatic, high-pressure atomizing type. A motor connected directly to a blower supplies air for combustion. A two-stage fuel unit draws oil from a storage tank and delivers it under controlled pressure to the oil-atomizing nozzle. The oil is automatically ignited by a high-tension spark from an ignition transformer. The ignition spark is turned off by the safety stack control after ignition has been established. This same control, actuated by the stack temperature, will shut off the burner if ignition is not established in about 90 seconds. The 120-VAC voltage supply is fed through the stack switch into the primary of the ignition transformer. The secondary, or high-tension, side of this ignition transformer supplies 10,000 volts at 250 milliamperes to the ignition electrodes. These are connected to the ignition transformer by ignition cables. During the ignition period start-up, an electric spark between the ignition electrodes ignites the oil atomized by the nozzle tip. This atomizing nozzle is protected by a fine-mesh Monel strainer mounted in the nozzle adapter. Oil passes through the fuel tube to the atomizing nozzle at a pressure of about 100 psi.

The normal on-and-off operation of the burner is controlled by an adjustable water temperature controller mounted on the boiler. The water circulating pump connected to the inlet of the boiler can be controlled by a cabin or room temperature controller mounted in a central or convenient location for average temperatures. Or it can be turned on and off manually as heat is required. The burner fires into the heat-resisting, perforated combustion cone. After passing through the center firing tube, the gases return through the fire tubes to the boiler stack outlet. The bottom of the boiler is fitted with a removable, wet bottom section to which the return connections must be made. A cleanout and observation port is provided in the base of the boiler. Another observation port is located in the top of the boiler so that the oil spray pattern can be observed during operation.

A hot water safety relief valve is provided to relieve pressure over 30 psi. The circulating pump is connected in the heating system return line and is connected to the lower coupling connection on the boiler. The hot water outlet to the heating system is made from the upper connection. The boiler water temperature and pressure gage is mounted on the front of the boiler to the 1/2-inch coupling connection.

The stack switch is mounted in an opening on the front of the boiler and provided with a setscrew to secure it. The helix of this control projects into the upper return flue and is actuated by the temperature of the stack gases. This control ensures that ignition is on when the burner starts. After the temperature of the stack gases has increased to about 200°F, the helix of this control operates a contact to open the ignition circuit. During this preliminary ignition period, the current through the main relay in this control is shunted through a bimetal, lockout-warp switch resistor. If the temperature of the stack gases has not increased about 100°F before the present lockout time of approximately 90 seconds, the burner motor will stop, thus shutting off the oil. The control will then have to be manually reset by pressing the button on the cover of this control and after allowing about 2 to 5 minutes for the safety, lockout-warp switch to cool.

In normal operation, the stack gas temperature will increase the required approximately 100°F within 15 to 30 seconds after a start, at which time the helix will operate a contact to open the circuit to the lockout-warp switch resistor. Then, after another temperature increase of about 100°F, the ignition circuit is opened. In case of power failure or momentary interruption during operation, the control will shut the burner down and automatically restart after the stack gases have cooled. This allows the cold or starting contact of the stack switch to be made. In case of flame failure during operation, the stack temperature and helix will cool. This causes the cold or starting contact and the burner to lock out after the preset time of about 90 seconds.

The oil burner unit motor is flange-mounted on the burner case. The motor drives the burner blower mounted on the motor shaft and also the fuel unit by means of the flexible coupling. The fuel unit incorporates a two-stage pump, strainer, and pressure-regulating shutoff valve in one unit. In addition to the mechanical shutoff, pressure-regulating valve incorporated in the fuel unit, an electrically operated, solenoid shutoff valve is provided. This is located in the fuel line from the fuel unit to the burner fuel-inlet assembly and is for additional safety.

A fuel pressure gage and fuel vacuum gage are installed in the top of the oil burner assembly. These are to measure the pressure vacuum in the oil burner fuel supply. The pressure gage is fitted with a restricting orifice screwed into the stem to dampen pulsation. A retardant on the segment of the scale from 160 psi to 500 psi prevents damage from pressures exceeding 160 psi.

A hot water control, specifically designed for hot water heating systems, is provided. The hot water control has a single-immersion angle well that is immersed directly into the boiler water. The expansion and contraction of the liquid in the capillary tube within the well hydraulically operates a diaphragm to control the switching mechanism. This feature gives unusually quick response to rapid changes of water temperature, thereby preventing thermal lag.

The contacts are enclosed. and the internal parts are heavily plated to resist corrosion.

The following paragraphs outline the tests, adjustments, and procedures for operation of the hot water supply system.

Preoperational tests

After the controls and burner have been installed and wired, test the system to make sure the installation is correct. Proceed with the *installation check* as follows:

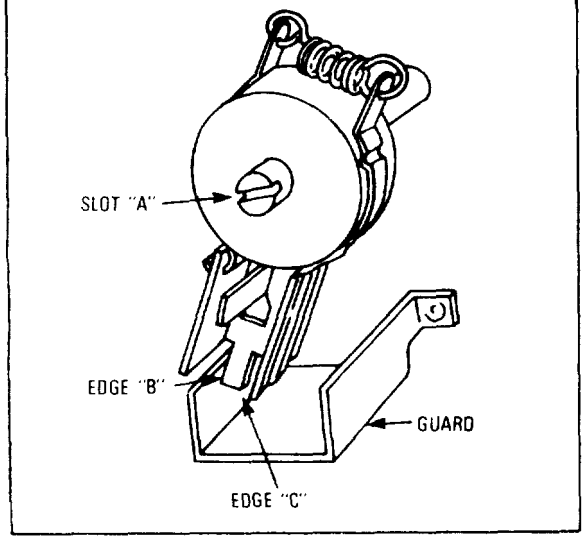
Step 1. With the boiler burner blower motor circuit breaker (P-101) open, turn the room thermostat to its maximum setting.

Step 2. With the cover removed from the oil burner control, put combustion switch in step:

- With screwdriver in slot "A," rotate shaft counterclockwise until edge "C" touches guard.
- Rotate shaft another 1/8 turn in same direction.

Ž Then slowly release shaft until edge "B" touches the other side of the guard. Control is now "in step."

Placing Combustion Switch "In-Step"



Step 3. Push the red safety RESET button on the oil burner control.

Step 4. Make sure that the high limit control is set to the correct temperature.

Step 5. Open the hand valve in the oil line.

The system is now ready for the following tests.

Check the *ignition timing* as follows:

Step 1. Close the boiler burner blower motor circuit breaker (P-101); the burner and ignition should start.

Step 2. About 30 seconds later, the left hand relay should drop out (stopping the spark). This is the ignition timing and should be about 30 seconds. However, timing will be shorter at high flue temperatures and longer at low flue temperatures.

Check the *scavenger timing* as follows:

Step 1. Let the burner operate for about 5 minutes.

Step 2. Open the circuit breaker; this should stop the burner. (If it fails to, replace the oil burner control.) Then close the circuit breaker again.

Step 3. Note the length of time from reclosing the circuit breaker until the burner restarts.

This is the scavenger time and should be about 60 seconds. Scavenger times longer or shorter than 60 seconds can be expected due to variations in flue temperature.

Check the *safety timing* as follows:

Step 1. Open circuit breaker, stopping the burner.

Step 2. After the burner has been off for about 5 minutes, remove the lead from terminal 3 of the oil burner control.

Step 3. Close circuit breaker; the oil burner control relays should pull in, but the burner should not start.

Step 4. Note the length of time that elapses between the closing of the circuit breaker and the time when the relays open. This is the safety timing and should be about 70 seconds at rated input voltage.

Step 6. Open circuit breaker and replace lead to terminal 3 which had been removed in Step 2 above.

Step 6. Wait about 3 minutes; then push the red RESET button. Close circuit breaker and burner will start.

Make the *limit control check* on the thermostat as follows:

Step 1. With the burner running, lower the setting of the limit control to its minimum setting; this should stop the burner. (If it does not stop the burner, the limit is inoperative or improperly wired).

Step 2. Return the limit control to its proper setting. A short time later, the burner will restart.

Starting adjustments

On a new installation, metal chips from pipe threadings or traces of compound may be present. Any filings, compound, or other foreign substance must be removed before starting the system.

Before starting the hot water system for the first time, be sure that—

- The boiler is full of water.
- The circulating pump is operating.
- The water is circulating through the boiler. Increase the water pressure to 30 psi. Check to see that the safety relief valve opens.

Clean the burner as follows:

Step 1. Remove the burner tailpiece assembly.

Step 2. Remove the nozzle tip and strainer assembly, and then reconnect the tailpiece assembly to the fuel pipe.

Step 3. Make sure that the ignition transformer is disconnected. Place a can or container under the outlet end of the fuel-feed assembly to collect fuel that maybe in the fuel line.

Step 4. Close the boiler burner blower motor circuit breaker on the engine room, 120-VAC power panel (P-101).

Step 5. On the motor controller, press the toggle switch to ON.

Step 6. Start the burner and allow the pump to flush 1 to 2 gallons of oil through the system.

Step 7. Replace the nozzle tip and strainer assembly on the burner. Check to see that the electrode setting is correct.

The burner can now be put into operation and fired. If ignition does not take place immediately after oil pressure has been established on the pressure gage mounted on the fuel unit, immediately shut down the burner. This is done by opening the main starter switch. Check to see that the electrodes are properly set and that there is a spark for ignition. A hissing sound should be heard when the ignition is on. The electrodes should be set 1/8 inch apart, but the setting can, with some grades of oil, be increased to 3/16 inch.

The air-inlet shutter on the burner should be set about half open on starting. If any oil has accumulated in the boiler due to faulty ignition caused by a partially plugged nozzled or incorrect electrode setting, the burner is apt to start up with a rumbling noise. If this occurs, open the air shutter to the full-open position and then gradually close down. Adjust the burner air-inlet damper so there is absolutely no trace of smoke, not even a haze on starting up or under running conditions.

The flame should have a smooth steady sound without pulsations or rumblings. The fire can be observed through the observation port at the bottom of the boiler. The flame as viewed through this port should come down almost to the wet bottom plate and be a light orange color. The flame tips should not be red. Usually, air is insufficient if flame tips are red.

After the burner has been in operation for two to three hours, remove the fuel-feed assembly again. Check the nozzle tip itself to be sure that no dirt particles are lodged in it. A clogged nozzle usually occurs in the first few days of operation due to dirt in the oil lines and improper flusing. It is therefore important to inspect the boiler frequently during this period to be sure that it is not smoking, smoke being the first sign of a clogged nozzle. The oil burner nozzle usually does not become completely clogged, only partially so. This condition distorts the spray, causing poor combustion and a smokey fire which will soot up the tubes of the boiler.

System into Operation

Before the system is put into operation, the circulating pump must be filled with water. After the pump has been filled, turn the shaft a few times by hand to allow the air to escape. If necessary, add more water.

Operate the following circuit breakers and switches to energize the system:

- At the engine room, 120-VAC power panel (P-101), close the 15-ampere breakers to the boiler burner blower motor, the hot water circulating pump motor, and the hot water tank auxiliary heater.
- At the galley and quarters lighting distribution box (P-105), close the two heater-fan power switches.

Set the thermostats located in the berthing and galley areas to the desired temperature.

During normal operation, the thermostats start the heater fans and the hot water circulating pumps simultaneously when the room temperature in the crew's quarters falls below the thermostat setting. Adjustable louvers are provided on heaters.

When the temperature of the water in the storage tank falls below its thermostat setting, the thermostat actuates the hot water circulating solenoid valve. This opens the hot water line and simultaneously starts the hot water circulating pump.

The temperature control mounted on the front of the boiler governs the normal on-and-off operation of the burner according to the selected setting. The contacts of the temperature controller operate the relay of the stack switch so that the full load of the burner motor and ignition circuit are made through the heavy-duty contacts of the stack switch.

The operation of the hot water supply system is automatic. No further procedural steps regarding the operation are required.

When the hot water supply system is to go out of service for any reason, all electrical power in the system must be switched off. Proceed with the following shutdown procedure:

Step 1. Switch hot water circulating pump motor controller to OFF.

Step 2. Open the three 15-ampere, hot water system circuit breakers on the engine room, 120-VAC power panel (P-101).

Step 3. Open the two heater fan switches on the lighting distribution box (P-105) for the crew's quarters.

Step 4. Close the valve in the fuel-inlet line.

Step 6. If the shutdown is to be for a long time, drain the boiler.

MAINTENANCE

Preventive maintenance

The *hot water boiler* **must** be inspected and cleaned every six months. To clean the boiler, remove the burner, top-mounting cover, and insulation. Punch the tubes with the flue cleaning brush. The main firing tube should be cleaned in the same manner, scraping down any accumulation of soot or carbon that has formed in the center firing tube. The heat-resisting combustion cone should be inspected and cleaned thoroughly if there has been any impingement due to a defective or partially clogged nozzle. A combustion cone should not need replacement until after years of operation and service. Any accumulation of soot or carbon which has been punched through the tubes of the main firing chamber can be cleaned out through the cleanout port at the bottom. The entire cleaning operation is best done with an industrial-type vacuum cleaner. It does a better job of picking up the loose soot and carbon accumulation than a hand brush.

During the periodic cleaning operation, the *burner fan* will be removed and cleaned. To remove the burner fan, disconnect the electrical connections to the motor and loosen the two bolts holding the motor to the burner housing. The motor and fan are then removed as an assembly. Rinse the fan in a cleaning solution or solvent to remove any grime or dirt that has accumulated on it. Inspect it for damage that might cause it to be out of balance.

The *fuel unit* should be removed, cleaned, and inspected. The electrodes should also be thoroughly cleaned and inspected to ensure that there are no cracks in the porcelain

insulator. Inspect the electrode cables at this time, and reassemble after cleaning, following the details on the burner drawing.

Inspect the *oil filter* in the suction line to the fuel pump at least once a month. This filter is provided with a replacement cartridge that can be cleaned. It should, however, be replaced at least once a year, depending upon the grade and cleanliness of the oil used. At the same time that this line filter is cleaned and inspected, inspect and clean the strainer in the fuel unit.

The *oil burner nozzle* is one of the most important components of the oil burner and normally will not require thorough cleaning more than once every seven months. The slightest sign of the boiler smoking or operating erratically, such as a pulsating fire, rumbling on starting or shutting down, or a change in the normal combustion sound of the unit, usually indicates a partially clogged nozzle. The nozzle should be inspected and thoroughly cleaned.

Deposits of so-called "carbon" in slots, swirl chamber, and orifice are difficult to remove. The deposit is not carbon. It is the varnish and gum formed by the heating of the oil under operating conditions.

CAUTION: Clean the nozzle with great care to avoid damage. Do not use any tool harder than wood. Use of any metal tool could result in damage to the nozzle.

The slots and orifices are best cleaned with a wooden toothpick. Insert the toothpick into the slots and orifices, and gently scrape the varnish and gum from the nozzle surfaces.

The surfaces of the nozzle tip and strainer assembly must be kept clean and free of scratches and notches. A 5/8-inch wrench is used on the nozzle tip. A 3/4-inch wrench is used to prevent turning of the adapter on the fuel-feed pipe. The parts must be tight and not leak oil under an operating pressure of 100 to 150 psi.

At the time of the six-month cleaning and inspection operation, the helix of the stack *switch* should be thoroughly inspected and cleaned. After many years of operation or due to excessive temperatures caused by a badly sooted boiler, this part may become distorted. It should be replaced. Filing or dressing of contacts on the stack switch is not recommended.

The *motors* on both the oil burner and the circulating pump are furnished with either sleeve bearings or ball bearings of the pre-sealed type having adequate grease for two years in normal service. After about two years of service, the ball bearings should be flushed and thoroughly cleaned with kerosene and then replaced with ball bearing grease about 1/8 full. With sleeve bearings, it is necessary to oil only occasionally with light lubricating oil. Do not overlubricate.

The *circulating pump is* test-run at the factory, but it must be lubricated before being put into operation.

A periodic cleaning of the *solenoid valve* is desirable. The time between cleanings will vary depending on media and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive leakage, or noise will indicate that cleaning is required. Be sure to clean the valve strainer or filter when cleaning the solenoid valve.

Keep the medium flowing through the valve as free from dirt and foreign material as possible. While in service, operate the valve at least once a month to ensure proper opening and closing.

Corrective maintenance

The troubleshooting charts for the hot water system and the recirculating pump motor provide the probable causes of malfunction.

Troubleshooting Chart: Hot Water System

SYMPTOM	PROBABLE CAUSE/REMEDY
Ignition failure.	Dead transformer. Broken or grounded high-tension leads. Cracked high-tension electrode insulators. Incorrect electrode setting. Faulty ignition cable connector. Solenoid oil or air valve fails to open. Water in oil. Dirty or clogged burner tip.
Flame failure.	Out of oil or water in oil. Clogged nozzle. Clogged oil line or strainer. Broken pressure-regulator spring Dead solenoid valve.
Burner smokes or pulsates.	Dirty nozzle. Excessive return-line oil pressure. Nozzle not positioned correctly. Insufficient combustion air. Low oil pressure. incorrect burner-linkage setting. Incorrect setting of primary air. Fluctuating voltage.
Oil not being delivered.	Leek in suction line. Insufficient fuel in tank, Dirty strainers. Worn pump members. Improper oil-valve setting. Defective gaskets on oil pump. Leaky pump seal.
Blower fails to deliver.	Misalignment. Dirty fan blades. Restriction at blower inlet. Seized bearings in blower. Bent or broken shaft. Dirty air-inlet screen. Insufficient supply voltage to motor. Fluctuating voltage.
Feed pump fails to deliver.	Dirty suction strainer. Suction line leaks. Pump gland packing leaks. Plugged inlet piping. Excessive discharge head. Slipping or broken drive coupling. Jammed pump impeller. Pump vapor-locked. Insufficient water supply. Reversed rotation. Worn out impeller. Defective water pressure gage.

Troubleshooting Chart Hot Water System (Continued)

SYMPTOM	PROBABLE CAUSE/REMEDY
Excessive vibration.	Combustion pulses. Loose hold-down bolts. Worn bearings. Insufficient air to burner. Insecure mechanical fastenings. Misalignment of rotating auxiliaries. Dynamic unbalance of rotating auxiliaries.
Improper operation of solenoid valve.	Faulty control circuit check electrical system by energizing solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for open-circuited or grounded coils, broken lead wires, or spliced connections. Burned-out coil:check for pen-circuited coil. Replace coil if necessary. Low voltage: Low voltage check voltage across coil leads Voltage must be at least 85 percent of nameplate rating. Incorrect water pressure check water valve pressure Pressure to valve must be within range specified on nameplate. Excessive leakage disassemble valve and clean all parts. Replace worn or damaged parts.

Troubleshooting Chart: Recirculating Pump Motor

SYMPTOM	PROBABLE CAUSE/REMEDY
Motor won't start (no hum).	Loss of power: check fuses Reset thermal backload protector. Open connection check for broken wiring, improper connection.
Motor hums, but fails to start.	Excessive overload: check for equipment jams, clogging, or freezing. Open in starting circuit: check starting capacitors for open or short. Grounded windings check winding continuity. Check starting and running windings for grounds. Switch contacts not closing check switch operations.
Motor fails to accelerate normal load to running speed.	Starting winding remains in circuit switch contact points may be in stuck together, Switch actuator may be defective. Defective starting capacitors check for open, leaking, or dried-out capacitors.
Motor starts and accelerates load but is rough and noisy; draws very high current (motor not switching out starting capacitor).	Faulty rotating-switch actuator check rotating-switch actuator operation. Faulty switch check switch operations.
Motor starts properly, but will not come up to full speed. Motor speed-cycles between the switch dropout and cut-in speeds.	Switching speed too low because of faulty or Improperly located rotating switch actuator: check rotating switch-actuator operation.
Bearings over-heating.	Improper lubrication: lubricate motor with proper grease. Worn bearings inspect bearings and replace if required.
Vibration.	Misalignment with equipment check alignment of motor with equipment and realign if required.

GALLEY EQUIPMENT

ELECTRIC RANGE

Specifications

The electric range in the galley of the crew's quarters has an oven and a cooking surface top composed of one griddle-hotplate. Adjustable searacks are provided over the cooking surface to prevent pots and pans from sliding in heavy weather. A removable drip pan is located under the griddle-hotplate to catch surface spillage.

The griddle-hotplate has a high-temperature thermostat, and the oven also has its own thermostat. Thermostat dial knobs are located on the front of the range. The griddle-hotplate is controlled by three-heat (low, medium, high) switches located on the overhead switch box.

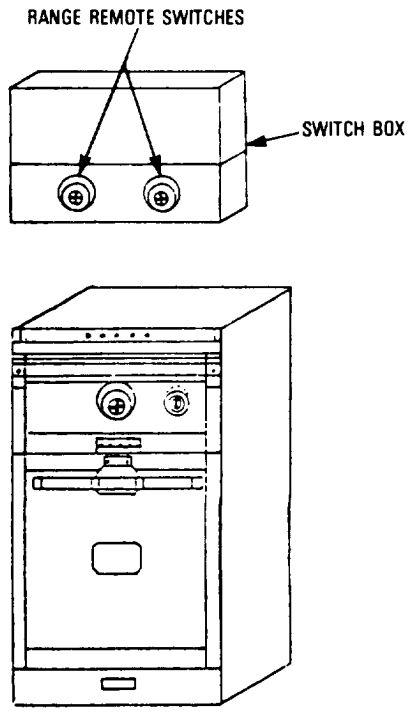
The griddle-hotplate, having a smoothly ground surface, is suitable for pot work and general surface cooking operations. At the rated wattage of 4 kilowatts, the gnddle-hotplate will reach operating temperature in about 20 minutes. The griddle-hotplate's high-temperature thermostat has a range of 250° to 850°F.

The oven has two heating units, one in the top of the compartment and the other in the bottom. The setting of the temperature control establishes the temperature in the oven. The following table and illustration describe the electric range.

Cooking Range Data

Power requirements	240-VAC, 3-phase, 60-Hz
Wattage	7 kw
Nominal amperage per line	X: 17.4 amp Y: 27 amp Z: 13 amp
Size:	
Range unit	42 inches high, 21 inches wide, and 22 1/2 inches deep
Switch box	12 inches high, 21 inches wide, and 6 inches deep

Electric Cooking Range and Switch Box



Functional description

The range is designed to give uniform and well-regulated heat over the entire gnddle-hotplate surface and in the oven.

The oven must be thoroughly preheated for satisfactory baking. To preheat oven, set temperature control at temperature desired and the three-heat switches to HIGH. The oven will reach a temperature of 450°F in about 20 minutes. For best baking results, the oven should be allowed to maintain constant temperature for at least another 15 or 20 minutes before use.

Preventive maintenance

To care for the range—

- Clean the range thoroughly at least once a week in addition to normal daily cleaning to ensure against the accumulation of foreign material.

Ž Keep inside of oven and unit cover scraped clean, especially around door opening, so that the door will close tightly.

- Keep removable drip pan under the griddle-hotplate clean.
- Keep grease trough in range top clean and free of carbonized material.
- Do not allow grease to accumulate in the grease receptacle; empty frequently.

Ž Inspect and check electrical circuits monthly, and make sure that wire connections are tight.

Both the oven temperature control and the high-temperature thermostat may be checked and adjusted for accuracy.

WARNING: Before starting any service work on the range, be sure that it is entirely disconnected from the electrical circuit. When removing any electrical parts, observe closely the arrangement of parts and identity of leads to facilitate replacement.

Check and adjust the oven temperature control as follows:

Step 1. Place a temperature indicator in the center of the oven. Close oven door.

Step 2. Thoroughly preheat the oven to between 350° and 450°F.

Step 3. Turn oven switch to OFF and let stand about 10 minutes.

Step 4. Turn temperature control dial counterclockwise until the control turns off (can be detected by a click in the control switch), and note the temperature reading on the dial at the OFF point. Turn the dial clockwise until the control turns ON, and note the temperature reading at this ON point. Average these two temperature readings.

Step 5. If necessary to open oven door to read temperature, read oven temperature quickly (temperature will drop rapidly with oven door open). Compare oven temperature with the average temperature obtained under Step 4 above.

Step 6. If the oven temperature is not in approximate agreement with the average temperature as indicated by the dial knob, remove dial knob by pulling it forward, loosen screw holding adjusting plate on back of knob, rotate plate toward RAISE or LOWER, and tighten screw.

Step 7. Replace knob and recheck calibration (return to Step 1). Proceed to the following paragraph to adjust thermostat if required.

To adjust the high-temperature thermostat, turn the adjusting plate on the back of the dial knob (similar to the oven dial knob). Rotate the plate toward RAISE or LOWER as applicable. The griddle-hotplate temperature at the center of the plate surface can be determined by a thermocouple in a bead of solder or by a surface pyrometer.

The OFF position can be mechanically adjusted (if necessary) to the panel behind the dial knob.

Corrective maintenance

When replacement of electrical components becomes necessary, the following procedures and troubleshooting charts apply.

WARNING: The range is a high-voltage piece of equipment; make sure that 240-VAC is switched OFF at the power panel (P-205) before servicing.

To replace a *defective oven-heating unit*—

Step 1. Remove cotter pin that holds front of unit frame to bracket fastened to oven lining.

Step 2. Pull unit assembly straight forward until terminals clear the terminal block at the rear. If the bottom unit is being removed, lift up to clear bracket. No wiring connections have to be disconnected.

Step 3. With the new unit, reverse the above procedure, making sure that the unit is pushed snugly back in position so that unit terminals engage firmly in the spring contacts at the rear.

Carry out the following procedure to replace a *defective griddle-hotplate or high-temperature thermostat:*

Step 1. Remove searack bars.

Step 2. Turn high-temperature dial knob to OFF, remove screw and spring at center of knob, and pull knob forward.

Step 3. Remove two screws from front panel that secure disk (behind knob) and extension-shaft assembly.

Step 4. Disengage shaft from thermostat by pulling forward.

Step 5. Loosen both locknuts holding griddle-hotplate at front and move hex-head cap screw forward.

Step 6. Pull griddle-hotplate forward and lift front until support members disengage from slots.

Step 7. Hold front of griddle-hotplate up (about a 45 degree angle) and block in place.

Step 8. Disconnect the lead wires from the griddle-hotplate and high-temperature thermostat terminals, noting connections. These leads are connections between terminal board and griddle-hotplate. Be careful not to twist the terminals of the griddle-hotplate when removing the cap screws to remove the wires.

Step 9. Remove high-temperature thermostat and install high-temperature thermostat on new griddle-hotplate. Be sure that the two screws securing the thermostat to the griddle-hotplate are pulled up tight to ensure a good thermal contact with the griddle-hotplate.

Step 10. To engage the thermostat extension shaft, allow shaft to rest in hole in sloped-front grease deflector. This aligns the shaft with the thermostat stud and permits pushing the extension shaft back to engage with thermostat when griddle-hotplate is in lowered position.

Step 11. Reverse above procedure to install new griddle-hotplate or high-temperature thermostat.

To replace a *defective oven-temperature control—*

Step 1. Open oven door and remove control bulb from supporting clips.

Step 2. Remove temperature control dial knob by pulling straight forward.

Step 3. Remove two screws holding thermostat assembly to panel.

Step 4. Turn high-temperature thermostat dial knob to OFF and remove screw, spring, and knob. Remove two screws from front panel that secure extension shaft assembly. Disengage shaft from high-temperature thermostat by pulling forward.

Step 5. Remove two screws that hold panel in place and pull panel forward.

Step 6. Disconnect wires from thermostat, noting lead connections.

Step 7. Remove control assembly with bulb; do not bend bulb any more than required.

Step 8. To install temperature control, reverse above procedure. Follow procedure for adjusting the temperature control.

The *contractor, transformer, and fuse* are accessible by removing the upper panel from the switchbox. Remove the four panel-retaining screws and the panel to replace them.

Each *three-heat oven switch* is mounted through a hole in the panel and secured with a spring clip mounted on the switch case. To remove the switch from the panel, depress the spring clip until it clears the locking notch in the panel. Turn the switch to the left slightly and pull out. Disconnect all wires. To install a new switch, reverse the preceding steps. Make sure that the leads are connected tightly to the switch terminals.

Troubleshooting Chart: Electric Cooking Range

SYMPTOM	PROBABLE CAUSE
Griddle section does not heat up.	Blown fuse or fuses. Thermostat and relay contacts closed. Loose terminals or broken wires. Shorted heating element.

Troubleshooting Chart: Electric Cooking Range (Continued)

SYMPTOM	PROBABLE CAUSE
Upper, lower, or both oven-heating elements do not heat up.	Blown fuse or fuses. Thermostat and relay contacts closed. Loose terminals or broken wires. Shorted heating element. Defective oven switch.
No power to control circuit.	Blown control circuit fuse. Circuit breaker open. Loose terminals or broken wire.
Relay contacts do not close on one circuit.	Defective thermostat. Defective relay-operating coil. Loose terminals or broken wire.
No power to range.	Check all fuses. Power service lines disconnected. Loose terminals. Circuit breaker tripped.

DRINKING FOUNTAIN

The drinking fountain provides hot and cold drinking water to the crew's quarters.

Functional description

The compressor pumps refrigerant through the fan-cooled condenser. Operating pressure on the high, containing side of the system is controlled by a capillary tube assembly containing a combination dryer-strainer. Liquid refrigerant enters the evaporator lines wrapped around the cooling tank. The rapid expansion of the refrigerant from liquid to gas (the cooling process) takes place at this point. Refrigerant gas on the low side of the system is then returned by the suction line to the compressor, which completes the refrigeration cycle. Incoming water is precooled by routing it around the cold water drain and evaporator lines to improve efficiency.

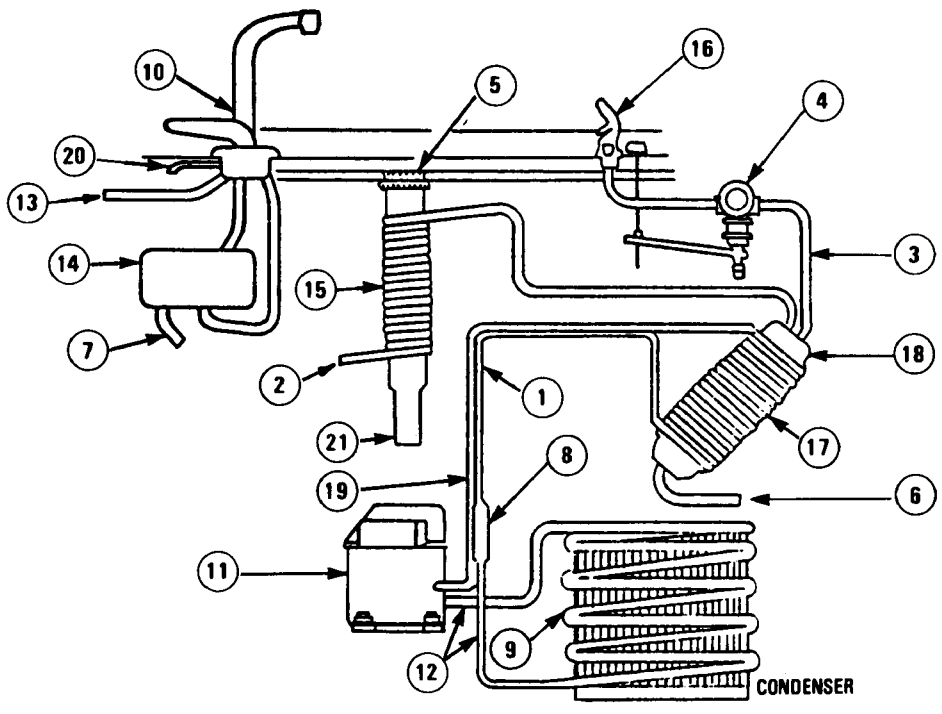
The electrical circuit includes automatic compressor-overload, plus an adjustable thermostat to regulate water temperature. A secondary, nonadjustable thermostat is included for backup freeze protection.

The hot water portion of the unit consists of an electrically heated, hot water tank assembly with heating element, adjustable thermostat, and a gooseneck, lever-operated cup filler. The hot water tank holds 4 pints and can provide 60 six-ounce cups of 180°F water per hour.

The inlet and outlet water lines for the hot water tank run through the stem assembly for the gooseneck. The gooseneck stem assembly is constructed so that operating the gooseneck lever opens both the inlet and outlet lines for the hot water tank. This provides heated water out of the gooseneck and at the same time allows refill of the tank. With the gooseneck lever released, the hot tank inlet and outlet water lines are both closed. Refer to the following diagram.

Before starting the drinking fountain, make sure the following steps have been carried out:

Schematic Diagram of Drinking Fountain



1 CAPILLARY TUBE
2 COLD WATER INLET
3 COLD WATER LINE
4 COMBINATION STOP AND STREAM REGULATOR
5 DRAIN
6 DRAIN
7 DRAIN
8 DRYER STRAINER
9 FAN
10 GOOSENECK
11 HERMETIC COMPRESSOR
12 HIGH PRESSURE LINE
13 HOT WATER INLET
14 HOT WATER TANK
15 PRE-COOLER COILS
16 PROJECTOR
17 STORAGE TANK COOLING COILS EVAPORATOR)
18 STORAGE TANK
19 SUCTION LINE
20 VENT
21 WASTE LINE

- Plumbing hookup is made.
- Power cable is connected to 120-VAC, 1-phase, 60-Hz receptacle.

ŽAll air is purged from waterline so that only water comes-out of bubbler and gooseneck when operated.

CAUTION: Ensure that hot water tank is filled with water a ALL TIMES when the unit is connected electrically. Providing electrical power to unit with no water in hot tank can damage the hot water tank heating element.

With power applied, the unit will start and should run from 15 minutes to 1 hour, depending on the temperature of the water supply before thermostat is set.

The push-button valve on the bubbler can be adjusted as follows:

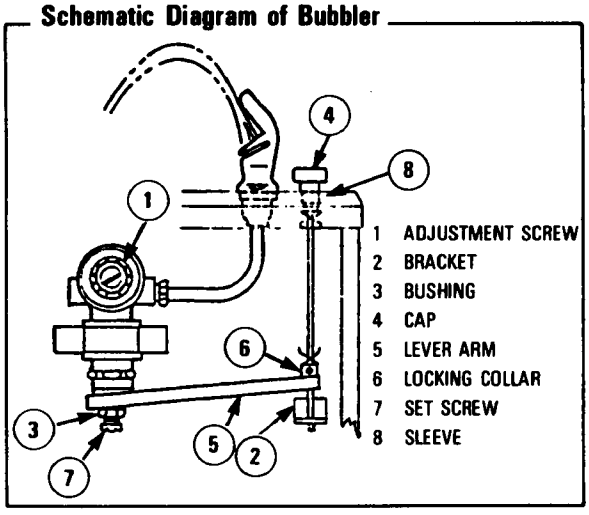
Step 1. Remove top and front panels; loosen setscrew and locking collar.

Step 2. Turn hex bushing clockwise until snug against lever arm and until water does not trickle from the projector (bubbler head).

Step 3. Hold cap so bottom of cap is in line with top of sleeve. With locking collar resting on lever arm, tighten screw in collar securely on stem. Tighten setscrew; push-button stem must align with bracket.

Refer to the following diagram of the bubbler.

Schematic Diagram of Bubbler



To adjust the stream regulator, turn adjustment screw clockwise to raise and counterclockwise to lower projector stream height. The top arch of the stream should be 1 1/2 inches above the top of the projector guard.

The cold water thermostat is located behind the front panel. Turn the adjustment screw clockwise for colder water, counterclockwise for warmer water.

The hot water thermostat is located on the hot water tank. Turn adjustment screw clockwise for cooler water, counterclockwise for hotter water.

Preventive maintenance

The drinking fountain refrigeration system is hermetically sealed at the factory. It is sealed by the pinch-off method at the process tube of the compressor. Sufficient length is left on the process tube so that a piercing valve (tap-a-line) can be installed for testing purposes. After tests and repairs are completed, the valve is to be removed and a new piece of 1/4-inch copper tube soldered into the flared process tube of the compressor. After the system has been properly charged, the copper tube should be pinched shut, the piercing removed, and the end of the tube soldered shut with hard solder.

Very little maintenance is required on the drinking fountain except to keep the cabinet clean and the condenser free of dust or lint. Washing with mild soap, followed by waxing, will keep the stainless steel wrapper and top presentable.

WARNING: When working inside of unit, first disconnect power cable from wall receptacle.

The condenser should be cleaned twice a year. After removing top and front panels, remove accumulated dust or dirt with a nonmetallic brush, air hose, or vacuum cleaner. Personnel should be cautioned not to place objects close to the condenser or air exhaust so as to block the air circulation through the machine compartment.

The refrigeration system is permanently lubricated and needs no further attention. The bearings of the fan motor are lifetime-lubricated. Additional electric motor oil can be added if needed.

Corrective maintenance

When all testing has been completed and a defect isolated, the refrigeration system should be slowly discharged to the outside atmosphere. The defective component and/or leak must be repaired or replaced as quicky as possible so that the refrigeration system is not exposed to the atmosphere any longer than required. The 1- to 2-inch drier-strainer located at the condenser outlet must also be replaced.

The repaired system must be evacuated to a minimum pressure of 29.6 inches of mercury for at least 30 minutes. If the system is suspected of having a high level of moisture, it should be evacuated to 29.99 inches of mercury, or about 250 microns, for at least **2** hours.

The system must be charged with the proper amount of refrigerant as specified on the data plate of cooler. Use a temperature-compensating charging cylinder, accurate to within 1/4 ounce.

Suction pressure readings (back-pressure) may serve to check the refrigeration charge. Under normal conditions, the suction line will be slightly cooler than ambient temperature prior to the system cycling off.

The following troubleshooting chart for the drinking fountain lists the troubles that may occur, the probable causes, and the remedies for correcting the trouble.

Troubleshooting Chart: Drinking Fountain

SYMPTOM	PROBABLE CAUSE	REMEDY
Not water from projector.	Water supply cut off.	Restore water supply.
	Improper linkage adjustment.	Readjust linkage.
	Restriction in regulator or stream regulator.	Remove and check.
	Cooling tank frozen.	See that cold control bulb is fully and firmly inserted into thermowell. Adjust or replace cold control.
		Check secondary thermostat.
Projector stream too high or too low.	Stream regulator improperly set.	Adjust regulating screw clockwise to raise stream, counterclockwise to lower.
	Holes restricted in projector.	Clean holes with small-diameter wire or round file (do not enlarge holes).
	Improper linkage adjustment.	Readjust.
	Partial restriction in regulator.	Remove restriction or replace regulator assembly.
Projector streams misaligned.	Mineral buildup or foreign matter in projector holes.	Clean holes with small-diameter wire or round file (do not enlarge holes).
Push button not working.	Improper adjustment.	Readjust.

Troubleshooting Chart: Drinking Fountain (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Water leaks.	External plumbing connections.	Repair.
	Projector connection, regulator assembly.	Tighten fittings, replace gaskets, or reflare.
	Cooling tank defective.	Contact local distributor, service agency, or factory.
Water cool, but not 50°F.	Temperature control set too warm.	Adjust control to colder setting
	Dirty condenser.	Thoroughly clean condenser with brush, vacuum, or air pressure.
Compressor runs continuously.	Temperature control too cold.	Adjust to warmer setting.
	Temperature control sensing line (capillary) not making good contact or out of thermowell.	Insert line fully and firmly into thermowell. (May have to bend line slightly for good contact).
	Defective temperature control.	Replace, using exact factory replacement.
Compressor and fan do not run.	No power at receptacle.	Check fuse or circuit breaker.
	Temperature control contacts open.	Check for continuity. Replace, using exact factory replacement.
	Open circuit.	Check for continuity. Repair or replace.
Fan runs, but not compressor.	Defective overload protector.	Remove and check continuity. Replace, using exact factory replacement.
	Loose or broken wiring.	Check visually and with continuity tester. Repair or replace.
	Defective compressor.	Check with continuity tester or hermetic test cord. If defective, contact local distributor, service center, or factory. **WARNING: Disconnect power cable from receptacle.**
Compressor runs, but not fan.	Defective fan motor.	Remove wiring leads from circuit, and check continuity. Spin blade to see if it moves freely. Replace if required, using exact factory replacement.
	Fan blade caught on shroud.	Reposition shroud.
Short cycling of refrigeration system.	Defective temperature control.	Replace component and recheck.

Troubleshooting Chart: Drinking Fountain (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Compressor starts but cycles on overload.	Low line voltage.	Check voltage with meter. Disconnect electrical power to cooler. Do not reconnect until problem is corrected.
	Dirty compressor.	Clean with brush, air, or vacuum.
	Restriction in capillary tube or strainer.	Contact local distributor, service center, or factory.
	Defective starting capacitor.	Use proper replacement and check.
	Defective starting relay.	Check in manner mentioned earlier and replace if required.
Cooler noisy.	Loose parts or mounting.	Find and tighten.
	Tubing rattle.	Reform so tubing does not come in contact with other parts or cabinet.
	Bent fan blade.	Repair or replace blade.
	Noisy fan motor.	Replace.
	Internal compressor mounting springs broken.	Contact local distributor, service center, or factory.
No water from gooseneck.	Water supply off.	Restore water supply.
	Hot water line service stop plug closed.	Open service stop plug.
	Restriction in gooseneck stem.	Remove gooseneck assembly and check.
Water from hot	Hot water thermostat set too low.	Adjust hot water thermostat to 180°F.
	Hot water heater element and thermostat not connected electrically.	Check electrical connections to heater element and thermostat.
	Hot tank inlet line leaking into hot tank outlet line at gooseneck stem.	Replace gooseneck assembly.

REFRIGERATOR

Specifications

This section describes the function, operation, and maintenance of the refrigerator located in the crew's quarters. The refrigerator is used to maintain foods and beverages at a temperature of about 38°F. Refer to the following table for information on the refrigerator.

Refrigerator Data

Power requirements	120-VAC, 1-phase, 60-Hz
Power output	1/3 HP
Capacity	8 cubic feet
Dimensions	72 inches high, 33 inches wide, and 24 1/2 inches deep

Operation

The following operating tips are given for loading the refrigerator:

Ž Be sure the refrigerator temperature has reached 38°F before loading with food. It will take from 2 to 4 hours to reach this temperature when the unit is first started. During this period, the condensing unit will be running continuously.

• Do not attempt to chill too much food at one time. Loading up the refrigerator with an excessive amount of warm or hot food will increase the temperature.

• Minimize the time for loading and unloading the refrigerator, since having the door open will also cause a rise in temperature, reducing the shelf life of the foods inside. This is particularly important because the refrigerator is located in the galley where the temperature is high.

If there is a power shutdown or failure, the following precautions should be taken:

Ž If power will be off less than 24 hours, keep refrigerator door shut and the contents will stay cold.

• If power will be off more than 24 hours, remove food from refrigerator and take to a refrigerated storage space.

Generally speaking, foods will stay chilled for 24 to 48 hours from the time the condensing unit stops running. The length of time depends on several factors:

• The amount of food in the cabinet. (A full cabinet remains cold longer than one paretically filled.)

• The kind of food in the cabinet.

Ž The inside cabinet temperature at the time of shutdown.

Ž The room temperature where the refrigerator is located.

Preventive maintenance

Several *safety precautions* should be observed when testing for leaks in the tubing of the compressor line. Use carbon dioxide or nitrogen for testing; never use oxygen which may cause an explosion.

Silver brazing materials sometimes contain cadmium. Fumes from cadmium are very poisonous. Be sure that the work space is well-ventilated. If at all possible, use silver brazing alloys that DO NOT contain cadmium.

Refrigerant cylinders must never be filled above 85 percent of their capacity. If overfilled, the hydrostatic pressure may cause them to burst.

Wrenches used on refrigeration line fittings should always fit the nuts well. Poorly fitting wrenches will ruin nuts and bolt heads.

Always "crack" service valves and cylinder valves before fully opening. This gives positive control of the flow of gases and prevents damage to gage.

Tubing should be bent in as large a radius as possible.

Moisture is always a hazard to refrigerating mechanisms. Keep everything connected with refrigerating mechanisms thoroughly dry.

Emery cloth should not be used to clean tubing preparatory to soldering. The emery cloth may leave an oily deposit on the tubing. The grit is hard and will cause considerable damage if it enters the system.

Care and cleaning of the refrigerator is important to efficient operation of the unit. The finned condenser on the condensing unit must be kept clean. A suction fan is constantly pulling air through the condenser and over the compressor. It serves a dual purpose by cooling the refrigerant in the condenser and cooling the compressor dome. The condenser must be cleaned at least once every 60 to 90 days. Shut off the power to the refrigerator when cleaning the condenser.

When cleaning the interior of the refrigerator, use a solution of baking soda or borax and hot water. A suitable soda solution consists of half a teaspoonful of ordinary baking soda to a quart of water. The exterior of the cabinet can be cleaned in the same manner.

The vinyl door gasket will remain in the best condition if washed once a week with mild soap and water, followed by a fresh-water rinse.

Periodic *defrosting* is required for the efficient operation of the refrigerator. The frequency of defrosting will depend on the type and quantity of chilled foods, the temperature and humidity of the compartment in which the cabinet is located, and the number of times the door is opened and closed. The refrigerator can be defrosted as follows:

Step 1. Turn off power to unit.

Step 2. Remove and place all food in cardboard boxes, or wrap it in several thicknesses of paper to keep it safely chilled while the refrigerator is being defrosted and cleaned.

Step 3. Take out the removable shelves.

Step 4. Leave the door open and wait for frost to soften. An electric fan blowing into the refrigerator speeds defrosting.

CAUTION: Never chip at frost using a knife or sharp object.

Step 5. Remove softened frost with a plastic or wooden scraper, cloth, or sponge. MOP UP any water and thoroughly dry the cabinet.

Step 6. Replace shelves and chilled food.

Step 7. Turn power on.

Corrective maintenance

Servicing procedures for the refrigerant system often require *adding refrigerant.* Use Freon 12 refrigerant. Weigh the service cylinder before and after adding Freon; this is the only way to determine how much Freon has been added.

Be sure the low-side suction valve is turned all the way to the left to close the gage port. Install a compound gage hose on one end, and connect the center hose from the manifold to the Freon cylinder. Before tightening the connection, crack the service valve to purge air in the regular way. Attach the pressure gage to the high-side valve.

Now open the low-side valve and start the compressor. Watch the compound gage, then open the valve on the service cylinder. Add the proper amount of Freon corresponding to the temperature and pressure of the system.

Pooling of refrigerant in receiver and condenser allows refrigerant to be used again after the repairs are complete. When necessary to open or remove the expansion valve, expansion coil, or suction line for repairs, all the Freon must be pumped back into the receiver and condenser. The receiver and condenser will hold the entire charge of refrigerant.

Attach a compound gage to the suction valve and a pressure gage to the discharge shutoff valve, purging the connections in the usual way. Turn both valves back one turn for reading. Now close the receiver valve to shut off the receiver from the liquid line going to the expansion valve.

Start the compressor and run it until the compound gage shows about 5 psi. This operation pulls the Freon all the way through the system in the direction of the arrows shown on the master drawing and forces it into the condenser and receiver. When the 5 psi reading is reached, it is almost certain that all the refrigerant is pumped back into the condenser and receiver. At this point the unit can be stopped and the high-side shutoff valve closed to prevent any Freon vapor going back into the compressor should the compressor valves leak.

CAUTION: Never open a system under vacuum as air will rush in, probably drawing some moisture into the system.

With the refrigerant back in the condenser and receiver, any part can be removed from the unit with the exception of the high-side shutoff valve, the condenser, and the receiver. These parts still have refrigerant in them.

Care must be taken in *discharging excess refrigerant.* Do not discharge large amounts at a time or an undercharge could result. Excess Freon can be discharged through the discharge service-valve gage port. Install service and charging manifold in the regular manner. Do not hook center charging line to a refrigerant service drum. An excess charge can be bled off through the center charging hose, and the amount of pressure drop can be observed on the manifold pressure gage.

A halide torch is used in *testing for leaks* of Freon. A change of flame color from blue to green indicates a leak around the joint being tested.

To test the compressor, install a compound gage at the suction service valve on the compressor. Shut off the suction line after starting the compressor. A hammering sound coming from the cylinder head indicates that an excessive amount of oil is being pumped through the compressor. The valves are designed to stand this abuse. It is undesirable, nevertheless, because the oil is gradually being transferred to the condenser and receiver. This indicates that insufficient oil remains in the crankcase to lubricate the compressor. As soon as the compressor starts to pump oil, the motor should be shut off for a short time, restarted, and stopped until compressor operates quietly.

During this time the compound gage should be watched carefully. When the compressor pumps a 24-inch to 26-inch vacuum or more, it is operating properly. When a 24-inch to 26-inch vacuum is reached, the motor should be shut off and the compound gage carefully watched. If the loss of vacuum is pronounced, that is, the back-pressure readings move up to pressure within a short time, it is a good indication of a leaky discharge valve.

An intake valve leak is indicated by the inability of the compressor to produce a high vacuum, but vacuum is maintained after the compressor is shut off, providing the discharge valve is holding.

If there is *malfunctioning of the overload protector,* it must be replaced with a factory-adjusted assembly.

The motor overload protector consists of a small, round, plastic casing containing a heater coil and bimetallic disk. The heater coil is designed to carry normal starting and operating currents. However, should the current increase abnormally for any reason, the excessive heat from the coil causes the bimetallic disk to snap open. This breaks the electrical circuit and stops the motor. When the overload trips, the circuit remains open until the shell temperature cools down to the proper point. At this time the bimetallic disk snaps closed and again starts the motor. This process is repeated so long as there is an abnormal load condition on the compressor.

Refer to the following troubleshooting chart to remedy any problems with the refrigerator.

Troubleshooting Chart: Refrigerator

SYMPTOM	PROBABLE CAUSE	REMEDY
Compressor will not start (no hum).	Line-disconnect switch open.	Close start or disconnect switch.
	Fuse removed or blown.	Replace fuse.
	Overload protector tripped.	Refer to elecrical section.
	Control stuck in open position.	Repair or replace control.
	Control off due to cold location.	Relocate control.
	Wiring improper or loose.	Check wiring diagram.

Troubleshooting Chart: Refrigerator (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Compressor hums but will not start: trips on overload protector.	Improperly wired.	Check wrong against diagram.
	Low voltage to unit	Determine reason and correct.
	Starting capacitor defective.	Determine reason and replace.
	Relay failing to close	Determine reason and correct; replace if required.
	Compressor motor has a winding open or shorted.	Replace compressor.
	Internal mechanical in compressor.	Repair or replace compressor.
	Liquid refrigerant in compressor.	Add crankcase heater and/or accumulator.
Compressor starts but does not switch off start winding..	Improperly wined.	Check wiring against diagram.
	Relay failing to open.	Determine reason and correct; replace if required.
	Run capacitor defective.	Determine reason and replace.
	Excessively high discharge pressure.	Check discharge shutoff valve. Check possible overcharge or insufficient cooling of condenser.
	Compressor motor has a winding open or shorted.	Repair or replace motor.
	Internal mechanical trouble in compressor (tight).	Replace compressor.
Compressor starts and runs, but short-cycles on overload protector.	Additional current passing through overload protector.	Check wiring diagram. Check for added fan motors, pumps, and so forth, connected to to wrong side of protector.
	Low voltage to unit.	Determine reason and correct.
	Overload protector defective.	Check current; replace protector.
	Run capacitor defective.	Determine reason and replace.
	Excessive discharge pressure.	Check ventilation, restrictions in cooling medium, and restrictions in refrigeration system.
	Suction pressure too high.	Check for possibility of misapplication. Use stronger unit.
	Compressor too hot, return gas hot.	Check refrigerant charge; if required, fix leak and add refrigerant.
	Compressor motor has a winding shorted.	Replace compressor.

Troubleshooting Chart Refrigerator (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Unit runs OK, but with short cycles.	Thermostat.	Differential set too close: widen.
	High pressure cutout due to-	Check the following:
	Insufficient air or water supply.	Check air or water supply to condenser; correct.
	Overcharge.	Reduce refrigerant charge.
	Air in system.	Purge.
	Low pressure cutout due to-	Perform the following:
	Liquid-line solenoid leak.	Replace.
	Compressor valve leak.	Replace.
	Undercharge.	Fix leak: add refrigerant.
	Restriction in expansion device.	Replace device.
Unit operates long or continuously.	Shortage of refrigerant.	Fix leak, add charge.
	Control contacts stuck or frozen closed.	Clean contacts or replace control.
	Refrigerated or air-conditioned space has excessive load or poor insulation.	Determine fault and correct.
	Evaporator coil iced.	Defrost.
	Restriction in refrigeration system.	Determine location and remove.
	Dirty condenser.	Clean condenser.
	Filter dirty.	Clean or replace.
Start capacitor open, shorted, or blown.	Relay contacts not operating properly.	Clean contacts, or replace relay if blown.
	Prolonged operation on start cycle due to-	Perform the following:
	Low voltage to unit.	Determine reason and correct.
	Improper relay.	Replace.
	Excessive short-cycling.	Determine reason for short-cycling and correct.
	Improper capacitor.	Determine correct size and replace.
Run capacitor open, shorted, or blown.	Improper capacitor.	Determine correct size and replace.
	Excessively high line voltage.	Determine reason and correct.

Troubleshooting Chart: Refrigerator (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Relay defective or burned out.	Incorrect relay.	Check and replace.
	Incorrect mounting angle.	Remount relay in correct position.
	Line voltage too high or too low.	Determine reason and correct.
	Excessive short-cycling.	Determine reason and correct.
	Relay being influenced by loose vibrating mounting.	Remount rigidly.
	Incorrect run capacitor.	Replace with proper capacitor.
Space temperature too high.	Control setting too high.	Reset control.
	Expansion valve too small.	Use larger valve.
	Cooling coils too small.	Add surface or replace.
	Inadequate air circulation.	Improve air movement.
Suction line frosted or sweating.	Expansion valve passing excess refrigerant, or valve is oversized.	Readjust valve or frosted or replace with smaller valve.
	Expansion valve stuck open.	Clean valve of foreign particles; replace if required.
	Evaporator fan not running.	Determine reason and correct.
	Overcharge of refrigerant.	Correct charge.
Liquid line frosted or sweating.	Restriction in dehydrate or strainer.	Replace part.
	Liquid shutoff partially closed.	Open valve fully.
Unit noisy.	Loose parts or mountings.	Find and tighten.
	Tubing rattle.	Re-form to be free of contact.
	Bent fan blade causing vibration.	Replace blade.
	Fan motor bearings worn.	Replace motor.

POTABLE WATER SYSTEM

FUNCTIONAL DESCRIPTION

The potable water system is an independent freshwater system designed to deliver potable water to selected areas in the barge. The following requirements are basic to a safe potable water distribution system:

- There are no cross-connections with nonpotable systems.
- Protection has been provided against back-siphonage, backflow, or leakage into any part of the system.
- No lead pipe, fittings, putty, or other lead-containing substances have been used in any part of the system.
- If any break, accidental or intentional, occurs in the system, all involved parts and lines must be disinfected and flushed before returning the system to use.
- The potable water pump must be airtight and free from cross-connections. Nonpotable water should never be used for priming pumps or maintaining packing gland seals.
- If the pump has been dismantled for repair, it must be disinfected and flushed after reassembly and before being returned to service. Refer to the following section for disinfection of potable water when installing a new system or part of a system.

The potable water system consists of the hydropneumatic tank, water pump assembly, and associated pressure switch for automatic system operation. The pump motor is energized through a motor controller. Its operation is controlled by the pressure switch which is actuated by the discharge pressure of the potable water pump.

DISINFECTION PROCEDURES

Potable water

Disinfection of water is required to destroy any pathogenic organisms present in a water supply.

Maintenance of a disinfecting residual is the usual method of guarding against sanitary defects or accidents that may occur during the production, handling, storage, and distribution of potable water. The absence of a free, available chlorine (FAC) residual in the barge's potable water may indicate contamination. The presence of a residual provides a safety factor but does not correct unsanitary practices or conditions. In potable water, FAC concentrations as high as 2.0 parts per million (ppm) usually do not cause objectionable tastes and odors. However, when certain organic substances are present, very small concentrations of combined chlorine can produce undesirable tastes and odors. These undesirable tastes and odors do not affect the safety of water if the chlorine residual is satisfactory.

A convenient proportion to remember is that 1 ounce of full-strength, Grade A calcium hypochlorite added to 5,000 gallons of water yields an approximate 1 ppm initial chlorine concentration. This "rule of thumb" (1 ounce per 5,000 gallons) becomes a tool in calculating dosages for chlorination and is suggested as a starting point only. The required amount will depend on temperature, pH, and the chlorine demand of the water.

> *NOTE:* The amount of chlorine in Grade A calcium hypochlorite is reduced rapidly by exposure to air. Therefore, all the contents should be used as soon as possible after opening the container.

Chlorination procedures are not adequate until the required FAC residual is obtained after the allotted contact time and the following requirements are satisfied:

- A measurable residual of at least 0.2 ppm FAC is maintained in all parts of the system.
- All water received from approved sources or manufactured on board will be chlorinated to provide at least 0.2 ppm FAC at the end of a 30-minute contact time.
- Water received from an unapproved source, a source of doubtful quality, or an area where amebiasis or infectious hepatitis is endemic will be chlorinated to provide at least a 2.0 ppm FAC residual at the end of a 30-minute contact time.

- Bacteriological examination of water will be done weekly, more frequently if required.

Ž Maintenance of minimum chlorine residuals will not replace bacteriological analysis as a true indication of potability.

Potable water pipes

Pipes to be used for potable water will be disinfected by a thorough flushing with potable water and filling with a solution of at least 100 ppm chlorine for at least 2 minutes. Fittings and connections will be immersed in a solution of at least 1,100 ppm chlorine before being connected. Before making a final connection, potable water pipes must be flushed to waste for 15 to 30 seconds.

Potable water pipes must not be used for any other purpose. If used for water from an unapproved source, the pipes must be disinfected. If contamination of a pipe is suspected, the pipe must not be used until it has been adequately disinfected.

Potable water tanks and systems

There are two types of disinfection procedures: mechanical cleaning with chemical disinfection and chemical disinfection only.

Mechanical cleaning of tanks includes all measures required to clean tanks of foreign materials, rust, and other solid matter present within the tanks.

Mechanical cleaning with chemical disinfection will be done when the condition of the tanks has deteriorated to the point where the chlorine demand has increased significantly and bacteriological evidence indicates that the tank has become grossly contaminated. After any tank has been mechanically cleaned, it will be chemically disinfected.

To chemically disinfect a system, the following steps are required:

Step 1. Introduce enough chemical into the tank to provide at least 100 ppm FAC.

Step 2. Fill tank with water.

Step 3. The chlorine residual after 4 hours of contact time will not be less than 50 ppm. It must be tested at hourly intervals to maintain the proper FAC residual. If at any time during this period the chlorine residual falls below 50 ppm, chlorine must be added to bring the residual to 100 ppm and the 4-hour period started again.

Step 4. All valves, lines, and hoses used to carry polluted water must be included in this process to disinfect the entire system.

Step 6. Water should be pumped out of the lowest opening in the tank, through the contaminated lines, pump, and valves, and returned to the tank.

If this highly chlorinated water must be retained for potable water, it can be dechlorinated with sodium thiosulfate (photographic fixer) or sodium busulfite. If all the chlorine in the water is removed during the dechlorination process, dechlorinate the water to the proper FAC residual to maintain the prescribed minimum residual.

If it is impossible, for emergency reasons, to disinfect a potable water tank as prescribed, the following emergency procedure may be used:

Step 1. Thoroughly clean and rinse tank.

Step 2. Swab all surfaces of the tank with a solution of 200 ppm chlorine.

Step 3. Allow to dry.

Step 4. Rinse with potable water, and the tank is ready for use.

This is strictly an emergency procedure and is not satisfactory for routine disinfection of potable water tanks. An FAC of at least 2,0 ppm must be maintained in water transported and stored in these in tanks.

OPERATION

These instructions are for normal priming and starting of the pump, pressurizing the tank, adjusting pressure switches, and establishing proper water level in the tank.

Priming and starting pump

The following steps are required to prime and start the pump:

Step 1. Open suction and discharge valves on pump.

Step 2. Fill pump discharge piping, and pump casing with water from approved source, through the drain line beneath the hydropneumatic tank. This will prime the pump. Pump may also be primed by removing the pipe plug from the top of the pump-discharge tee, filling piping and pump with potable water, and then replacing the pipe plug.

Step 3. Shut hydropneumatic tank-drain valve.

Step 4. Open hydropnuematic tank inlet-and-outlet valve (single valve) at the bottom of the tank.

Step 6. Start pump motor:

- Close appropriate 15-ampere circuit breaker at power panel (P-104).
- Switch associated motor controller to ON; pump will start running and pick up its prime.

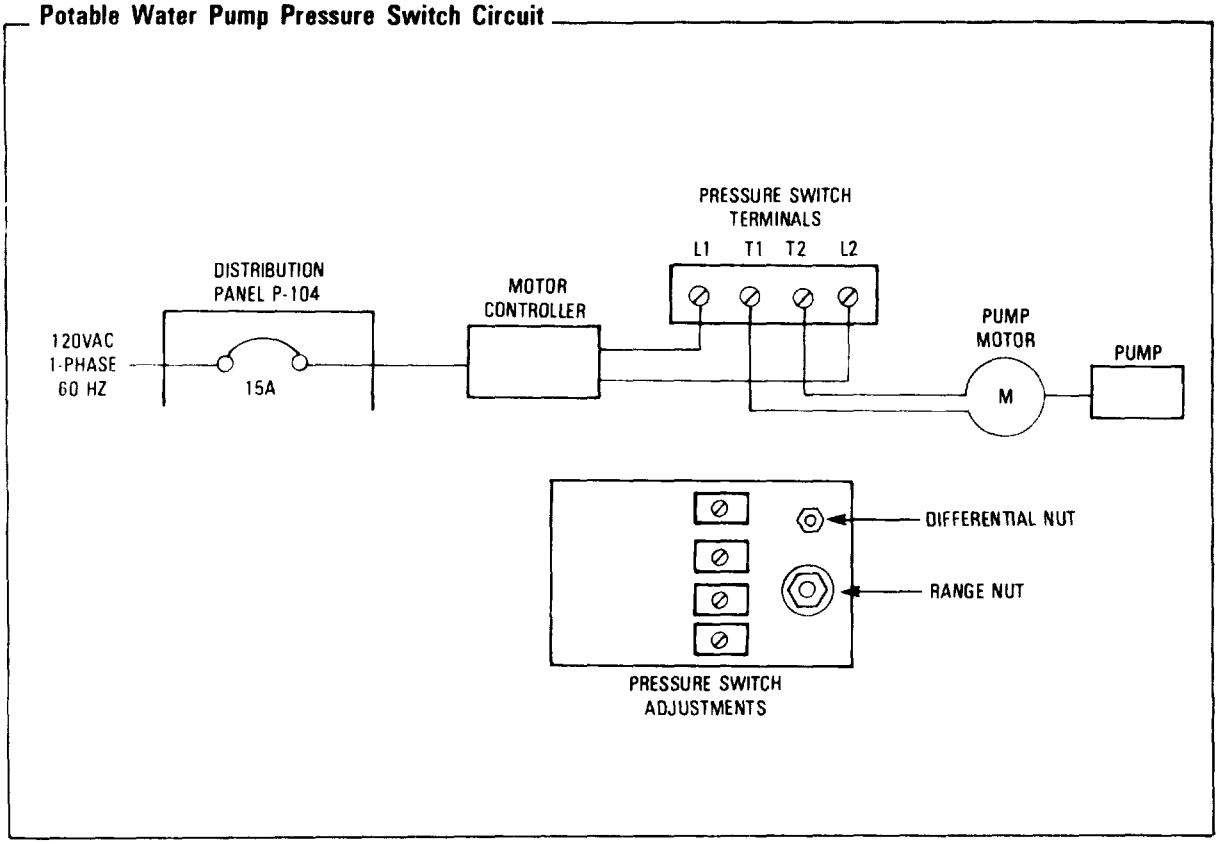
Pressurizing hydropneumatic tank

After the system is properly installed, pressurize the tank as follows:

Step 1. Startup the potable water pump and allow tank to fill; check pressure gage as tank fills. Pump should stop at 40 psi. Note the actual pump cutout pressure and proceed to Step 2.

Step 2. Verify system operation by opening faucet in system and allowing pressure to decrease. Pump should start at 20 psi. Note the actual pump cut-in pressure.

Potable Water Pump Pressure Switch Circuit



Step 3. If the pump does not cut in or cut out at the correct pressures, adjust the pressure switch as required.

Adjusting pressure switches

Adjustments to the pressure switches consists of pressure-range adjustment for pump cut-in and pressure-differential adjustment for pump cutout. Make appropriate adjustments as follows:

- If pump cut-in occurs at a pressure other than 20 psi, turn the range nut for 20-psi cut-in pressure as read on the pressure gage. Turn down for higher cut-in or up for lower cut-in.
- If the difference between the actual pump cut-in and cutout pressures is not 20 psi, turn the differential nut for 20-psi differential-pressure cutout (pressure gage reads 40 psi). Turn nut down for higher cutout pressure or up for lower cutout.
- Check pump operation. Open a faucet in the system until pressure drops to 20 psi. Pump should start, filling the tank until 40 psi registers on the pressure gage, and then stop. Reset pressure switch if pump operates improperly.

Establishing tank water level

When tank is pressurized to 40 psi, water level should be visible in top 5 inches of sight glass just after pump shuts off. If water is not at proper level, take the following steps:

- If the water level is too high, attach section of water hose to tank drain valve to drain water. Open tank drain valve until water level is below 2 inches from top of sight glass. Close tank drain valve, and continue with steps to correct low-water level.
- If the water level is low, lift hydropneumatic tank relief valve by hand to lower pressure to 20 psi. Pump will start again and raise level of water until 40 psi is reached. Repeat this step until water level is visible in top 2 inches of sight glass just after the pump shuts Off.

Draining tank

If for any reason the tank needs draining, proceed as follows:

Step 1. Release pressure in system by draining at tank drain valve. Connect a section of water hose to the drain valve to assist in draining water.

Step 2. Disconnect pressure and delivery pipes for complete drainage.

Step 3. Remove drain plug from pump case.

MAINTENANCE

Inspect the motor at regular intervals, keeping it clean and dry. Occasionally blow or vacuum the dust out of the windings and ventilating openings.

After three years of normal use or one year of heavy-duty service, oil sleeve bearing annually. No re-oiling is required on light-duty applications with a total operating time under 25,000 hours. Use electric motor or SAE 20W oil.

For the ball bearing, relubricate every 10 years of normal service using GE D6A2C13 ball bearing grease or equivalent. This is for approximately 12 hours per day operating time at an average ambient temperature of 30°C (86°F).

NOTE: Excess oil or grease is harmful. **Do not** over-oil or over-grease the motor bearings.

Relubricate every five years for either of the following:

- Operating time up to 24 hours per day and an average ambient temperature of 86°F.
- Operating time up to 12 hours per day and an ambient temperature not to exceed 104°F.

The following troubleshooting charts list the troubles that may occur when operating the potable water system, the probable causes, and remedies.

Troubleshooting Chart: Potable Water Pump

SYMPTOM	PROBABLE CAUSE AND REMEDY
Pump does not prime.	Stop motor, remove priming plug, and add water to case until full. Check suction line for leaks, high spots, or low spots. Pump shaft must turn clockwise when viewed from motor end opposite shaft. Check for plugged venturi tube.
Pump delivers water for a period, then stops.	Check for plugged or worn venturi tube. Check for plugged impeller parts
Tank becomes waterlogged.	Drain tank and restart pump. Check all connections in tank for air leaks.
Pump does not deliver rated capacity.	Check venturi tube for partial plugging or wear. With pump going, check suction lift using vacuum gage in suction line at pump. Vacuum gage reads total suction lift at this point, All capacity ratings are based on total suction lift. Check pressure gage; it may be defective, resulting in false readings.

Troubleshooting Chart: Pump Motor

SYMPTOM	PROBABLE CAUSE	REMEDY
Motor won't start.	Loss of power.	Check fuses; reset thermal overload protector.
	Open connection.	Check for broken wiring, improper connection.
Motor hums, but fails to start.	Excessive overload.	Check for equipment jamming, clogging, or freezing.
	Grounded windings.	Check starting and running windings for grounds.
	Switch contacts not closing.	Check switch operation.
Motor fails to accelerate normal load to running speed	Starting winding remains in circuit.	Switch contact points may be stuck together. Switch actuator may be defective.
Motor starts and accelerates load, but is rough, noisy, and draws very high current (motor not switching out starting capacitor)	Faulty rotating switch actuator.	Check centrifugal mechanism operation.
	Faulty switch.	Check centrifugal mechanism operation.

Troubleshooting Chart Pump Motor (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Motor starts properly but will not come up to full speed. Motor speed cycles between the switch dropout and cut-in speeds.	Switching speed too low because of faulty or improperly located rotating switch actuator.	Check operation and location of centrifugal mechanism.
Bearing overheating.	Improper lubrication.	Relubricate motor.
	Worn bearings.	Inspect bearings; replace if required.
Vibration.	Misalignment with equipment.	Check alignment of motor with equipment, realign if required.
	Possible overload.	Check to see that load is not excessive; if so, reduce load.

COLLECT, HOLD, AND TRANSFER SYSTEM

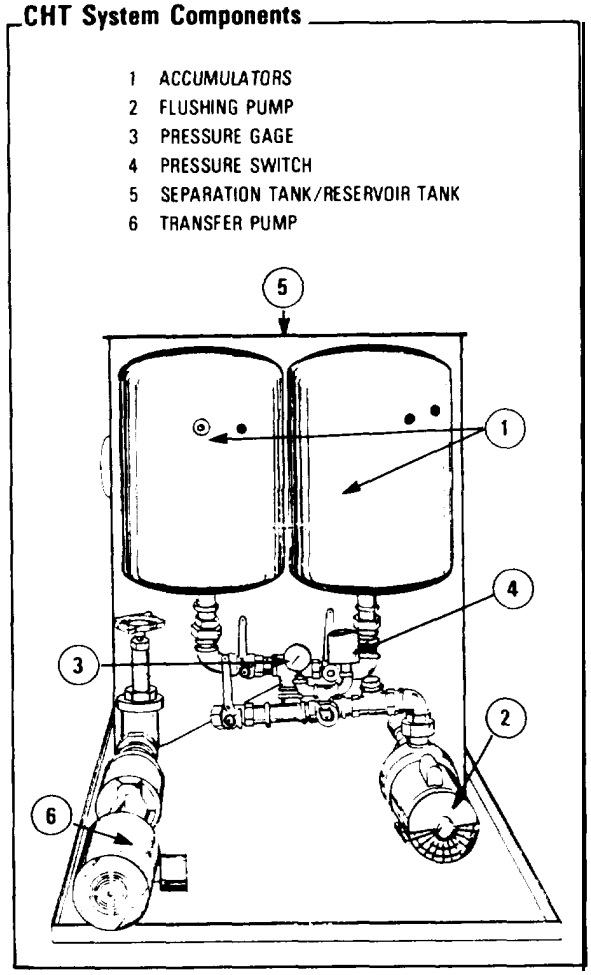
SPECIFICATIONS

The CHT system is basically designed for the crew's toilet. It consists of the required piping, pumps, tanks, and valves required to collect and hold raw sewage and human waste for transfer to shore-based facilities, thus reducing the pollution of port and harbor waters.

The CHT system uses a special inert, nonreactive mineral oil as the flushing vehicle to transport waste from the commode to the separation tank. The waste naturally settles to the bottom of the tank, and the flushing oil rises, passing through a purification system into a reservoir from which it is pumped, upon demand, back to the commode. When the flushing oil is returned to the commode for flushing, it is crystal clear, contains zero bacteria, and has a slight chlorine odor. When the waste in the separation tank reaches a certain level, as observed in the sight window, it is transferred to a holding tank for storage until removal to a shoreside facility.

The following figure shows the major components of the CHT system except for the short discharge pump, aeration blower, and holding tank. The following table gives detailed equipment data.

CHT System Components



CHT System Data

Transfer Pump

Motor:
- Power requirements 240-VAC, 3-phase, 60-Hz
- Rotation ..... 1,725 RPM
- Current ..... 4.1 amp
- Power output ..... 1 HP

Capacity ..... 35 GPM

Flushing Pump

Motor:
- Power requirements 240-VAC, 1-phase, 60-Hz
- Rotation ..... 3,450 RPM
- Current ..... 6.5 amp
- Power output ..... 1 HP

Capacity ..... 45 GPM

Shore Discharge Pump

Motor:
- Power requirements 240-VAC, 3-phase, 60-Hz
- Rotation ..... 1,725 RPM
- Current ..... 4.4 amp
- Power output ..... 1 HP

Capacity ..... 35 GPM

Aeration Blower

Motor:
- Power requirements 240-VAC, 3-phase, 60-Hz
- Rotation ..... 3,450 RPM
- Current ..... 4 amp
- Power output ..... 1.5 HP

Unit size ..... 14 5/16 inches high, 14 1/2 inches wide

Weight ..... 80 lb

Airflow ..... 110 CFM @ open (no restriction), 45 CFM @ 50 inches water pressure, 60 CFM @ 60 inches water pressure

FUNCTIONAL DESCRIPTION

The operation of the CHT system is automatic except for the operation of the waste-transfer pump, the shore-discharge pump, and the aeration blower. The following figure diagrams the operation of the system components.

When the commode in the crew's quarters is flushed, flushing oil under pressure goes from the accumulators to the commode. This lowers the pressure in the accumulators. The reduced pressure actuates the pressure switch to start the flushing pump, which transfers more flushing oil from the oil reservoir to the accumulators. The pump starts when the pressure has dropped to 30 psi and stops when the pressure reaches 45 psi.

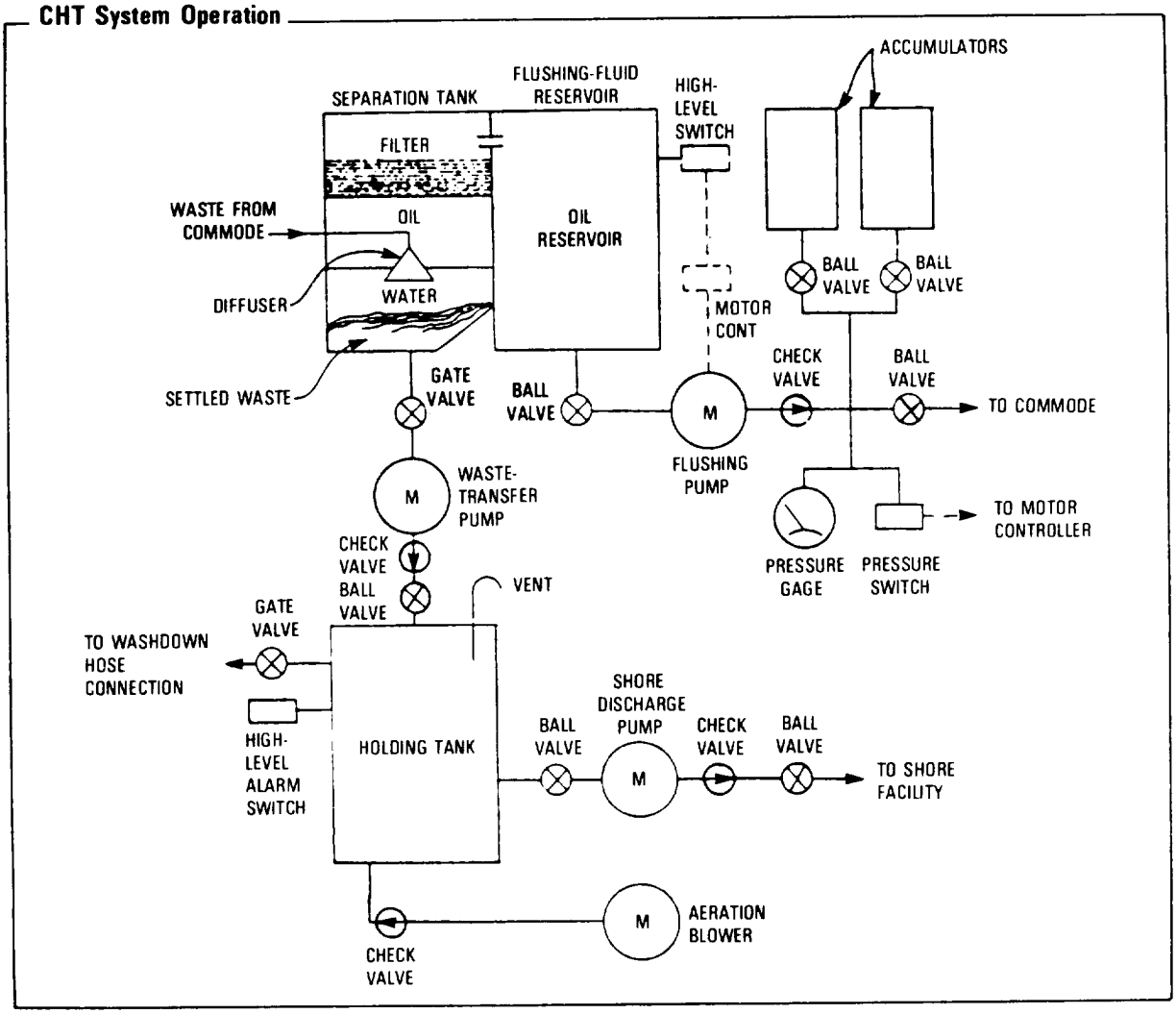
Waste material is flushed from the commode into a separation tank where the waste solids and liquids are separated. The aqueous and solid wastes settle to the bottom of the tank, and the flushing oil rises through purification chemicals and filters. The purified flushing oil spills over from the separation tank into the reservoir tank where it is stored. A level switch is located in the reservoir. When the flushing oil reaches the level switch, the flushing pump is deactivated through the motor controller and a red indicator lights in the toilet space.

The separator side of the tank assembly has two transparent windows to permit observation inside the tank. When waste material has accumulated to a high level, the transfer pump must be manually operated to pump the waste material into the holding tank. The waste material is then macerated by grinders in the pump while being pumped into a holding tank. The holding tank has a capacity of about 500 gallons.

An aeration blower, located in the aft port comer of the CHT room, furnishes a stream of up to 100 CFM of air to a diffuser located in the lower portion of the holding tank. Air is released through openings in the diffuser. The air bubbles through the accumulated waste material in the holding tank, constantly stirring the waste material and releasing accumulated gases. The gases are vented to the atmosphere through a 2-inch pipe that extends beyond the top of the engine room.

The holding tank has a level switch located about 8 1/2 inches above the centerline to monitor the high level of the waste material. When the waste material accumulates to the height of the level switch, an alarm is triggered. A bell is sounded in the CHT room, and a red indicator will light in the CHT room. The shore discharge pump must be manually turned on. The waste matter is then discharged through a 1 1/2-inch pipe, either to a shore holding facility or sewer system.

CHT System Operation



The pumps are motor-driven. Each pump operation is controlled by a motor controller through which power is applied to the motor. For the aeration blower, motor operation requires the pressing of an ON-OFF switch on the controller. The flushing pump operation is controlled automatically by a pressure switch wired into the motor-controller control circuit. The shore-discharge pump motor operation requires the pressing of START-STOP push buttons located at a push-button station on the main deck. This push-button station is wired into the control circuit in the shore-discharge pump motor controller. There are no START-STOP push buttons on the motor controller itself. The motor controller for the waste transfer pump has only a single START button. The transfer pump will operate so long as the START button is held down and will stop when the button is released.

All motor controllers for the CHT system provide low-voltage protection or low-voltage release and overload features. When either a low-line voltage or current overload is sensed, the motor controller will automatically shut off the power to the motor. Refer to Chapter 4 for the functional description of the motor controllers.

Nonautomatic system components

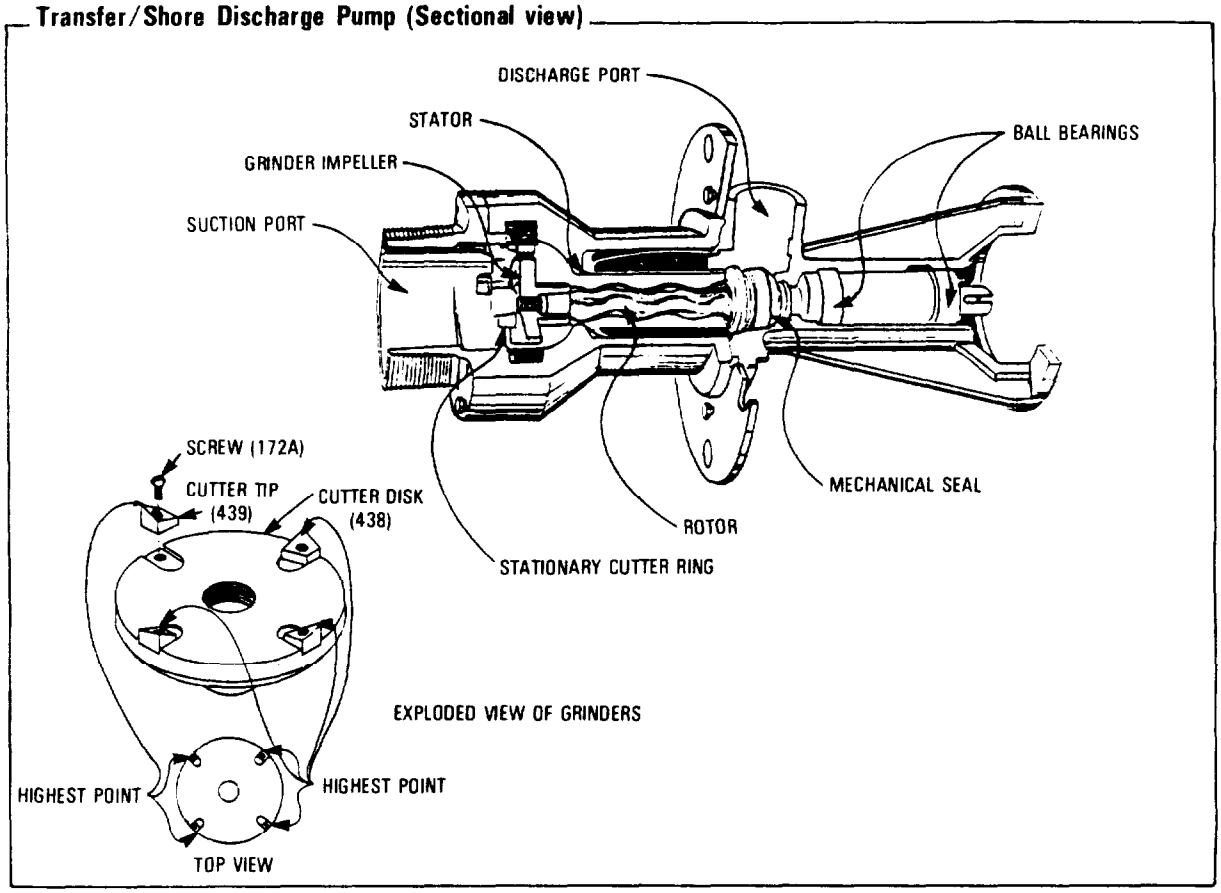
The operation of the *waste-transfer pump* is controlled by a motor controller which has START and RESET push buttons, but no STOP push button. The pump is started by pushing the START button and runs so long as the button is held down. Releasing the START button will stop the pump. RESET is described below.

The START-STOP operation of the *shore-discharge pump* is controlled by a main-deck push-button station that is wired into the motor-controller control circuit. Momentarily depressing the START button starts the pump; depressing the STOP button stops the pump. The only button located on the motor controller itself is the RESET button. RESET is described below.

The operation of the *aeration blower* is controlled by a motor controller having an ON-OFF switch. Pushing the switch to ON starts the blower; pushing the switch to OFF stops the blower. "Reset" is accomplished after an overload condition by pushing the ON-OFF switch to the extreme off position.

All the CHT system motor controllers provide *low voltage and current overload protection.* When either a low-line voltage or current-overload condition occurs, the magnetic contactor in the motor controller is de-energized, shutting off the power to the motor. After the faulty condition is remedied, the controller must be reset manually by depressing the RESET button. A 1- or 2-minute cooling period should be allowed before resetting after an overload condition. The motor can then be restarted by pressing the START button.

Transfer/Shore Discharge Pump (Sectional view)



Initial start-up

Before starting the system for the first time, or after it has been out of service for a period, perform the following steps:

Step 1. Install coalescer pad (fiber side down, mesh side up) on top of expanded metal rack in separation tank. Loosely fill polypropylene sack with activated carbon. Seal opening and place on top of coalescer pad, making a snug fit all around. Empty contents of one container of chlorine pellets on top of carbon pillow. Finally, place second coalescer pad on top of chlorine pellets.

Step 2. Make certain all valves are shut.

Step 3. Pour about 5 gallons of fresh water into separation tank (waste side), either directly or through the commode.

Step 4. Fill remainder of separation tank and about three-fourths of reservoir tank with flush fluid.

Step 5. Open valve on reservoir tank leading to a flushing pump.

Step 6. Check to see that pressure in accumulators is 30 psi, and open isolation valves on accumulators. NOTE: As labeled, the accumulators should have been factory-pressurized to 30 psi and the pressure switch set to start the flushing pump at 30 psi when power is applied to the motor.

Step 7. Adjust pressure switch so that pump shuts off at about 45 psi and restarts at about 30 psi.

Step 8. Open valve leading to commode.

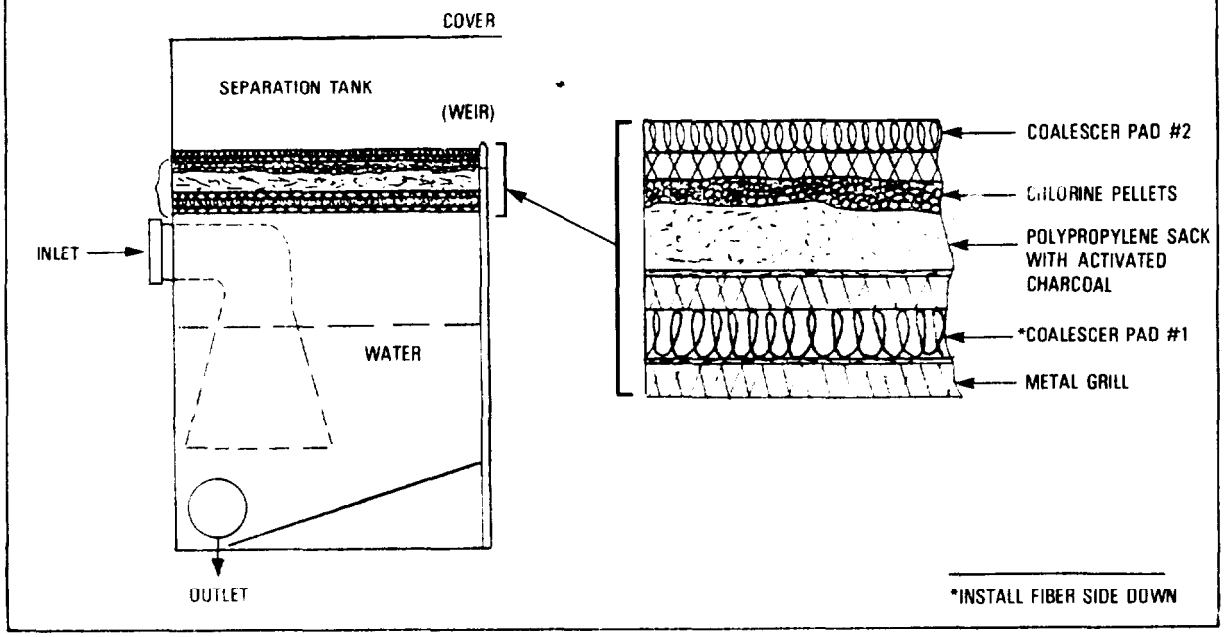
Step 9. Flush commode and check for normal flush.

Step 10. Open waste outlet valve at bottom of separation tank leading to waste-transfer pump suction.

Step 11. Open valve leading from waste-transfer pump to holding tank.

Step 12. Operate waste-transfer pump by pushing the START button and holding it down unti waste level (water initially) in separation tank falls to bottom of sight glass; release the button to stop the pump.

Purification Filters in Separation Tank



Special operations

When the high-level switch in the reservoir is activated because of high liquid level in the separation tank, a red indicator lights in the toilet space, a bell and red light are activated in the CHT room, and the flushing pump is disabled through the motor controller. Operation of the flushing pump is prevented until waste is transferred from the separation tank into the holding tank.

To transfer waste from the separation tank to the holding tank, perform the following steps:

Step 1. open valve in separation tank outlet.

Step 2. Open valve between waste-transfer pump and holding tank.

Step 3. Operate waste-transfer pump by pushing START button and holding it down. Pump will operate so long as button is held down.

Step 4. Check waste level in sight glass of separation tank. When waste level is at bottom of sight glass, release START button.

The aeration blower should run whenever there is waste material in the holding tank. When transferring waste from the holding tank to overboard, comply with all current national, state, and local antipollution regulations. To make this transfer of waste, carry cut the following steps:

Step 1. Connect flushing hose to the flushing connection on top of the holding tank.

Step 2. Connect the overboard-discharge hose to the overboard-discharge connection located on the main deck.

Step 3. Open the shore-discharge pump suction valve.

Step 4. Open the shore-discharge pump discharge valve. The shore-discharge pump can be operated only from the push-button station adjacent to overboard hose connection on weather deck.

Step 5. Open valve-to-shore connection.

Step 6. Start shore-discharge pump by depressing the START button at the deck push-button station.

Step 7. Open valves for flushing water when tank is empty.

Step 8. Shut flushing water valves when waste from overboard-discharge hose runs clean.

Step 9. Stop shore-discharge pump by depressing the STOP button at the deck push-button station.

Step 10. Shut shore-discharge pump suction and discharge valves.

Step 11. Shut shore-discharge pump suction and discharge valves.

Step 12. Remove flushing hose and overboard-discharge hose.

OPERATIONAL AND SAFETY PRECAUTIONS

The CHT system depends upon rapid separation of waste from the flush fluid. Any waste containing emulsifiers, detergents, soap, solvents, or certain other chemicals may inhibit the separation process. Therefore, these materials should not be placed in the system.

Personnel performing operation or maintenance procedures on the system will wear rubber gloves to avoid direct contact with parts contaminated by human waste. Hands will be washed with germicidal soap after removing gloves.

Care should be taken in handling chlorine pellets, which are very strong oxidizing agents.

All involved personnel should be thoroughly familiar with the following potential hazards and safety precautions before performing operational or maintenance procedures.

Potential Hazards and Safety Precautions

HAZARD	CAUSE	REMEDY
Bacterial or viral contamination.	System parts contaminated with organisms from human waste.	Wear rubber gloves and avoid skin contact when working on internal parts of system. Wash hands with germicidal soap after removing gloves.
Slipping or falling.	Flushing oil on deck.	Clean up spills with absorptive sweeping compound or strong detergent.
Electrical shock.	Exposed conductors during repairs.	Turn off electrical power before attempting repairs.
System nonoperational (commodes won't flush].	Flush fluid in reservoir has reached high level and has activated safety-level switch, shutting power off to flush-fluid pressure pump.	Activate switch to sewage transfer pump until waste level in separation tank returns to low-level mark. Flush fluid in reservoir will automatically retrurn to normal level through check valve between reservoir and waste side of tank.
External fire (fed by flush fluid).	Burning of system hoses would dump flush fluid into external fire.	Use extinguishers rated for Class B oil fire. (As a precaution, allow no fire hazards to exist in the area.)
Chlorine compounds (vapor and oxidation).	Activation of chlorine sanitizer results in harmful fumes and a strongly corrosive liquid.	Maintain adequate ventilation in area. Avoid breathing fumes. Handle activated liquid with care.

MAINTENANCE

Preventive maintenance

The entire system should be inspected at least once daily, checking the following:

- Waste level in separation tank.
- Flush-fluid pressure.
- Ž General condition of system and sign of leakage.

Avoid pouring detergents, soaps, emulsifying agents, or other chemicals into the system, as they can adversely affect separation of flush fluid from waste.

Waste must be transferred to the holding tank as required to maintain waste levels in the separation tank (high level when waste reaches top of sight window, low level when waste is at bottom of sight window).

If flush fluid becomes cloudy or develops any odor other than chlorine, the carbon pillow and/or chlorine pellets should be replaced. This is done by lifting out the bag containing activated carbon from the separation tank and replacing it with a new carbon pillow and chlorine pellets.

Because of spillage, flush fluid may occasionally have to be replenished. This can be done by adding flush fluid, as required, through a commode or directly into the separation tank or reservoir. Nominal level in reservoir should be about 12 inches below the weir (see the figure showing the purification filters in the separation tank).

Toilet bowls should be cleaned, as required, with a brush and solution of one part laundry bleach to four parts water. Flushing fluid spilled on the deck or toilet seats can be removed using either the diluted bleach solution described above or laundry detergent

The pumps and motors of the CHT system are permanently lubricated at the factory and do not require lubrication in normal operation.

The aeration blower also does not require lubrication. Sealed bearings are greased for life and are isolated from air path. Delivered air is completely oil-free. Care must be taken to ensure that air passing through the unit is clean and free from foreign material that could lodge between the impeller and housing.

Corrective maintenance

The following troubleshooting chart gives remedies for malfunction of the pumps and grinders of the CHT system.

Troubleshooting Chart: CHT System Pumps and Grinders

SYMPTOM	PROBABLE CAUSE	REMEDY
Pump will not start.	Motor shaft turns, pump shaft will not.	Check key, collar, screw. Adjust if required.
	Stator winding damaged.	Possibly excessive pressure. Replace stator Check pressure at discharge port.
	Wrong rotation.	Rotation must be clockwise when facing shaft. Reverse power leads at motor terminal strip, or any two leads if 3-phase powered.
	Threads in rotor or on shaft stripped.	Replace part. Check for proper rotation.
	Drive shaft broken at rotor connection.	Possibly excessive pressure. Replace parts.
	Excessive suction lift or vacuum.	Check pressure at discharge port.
Motor will not start.	Low voltage.	Check power supply and wiring.
	Faulty motor.	Replace or repair.
	Grinder section jammed.	Rotate drive shaft counterclockwise one quarter turn to unjam cutters. If pump still will not start, check grinder section for jammed material and remove.
Noisy operation.	Starved suction.	Check fluid level, size of piping, and obstructions in pipe.
	Bearings worm.	Replace parts.
	Insufficient mounting.	Mount securely, Reduce vibration-induced noise by using a short section of hose on discharge piping.
	Cutter disk contacts stationary cutter ring.	Refer to grinder-orientated problem below.

Troubleshooting Chart CHT System Pumps and Grinders (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Seal leakage.	Leakage at start-up.	If leakage is slight, allow pump to run several hours to let faces run in.
	Persistent seal leakage.	Faces may be cracked from freezing or thermal shock. Replace seal.
Grinder-associated problems.	Grinder will not grind.	Check for proper rotation. Check condition of cutter tips and cutter ring, replace as required.
		Cutter ring may be inverted to provide sharp cutting edge.
	Cutter disk interferes with stationary cutter ring.	Check location of cutter ring; adjust as required. Check cutter tips for position; reposition as required. Check for bent shaft. Replace shaft, adjust cutter section, and check pressure at discharge port.

CHAPTER 6

MISCELLANEOUS EQUIPMENT

This chapter describes the function, operation, and maintenance of those miscellaneous items of equipment that have been installed aboard the-crane under the modernization program,

RAW WATER PUMP

SPECIFICATIONS

Two raw water pumps are used for cooling the two main DC generator engines during operation, one pump for each engine. The following table gives detailed pump data.

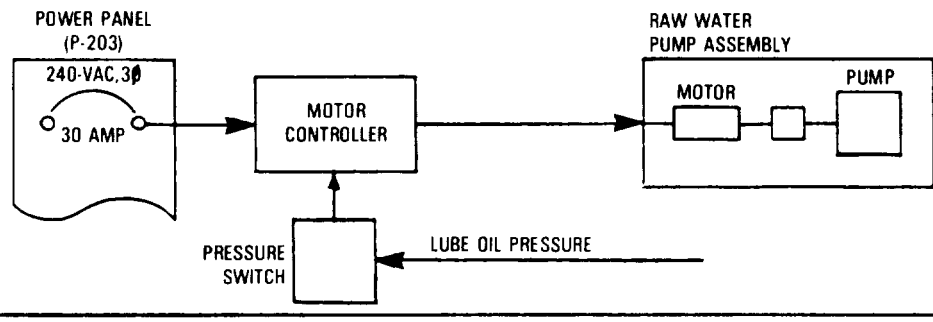
Raw Water Pump Data

Pump:		Motor:	
Type	PH-201	Power output	1 HP
Class	50	Power requirements	240-VAC, 3-phase, 60-Hz
Size	1 1/2 x 3 x 6	Current requirements	3.8 amp
Pressure	200 psi @ 100°F	Operating speed	1,140 RPM
Impeller diameter	6 inches	Coupling	T.B. Woods Son, Sureflex No 5
Capacity	80 GPM @ 12 ft TDH	Unit size	35 inches long, 10 1/4 inches wide, wide and 14 inches high

FUNCTIONAL DESCRIPTION

The raw water pump motor is energized through a motor controller. Its operation is controlled by a pressure switch actuated by the main engine lube oil pressure. The motor controller is equipped with a magnetic starter which, when energized, supplies 240-VAC, 3-phase power to the pump motor through the pressure switch when closed. The power is applied through a 30-ampere circuit breaker on the engine room, 240-VAC-load center panel (P-203) located in the engine room. With the circuit breaker closed, the pump motor will start as soon as the main engine lube oil pressure switch exceeds 3 psi. Another pressure switch is used to monitor the pump discharge line. If the pump should stop delivering cooling water to the main engine, this switch will close, supplying voltage to the main engine alarm circuit to initiate the alarm and sound the horn. See the following illustration.

Simplified Wiring Diagram for Raw Water Pump



When starting the pump for the first time, follow this procedure:

Step 1. Turn the pump by hand to make sure it is free. Tightness may indicate trouble in packing, pipe crimp, or misalignment between motor and pump.

Step 2. Check coupling for correct alignment between motor and pump.

Step 3. Open suction and discharge valves. The discharge valve should be opened just slightly for starting, then opened entirely.

Step 4. To check for correct pump rotation, apply power to unit momentarily, allowing motor to turn over a few times. The arrow on the side of the pump casing shows direction of rotation. If rotation direction is incorrect, change wiring connections (reverse any two phases) and recheck rotation.

Step 6. Be sure that the DC generator associated with the raw water pump to be checked is running. The pressure switch will not close otherwise.

Step 6. Prime pump in one of three ways:

- Connect an exhauster to the discharge pipe between the pump and discharge shutoff valve. With the discharge shutoff valve closed and suction valve open, the air can be exhausted from the pump and pipe.
- Install a foot valve in suction piping; the pump can be filled with water introduced somewhere in the pump's discharge line.
- Use a vacuum pump for evacuating air from pump and piping. The vacuum pump should be connected in the same way as the exhauster.

Step 7. With correct pump rotation established and pump properly filled with liquid, close the raw water pump circuit breaker on the engine room, 240-VAC-load center panel (P-203). The pump will start running if the lube oil pressure switch is closed.

MAINTENANCE

Preventive maintenance

To prolong the sleeve life on the pump shaft, the packing on a pump shaft must be properly installed and maintained. All packing must be allowed to leak. This leakage is the only lubrication for the packing. It also reduces some of the frictional heat built up between the shaft sleeve and the packing. Insufficient leakage will shorten the life of both the packing and shaft sleeve, as well as increase power consumption of the pumping unit. It is entirely possible to stall a centrifugal pump by clamping the packing gland down.

The ball-type radial and thrust bearings in the pump are lubricated with oil contained in the sump of the bearing housing. The oil level is controlled by an adjustable constant-level oiler.

The top of the bearing housing is fitted with a vent plug to provide the required ventilation. The bearing housing may be filled through the opening when this vent plug is removed, but extreme care must be taken to prevent overfilling.

To lubricate the bearing housing of the pump, use a good grade of rust- and oxidation-inhibiting, nonfoaming oil, SAE 20W. Carry out the following steps:

Step 1. Fill housing only until the oil appears in the very bottom of the base of the constant-level oiler when the oiler reservoir cup is removed. Do not fill above this level.

Step 2. Replace the bearing housing vent plug.

Step 3. Fill the oiler reservoir cup and put it in place; the oil will bubble slowly into the bearing housing until the proper level is attained.

Step 4. Remove the oiler reservoir cup and, after refilling it, put it back in place. Thereafter, the oil level will remain constant so long as some oil remains in the reservoir cup.

Step 5. To maintain the oil level between oil changes, fill the oiler reservoir cup.

The oil in the pump bearing housing should be drained and replaced at regular intervals. The intervals depend on the atmospheric conditions (such as dust, soot, corrosive vapors, humidity, and temperature variations) pre-

vailing at the pump installation site. The bearing housing should be flushed with a good solvent before the oil is replaced.

Inspect the pump motor at regular intervals, keeping it clean and dry. Occasionally blow or vacuum the dust and dirt out of the windings and ventilating openings.

Being a ball bearing motor, the bearings have been lubricated at the factory. No lubrication is required at start-up. The motor should be relubed every five years if running approximately 5,000 hours per year. Use high-quality ball bearing grease with a consistency suitable for class of insulation stamped on nameplate.

Observe the following precautions during maintenance on the pump motor:

- Keep the grease clean.
- Lubricate the motor at standstill.
- Remove and replace plugs at standstill.
- Do not mix petroleum grease and silicon grease in the motor bearings.

Corrective maintenance

The following troubleshooting chart will assist in maintenance problems on the raw water pump and its motor.

Troubleshooting Chart: Raw Water Pump Assembly

SYMPTOM	PROBABLE CAUSE/REMEDY
Failure to deliver water.	Not up to speed.
	Pump not primed.
	Discharge head beyond pump's shutoff head.
	Excessive suction lift; check with vacuum gage.
	Incorrect direction of rotation.
	Clogged suction line.
	No engine lube oil pressure.
	Pressure switch inoperative.
	Improper settings on pressure switch.
	Closed suction/discharge valve.
Reduced capacity.	Speed too low.
	Air leak in suction line or through stuffing box.
	Total head higher than for which pump was intended.
	Excessive suction lift; check with vacuum gage.
	Mechanical trouble such as damage to impeller or heads or insufficient or defective packing.
	Partly clogged suction line.

Troubleshooting Chart: Raw Water Pump Assembly (Continued)

SYMPTOM	PROBABLE CAUSE/REMEDY
Reduced pressure.	Speed too low. Air in water. Mechanical trouble such as damage to impeller or heads or insufficient or defective packing.
Pump loses prime after starting.	Leaky suction line. leak through pecking. Excessive suction lift.
Overload on motor.	Speed higher than rated. Total heed higher then rating. Liquid handled of different specific gravity or viscosity than intended for pump. Mechanical trouble of pump or motor. Packing gland too tight or packed with improper packing.
Pump vibrates or is noisy.	Misalignment. Insufficient or insecure foundation. Mechanical defects such as bent shaft, binding rotating element or worn bearings. Strain due to piping not being properly lined up or supported.
Motor won't start (no hum).	Loss of power: check fuses; reset thermal overload protector. Open connection: check for broken wiring improper connation. Pressure switch inoperative: replace pressure switch. Pressure switch sat incorrectly: reset pressure switch.
Motors hums, but fails to start.	Excessive overload: check for equipment jams, clogging, or freezing. Open in starting circuit: check rotary switch operation. Open in running circuit: check winding continuity, Grounded windings: check starting and running windings for grounds.
Motor fails to accelerate normal load to running speed.	Starting winding remains in circuit: Check for contact points stuck together.

Troubleshooting Chart: Raw Water Pump Assembly (Continued)

SYMPTOM	PROBABLE CAUSE/REMEDY
Motor bearing overheating.	Improper lubrication relubricate motor or possibly too much lubrication. Worn bearings: inspect bearings and replace if required.
Motor vibration.	Misalignment with equipment: check alignment of motor with equipment and realign if required.

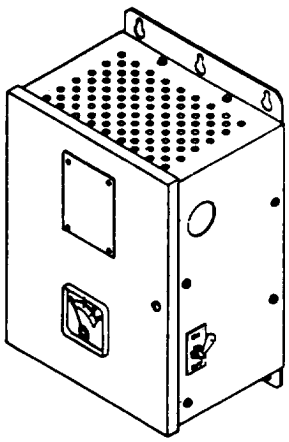
BATTERY CHARGER

SPECIFICATIONS

The battery charger is used to charge the 24-volt battery banks (two 12-volt batteries in series) used to start and run the diesel engines. One battery bank is used for each engine. The charger is designed to work in conjunction with a pair of control relays (one for each battery bank). These will allow the battery bank to be charged by the charger when the diesel engine is not running and to be charged by the engine alternator while the engine is running. The following table and illustration give detailed data on the battery charger.

Battery Charger Data

Power requirements 120-VAC, 1-phase, 60-Hz
Battery charge .....24 volts
Voltage output per cell .....2.33 VDC
Size .....14 inches high, 13 inches wide, and 10 inches deep.



FUNCTIONAL DESCRIPTION

The charger has four basic components: transformer, saturable reactor, silicon rectifiers, and control unit. The transformer transforms the incoming AC voltage to the required level to charge the battery. It also isolates the incoming power from the output The saturable reactor regul ates the power output of the transformer continuously over the charge cycle. The rectifier sticks are made up of silicon diodes connected in a full-wave, center-tap configuration. These silicon diodes rectify the secondary AC power to DC power. The control unit senses the condition of the battery and controls the reactor that, in turn, regulates the power output of the transformer.

The charger has a specially designed transformer-reactor combination that inherently compensates for variations in the incoming AC power. The impedance balance of the transformer-reactor comb nation compensates for a line voltage variation of ±10 percent of the nominal AC voltage.

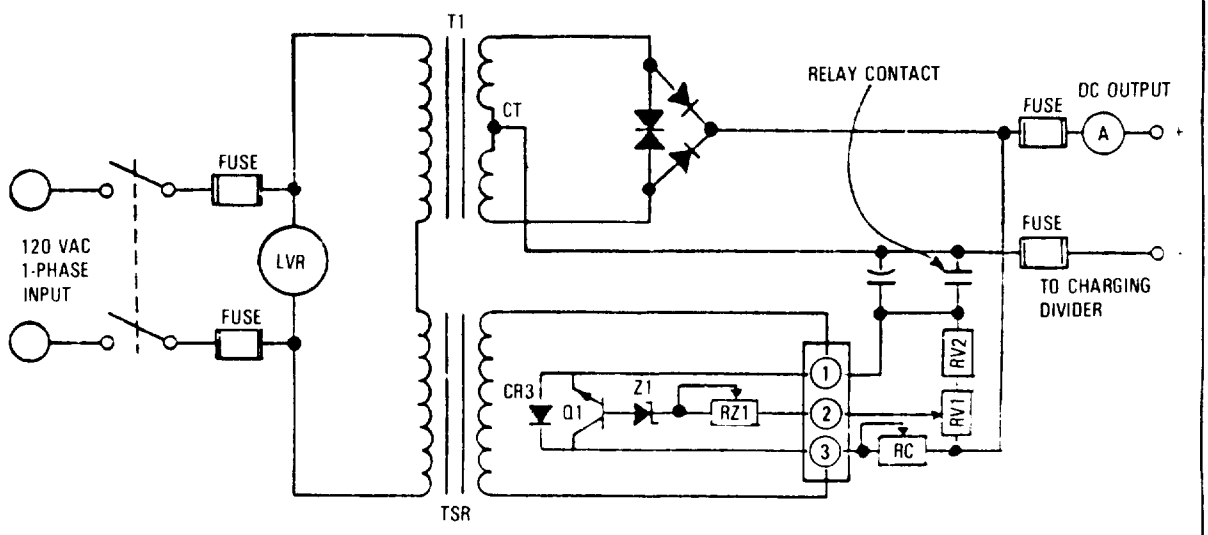
The charger will charge to its maximum current capacity and begin to current-limit if overloaded. The automatic current limiter controls the output of the charger to a maximum of 140 percent of the rated load The saturating current resistor is preset and factory-adjusted to the required current limit. The current limiting is accomplished by limiting the saturating current to the reactor, thus controlling the output of the unit.

To understand better how the automatic charge control operates, refer to the following

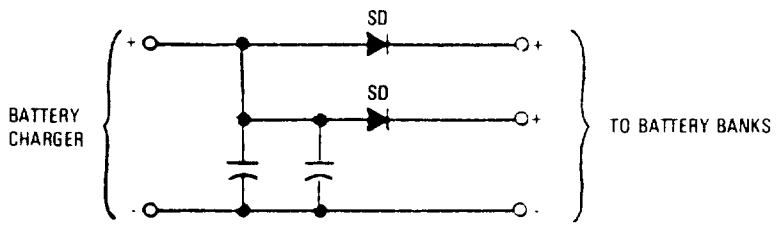
schematic diagram. The charge rate is completely controlled by the transformer-saturable reactor (TSR) and the sensing control. The battery voltage is sensed by the zener diode (Z1) (refer to the following paragraph). This diode conducts into the base of the transistor (Q1), and the transistor operates to shunt the saturating coil of the reactor (TSR). When the battery is discharged, the battery voltage is low and the reactor (TSR) saturating coil saturates the reactor. The impedance change of the reactor, due to the core saturating, shifts more voltage to the primary of the transformer (T1), which increases the induced voltage in the secon - dary of the transformer. This thereby increases the charge rate to maximum-rated output. When the battery voltage reaches its charge voltage, the control begins to operate to reduce the charge rate. The zener diode (Z1) begins to conduct into the transistor regulator (Q1) and shunts the current from the starting coil of the reactor. The reactor begins to desaturate, increasing the impedance. Then the voltage to the transformer primary begins to drop, thus decreasing the output.

A voltage divider across the input terminals of the charger provides the battery reference voltage to the zener diode. The voltage divider can be adjusted to give the required operating voltage.

Battery Charger Schematic Diagram



A — BATTERY CHARGER SCHEMATIC



B — CHARGING DIVIDER

OPERATION

The battery charger is designed for use with the 24-volt system (two 12-cell batteries connected in series). The charger is factory-tested and preset so that field adjustments are not required.

To operate the charger, connect the AC power to the charger and the DC output cables to the batteries; then flip the ON-OFF switch (located on the right side of unit) to ON. The charger will charge at its maximum rate, as indicated on the DC ammeter, and taper to a trickle charge.

The charger is provided with a potentiometer to adjust the DC output voltage so that the desired level can be maintained. The DC output of the charger is factory-adjusted to 2.33 volts per cell.

When a battery is disharged or standing idle, its terminal voltage will be less than its on-charge voltage. Therefore, when the charger is put into operation, it will immediately begin to charge the battery. The charger will charge the battery at its rated output to a predetermined voltage. When this voltage is reached, the charge rate will begin to taper to a trickle charge sufficient to keep the battery fully charged.

The charger will maintain a constant battery voltage from no load up to its rated load capacity. If the external is exceeded, the charger will attempt to carry the excess load up to its current-limiting capacity. Beyond this point, the battery will carry the excessive loads. If the battery is discharged, the charger will recharge the battery on a taper curve from its current-limiting capacity to full charge.

MAINTENANCE

Because of the stable, rugged, and static design of the battery charger, very little preventive maintenance is required, Occasional blowing out of dust and tightening of connections are the only maintenance requirements.

The troubleshooting chart lists the troubles that may occur with the battery charger, the probable causes, and remedies,

Troubleshooting Chart: Battery Charger

SYMPTOM	PROBABLE CAUSE/REMDEY
Open AC fuse.	Shorted component: check power transformer; replace as required.
	Check saturable reactor. Check for shorted lugs on fuss board.
	Check for shorted diode.
	Incorrect AC line voltage.
Open DC fuse.	Shorted component: check for short in battery connector Repair/raplace as required.
	Check for short in output leads.
	Check for shorted diode (center-tap rectifiers).
	Check for shorted condenser in charge divider.
Charger operates but will not charge battery.	Open AC fuse: check AC supply. Repair/replace as required.
	Open DC fuse: check fuses.

Troubleshooting Chart: Battery Charger (Continued)

SYMPTOM	PROBABLE CAUSE/REMEDY
Charger operates but will not charge battery (Continued).	Low DC output voltage: check for open primary/ secondary.
	DC contact on open diode in charging circuit.
	Open RC resistor.
	Charge divider: open diode in charge divider.
Charger tapering but finish rate too high.	Control circuit: shunt transistor not conducting properly. Replace transistor.
Charging of one set of batteries being affected by charging rate of the other set.	Charge divider: shorted diode in charge divider.

PORTABLE BILGE AND BALLAST PUMP

SPECIFICATIONS

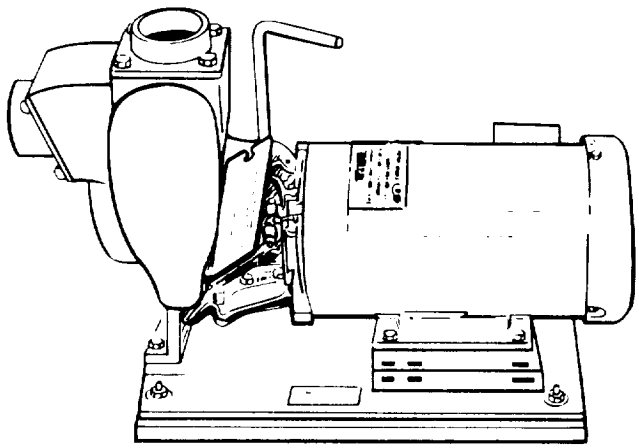
The portable bilge and ballast pump is used to fill or empty the ballast tanks or pump the water out of the bilges when required. It can also be used as an emergency fire pump. The following table and illustration give detailed data on the portable bilge and ballast pump.

Portable Bilge and Ballast Water Pump Data

Pump:
- Type ID ..... Flomax 8, self-priming
- Size ..... 2 x 2 suction/ discharge threaded openings
- Coupling ..... Coupled electric motor drive, pump and motor base-mounted.
- Volume ..... 91 GPM with 20-ft suction lift

Motor:
- Power output ..... 3 HP
- Power requirements 240-VAC, 3-phase, 60-Hz
- Current ..... 7.4 amp
- Speed ..... 3,450 RPM
- Weight (set) ..... 100 lb (approx)

Unit size ..... 23 1/2 inches long, 12 1/4 inches wide, and 14 1/2 inches high



FUNCTIONAL DESCRIPTION

The pump assembly is fitted with a carrier which is fitted with two U-shaped handles for moving the unit from place to place. When not in use, it should be covered with a canvas cover provided in the barge's equipment.

Three 10-foot lengths of 3-inch hoses are stowed on racks located at the forward end of the crane pedestal. Intended for use with the pump as suction hoses, the hoses are fitted with standard hose-thread couplings on either end. One 50-foot section of 1 1/2-inch-diameter fire hose, with one 5 8-inch smooth-bore nozzle, is stowed in a galvanized steel, pocket-type hose rack located on the forward end of the crew's quarters. This hose is for use with the pump as a discharge hose,

The pump suction connection (2-inch female pipe thread) is fitted with adapters. These are mounted on the pump itself and will allow either 3-inch or 1 1/2-inch suction hoses to be used with the pump. A reducing adapter, 3-inch-diameter female hose thread tapering to a 1 1/2-inch male hose thread, must be removed from the suction connection to couple a 3-inch suction hose to the pump. The pump discharge connection (2-inch-diameter female pipe thread) is fitted with adapters mounted on the pump itself to allow a 1 1/2-inch discharge hose to be used with the pump.

The pump motor is equipped with a male connector and a STOP push button for local emergency stop. A 100-foot electrical cable is used to connect the pump motor to a main deck, bulkhead-mounted connection box. The 240-VAC, 3-phase power for the motor is supplied from the engine room, 240-VAC-load center panel, through a motor controller, to the bulkhead-mounted connection box. A remote START-STOP push-button station is wired into the motor controller control circuit. The START-STOP push-button station, bulkhead-mounted connection box, and the 100-foot electrical cable are all located on the starboard side of the fixed base of the crane near the barge centerline. The motor controller is located in the engine room, on the starboard side at the bottom of the stairs.

The pump is a self-priming, centrifugal pump which requires priming only before its initial start. The pump will retain enough liquid for self-priming after initial start.

Starting procedure

Move the pump to the desired location and attach the hoses. Make sure that the suction and discharge hoses are properly connected according to pump instructions.

Make sure the discharge line is open; do not run pump with a closed or blocked discharge line.

The pump is self-priming, and once primed, it should not need repriming unless there is a leak in the suction line To prime the pump, fill the suction line and the pump with water.

Start the pump as follows:

Step 1. Connect the motor connector to the female connector of the 100-foot portable cable. The other end is head-wired to the junction box at the base of the crane.

Step 2. Ensure that the portable pump circuit breaker on the engine room, 240-VAC-load center power panel (P-203) is closed.

Step 3. With the correct pump rotation, depress the START push button at the main deck push-button station. The pump will start running, removing the remaining air from the suction line and picking up its prime.

In case of an overload condition on the motor, the overload relay contacts in the motor controller will open and stop the motor. When the overload condition has been cleared, it will be necessary to momentarily depress first the RESET button on the motor controller and then the START button at the main deck push-button station to place the unit in operation again.

Stopping procedure

CAUTION: Never attempt to stop the motor by pulling the portable cable plug from the pump motor receptacle.

A severe arc might result that could cause serious injury. Carry out the following steps to stop the pump:

Step 1. Depress the STOP push button. (Note: A STOP push button is located on the pump unit for local emergency stop.)

Step 2. Disconnect electrical cable from pump motor receptacle.

Step 3. Remove and stow hoses and electrical cable.

MAINTENANCE

Preventive maintenance

The pump is simply made with only one moving part. The impeller is threaded to a stainless steel drive sleeve. The sleeve slips over a standard drive shaft and is locked to the drive shaft with a two-piece clamp. There are no special tapers or threads, and the impeller is easy to adjust or remove.

The pump has a self-lubricated seal that is lubricated by the liquid in the pump. Do not operate the pump dry because serious damage will result to the seal.

If the pump is to be left standing idle for any length of time in freezing conditions, the pump housing should be drained. A drain plug is located at the base of the pump housing.

Inspect the pump motor at regular intervals, keeping it clean and dry. Occasionally blow or vacuum the dust and dirt out of the windings. This is a ball bearing motor and the bearings have been lubricated at the factory. No lubrication is required at start-up. After that the motor should be relubed once every five years if running approximately 5,000 hours per year. Always use a high-quality ball bearing grease having a consistency suitable for the class of insulation stamped on the nameplate. To maintain the pump motor, also-

- Keep the grease clean.
- Lubricate the motor at standstill.
- Remove and replace plugs at a standstill.
- Do not mix petroleum grease and silicon grease in motor bearings.

Corrective maintenance

Refer to the following chart for the troubleshooting procedures to be used on the pump motor.

Troubleshooting Chart: Pump Motor

SYMPTOM	PROBABLE CAUSE/REMEDY
Motor won't start (no hum).	Loss of power chock fuses: reset thermal overload protector. Open connection: check for broken wiring, improper connection.
Motor hums but fails to start.	Excessive overload: check for equipment jams clogging, or freezing. Open in stoning circuit: check starting capacitors for open or short. Open in running circuit: check winding continuity. Grounded windings: check starting and running windings for grounds.
Bearing overheating.	Improper lubrication: relubricate motor. Worn bearings: inspect bearings and replace if required.
Vibration.	Misalignment with equipment: check alignment of motor with equipment realign if required.

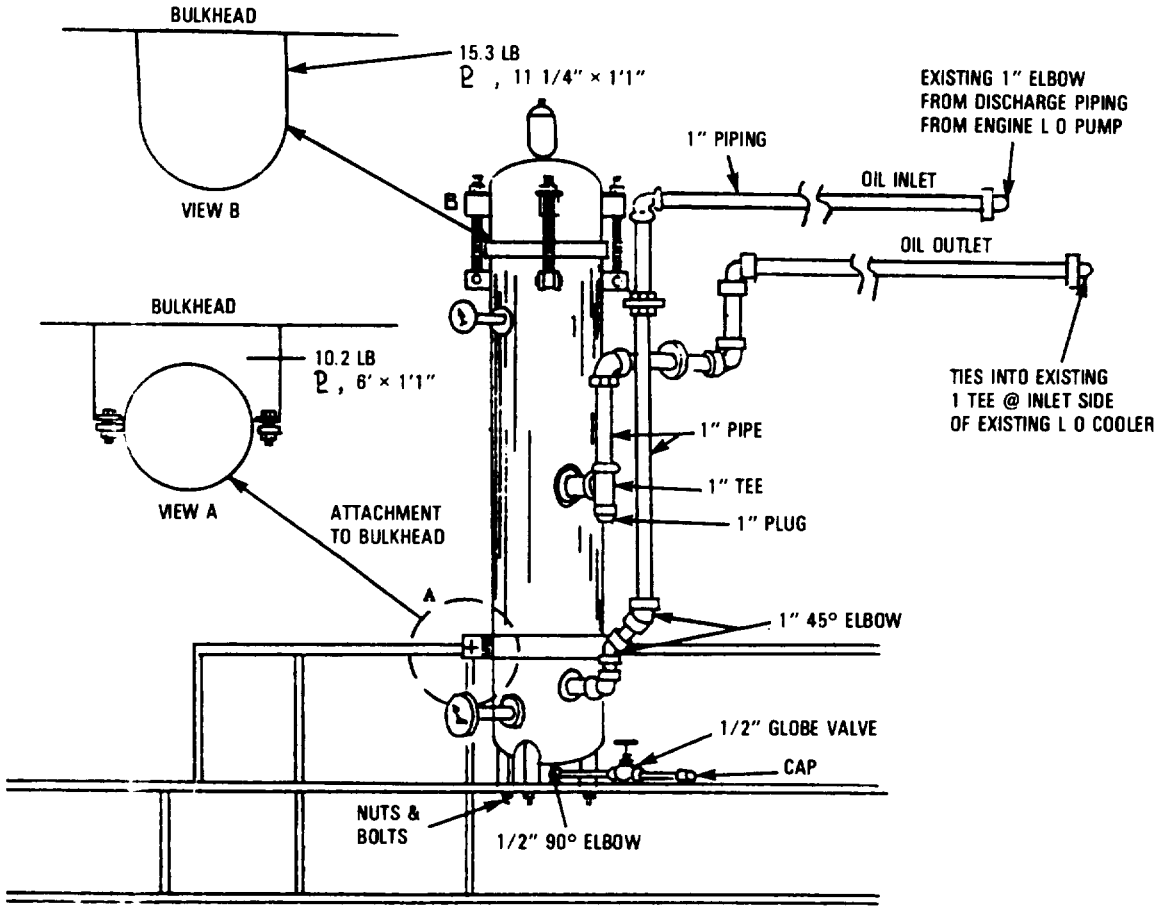
LUBE OIL FILTER

SPECIFICATIONS

The lube oil filter filters the dirt out of the lube oil circulating through the lubricating oil system when the engines are running. The following ta ble and illustration give detailed data on athe lube oil filter.

Lube Oil Filter Piping System

Lube oil ..... SAE 40W	Volume ..... 8 gal (approx)
Operating pressure ..... 100 psi (150 psi max)	Weight ..... 120 lb (approx)
Operating temperature ..... 250°F	Size ..... 54 1/2 inches high, 9 inches diameter
Number of cartridges ..... 2, 2 tiers	



FUNCTIONAL DESCRIPTION

The contaminated lube oil enters this type filter under pressure and fills the dirty fluid compartment containing the cartridges. As the tank fills, air escapes through the automatic air vent valve, which auto matically closes when all the air is released, or through the manual air vent valve. All the fluid must then pass through the filter cartridges, down the standpipe, and into the clean fluid compartment. The clean, filtered lube oil, still under pressure, is then returned to the system through the filter outlet.

The filters use depth-type cartridges with a relief valve built into one of the cartridge caps. This provides a safety factor against restricted flow through the filter. Thus, if filter cartridges become plugged with dirt or sludge, the relief valve automatically allows the fluid to flow directly into the standpipes

Carry out the following steps to put the lube oil filter into operation:

Step 1. Make sure the filter is properly installed and that the pressure gages read zero psi.

Step 2. Open the manual vent valve on the tank cover. With both the manual and automatic valves open, the tank will fill more rapidly.

Step 3. Start the main engine. This will then start the lube oil circulating pump attached to the main engine.

Step 4. After the tank is completely filled, close the manual valve. The automatic air vent will continue to operate as more air accumulates.

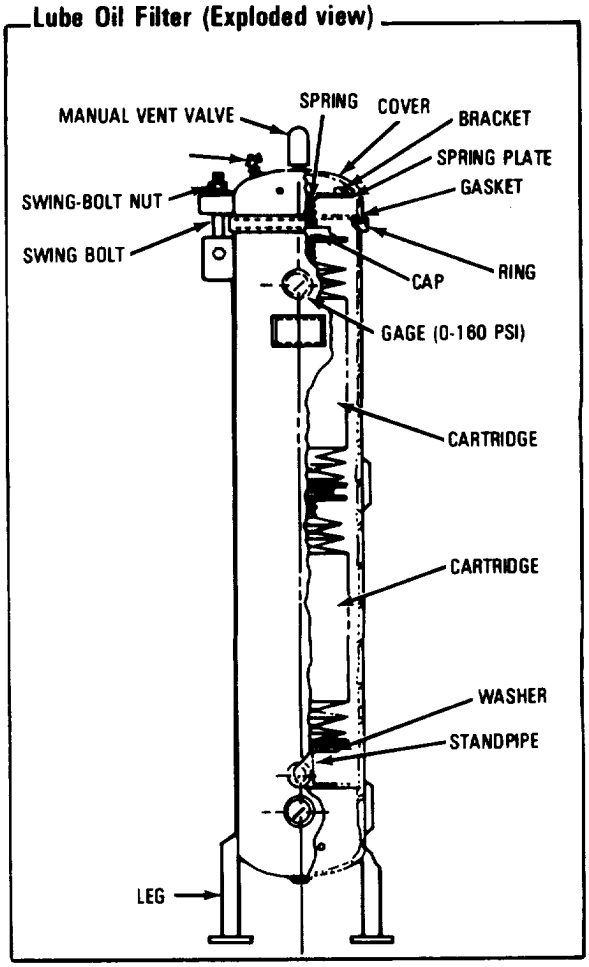
To stop the lube oil circulating pump, simply shut off the main engine.

MAINTENANCE

The following instructions are important to the maintenance of the lube oil filter:

- Drain the bowl at least once per work shift by opening the manual valve.
- Before servicing the filter, repressurize the tank by opening the manual vent valve on the cover.
- Clean each filter element periodically by removing it from the tank, tapping on its surface, and blowing off with an air blowgun.
- Check to see if the gasket is cracked or otherwise damaged; if so, replace the gasket.

Lube Oil Filter (Exploded view)



Normally, cartridge-type filters should be changed when 35 pounds differential pressure is indicated between the two pressure gages on the tank or by actual check on the lube oil condition. To change the filter cartridges (refer to the illustration), follow these steps:

Step 1. Stop filter.

Step 2. Drain filter.

Step 3. Loosen swing-bolt nuts with torquing wrench, and drop swing bolts down.

Step 4. Lift off cover.

Step 5. Remove cartridge caps and hold-down springs.

Step 6. Remove used cartridges by their individual handles. The standpipe is capped at the top to prevent dirt from entering the clean fluid compartment during this procedure.

Step 7. Install new cartridges, being sure to align the bottom gaskets properly with support washers inside the tank to seal the cartridges at the bottom.

Step 8. Replace cartridge cap and hold down spring: be sure that standpipe is uncapped.

Step 9. Replace and properly align cover on the tank.

Step 10. Replace all swing-bolt assemblies and torque nuts to 8 foot-pounds.

The spring plate compresses the spring, forming liquid-tight seals between the cartridge end gaskets, the support washer, and cartridge cap.

FUEL OIL TRANSFER PUMP

SPECIFICATIONS

Two pumps are used to transfer fuel oil from the main tank to two day tanks. These day tanks supply fuel oil to the two main engines, the two auxiliary engines, and the hot water heater. The following table gives detailed data on the fuel oil transfer pump.

Fuel Oil Transfer Pump Data

Motor:	
Power requirements	120-VAC, 1-phase, 60-Hz
Current	9.0 amp
Power output	1/2 HP
Rotation speed	1,725 RPM
Unit size	22 inches long, 10 inches wide, and 11 inches high
Pump:	
Capacity	10.5 GPM
Size	1 1/2 x 3 x 6 stainless steel
Impeller	Open type, 6-inch diameter
Coupling	T.B. Woods Son
Suction lift	20 feet

FUNCTIONAL DESCRIPTION

The fuel oil transfer pumps are operated manually by depressing the START-STOP push button on each motor controller. The fuel consumption for the day should be determined and the pumps operated long enough to satisfy the fuel need. If the day tanks should overflow, the overflow will be returned to the main fuel tank.

Each pump motor is supplied 120-VAC, 1-phase power through a 15-ampere circuit breaker at the engine room, 120-VAC power panel (P-101).

The pump is a positive-displacement pump; that is, when the pump is rotating, fuel oil will be delivered to the discharge side of the pump, The pump is equipped with a bypass valve to relieve the pressure at a predetermined value if too much pressure builds up in the discharge line. Such pressure can cause pump damage. The bypass valve is spring-loaded with a given force, determined by the spring size and the compression force of the adjusting valve nut. This valve is factory-set at 50 psi. The bypass valve is not intended to be a metering or flow-control device. Its main

purpose is to function as a discharge pressure relief when the spring tension is exceeded by the discharge pressure.

The normal operation of the entire fuel oil system is carried out as follows (refer to the following diagram):

Step 1. Ensure that the valve from the main tank (V-1) is open and that the valve to the bypass strainers (V-2) is closed.

Step 2. Open the strainer inlet and outlet valves (V-3 and V-4).

Step 3. Open the inlet and oulet valves (V-6 and V-8 or V-5 and V-7) for the pump to be turned on.

Step 4. Open day tank valve (V-10) and leave valve V-9 closed. V-9 is opened only to feed the hot water heater directly.

Step 5. Open day tank inlet and outlet valves (V-11 and V-13 or V-12 and V-14) for the tank to be placed in operation.

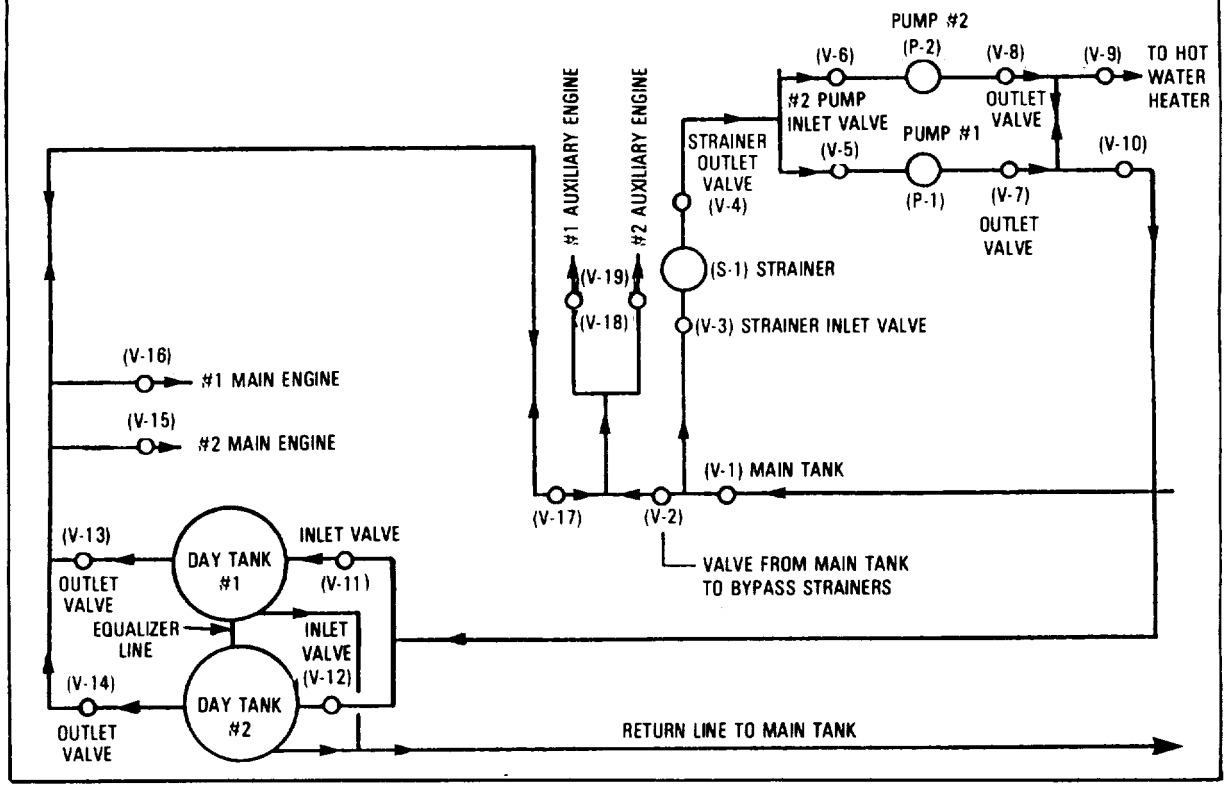
Step 6. Open appropriate valve (V-15 or V-16) to provide fuel oil to main engine to be operated.

Step 7. Open appropriate valves (V-17 and V-18 or V-17 and V-19) to provide fuel oil to auxiliary engine to be operated.

Step 8. Ensure that the 15-ampere circuit breaker on the engine room, 120-VAC distribution panel (P-101) is closed; then push the toggle switch on the associated motor controller to ON. If pump does not operate properly, refer to the troubleshooting chart.

In the event of a low-voltage or overload condition occuring during pump motor operation, the motor will stop automatically.

Fuel Oil Transfer System



MAINTENANCE

Preventive maintenance

Performing a few preventive maintenance procedures will extend the life of the pump.

Grease the pump fittings after every 500 hours of operation or after 60 days, whichever occurs first. If service is severe, grease more often. Do it gently with a handgun, using a #2 ball bearing grease. In hot weather use a heavier grease; in cold weather use a light one.

Occasional packing adjustment may be required to keep pump leakage to a slight weep. If impossible to reduce leakage by gentle tightening, replace packing or use a different type.

The ball-and-spring tension on the bypass valve should be adjusted periodically to make sure it is set to 50 psi. If readjustment is required, turn adjustment screw clockwise to increase pressure setting, counterclockwise to decrease it.

Inspect the pump motor at regular intervals, keeping it clean and dry. Occasionally blow or vacuum the dust and dirt out of the windings and ventilating openings.

The ball bearings of the pump motor have been lubricated at the factory. No lubrication is required at start-up. Thereafter, the motor should be relubed every five years if running approximately 5,000 hours per year. Use high-quality ball bearing grease. Consistency of grease should be suitable for the class of insulation stamped on the nameplate. To maintain the pump motor, also–

Ž Keep the grease clean.

• Lubricate the motor at standstill.

• Remove and replace the plugs at standstill.

Ž Do **not** mix petroleum grease and silicon grease in motor bearings.

Corrective maintenance

Refer to the following chart for troubleshooting hints in maintaining the pump and its motor.

Troubleshooting Chart: Fuel Oil Transfer Pump and Motor

SYMPTOM	PROBABLE CAUSE /REMEDY
Pump does not pump.	Pump has lost its prime due to air leak, low level in tank.
	Suction lift too high.
	Rotating in wrong direction.
	Motor does not come up to speed.
	Suction and discharge valves not open.
	Strainer clogged.
Pump starts then loses its prime.	Supply tank empty.
	Liquid vaporizing in the suction line.
	Air leaks or air pockets in the suction line; air leaking through packing.
Pump noisy.	Pump is being starved (heavy liquid cannot get to pump fast enough). Increase suction-pipe size or reduce length.
	Pump is cavitating (liquid vaporizing in the suction line). Increase suction-pipe size or reduce length; if pump is above the liquid, raise the liquid level closer to the pump; if the liquid is above the pump, increase the head of liquid.

Troubleshooting Chart: Fuel Oil Transfer Pump and Motor (Continued)

SYMPTOM	PROBABLE CAUSE/REMEDY
Pump noisy (Continued).	Check alignment.
	Check for bent shaft or rotor tooth; straighten or replace.
	May have to anchor base or piping to eliminate or reduce vibration.
	Check for foreign object trying to get into the pump through the suction port.
Pump not up to capacity.	Pump is starving or cavitating; increase suction pipe size or reduce length.
	Strainer partially clogged.
	Air leak in suction piping or along pump shaft.
	Motor running too slowly; correct motor speed and check to see that it is wired up correctly.
	Bypass line around pump partially open.
	Excessive pump wear; replace worn parts.
Pump takes too much power.	Check to see if liquid is more viscous than unit can *handle; heat the* liquid, increase the pipe size, slow the pump down, or get a bigger motor.
	Discharge pressure higher than calculated; check with pressure gage. Increase size or reduce length of pipe, reduce speed (capacity), or get bigger motor.
	Packing gland drawn down too tight.
	Pump misaligned.
Pump motor won't start.	Loss of power: check fuses; reset thermal overload protector.
	Open connection: check for broken wiring, improper connection.
Pump motor hums but fails to start.	Excessive overload: check for equipment start. jams, clogging, or freezing.
	Open in starting circuit: check starting capacitors for open or short.
	Open in running circuit: check running capacitors for open or short.
	Check winding continuity.
	Ground windings: check starting and running windings for grounds.
Pump motor fails to accelerate normal load to running speed.	Starting winding remains in circuit: switch contact points may be stuck together. Switch actuator may be defective.
	Defective starting capacitors: check for open, leaking, or dried-out capacitors.
	Improper value of replacement capacitors: check capacitor value.

Troubleshooting Chart: Fuel Oil Transfer Pump and Motor (Continued)

SYMPTOM	PROBABLE CAUSE/REMEDY
Pump motor bearing overheating.	Improper lubrication: relubricate motor.
	Worn bearings: inspect bearings and replace if necessary.
	Belts too tight: check belt tightness.
Pump motor vibrating.	Misalignment with equipment: check alignment of motor with equipment and realign if necessary.

AIR COMPRESSOR

SPECIFICATIONS

This section describes the function, operation, and maintenance of the air compressor assembly. The air compressor is used to supply low pressure air which is stored in a service air tank located in the engine room. Refer to the illustration and table for information on the air compressor.

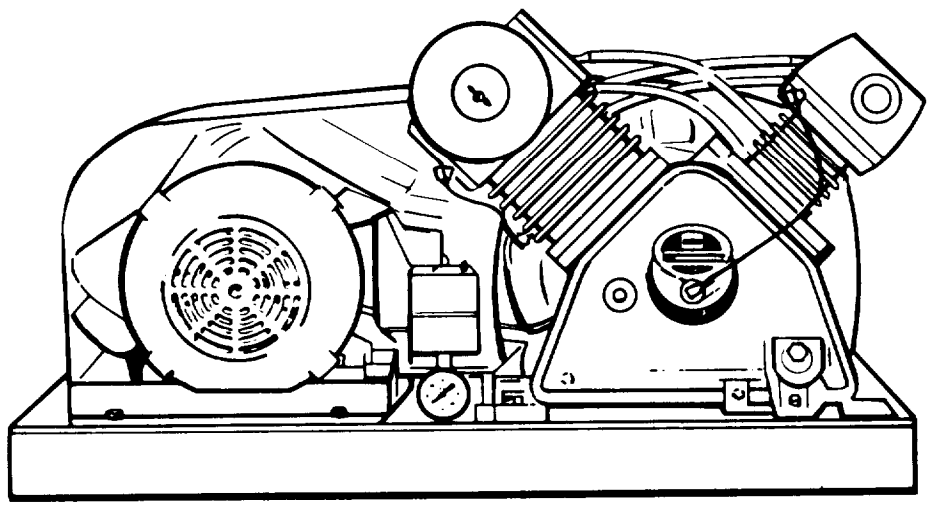
Air Compressor Data

Compressor:
- Capacity . . . . . 23 CFM @ 250 psi (max)
- Size of assembly . . . . . 45 1/2 inches long, 25 1/16 inches wide and 24 1/16 inches high

Weight of assembly . . . . . 800 lb

Motor:
- Power requirements 240-VAC, 3-phase, 60-Hz
- Power output . . . . . 10 HP
- Current . . . . . 26.4 amp

Air Compressor Unit



FUNCTIONAL DESCRIPTION

The air compressor is a V-type, single-acting, positive-displacement, two-stage, reciprocating-type unit. It is driven by a 10-HP motor that operates on 240-VAC, 3-phase, 60-Hz power supplied through a motor controller. Operation is controlled by a pressure switch that is set to maintain the air pressure in a service tank at approximately 150 psi. The air supply from the compressor to the tank passes through an air-cooled coil and a separator. The separator prevents oil that may be sucked out of the compressor from passing into the service tank.

The compressor is entirely air-cooled. It is provided with a large, fan-type flywheel sheave which, in addition to transmitting power, circulates air around the cylinders, heads, and intercooler. The intercooler is the multi ple-fin type; the fins must be kept free from dirt to ensure maximum efficiency. Cylinders and heads are also provided with deep fins for cooling, and these too are to be kept clean.

The compressor is splash-lubricated internally by an effective splash system. Connecting rods are provided with splashers that dip into the oil and thoroughly drench all wearing surfaces. Troughs are provided along the inside of the crankcase to carry oil to the main bearings. Cylinders and pistons are splash-lubricated. An oil seal is provided at the end of the shaft to keep the oil in and the dirt and dust out.

The valves of both first and second stages of the compressor are the Worthington Feather valve type, consisting of seat, guard, and strip.

The compressor is equipped with a centrifugal unloader, which is a speed-sensitive device that automatically actuates a check valve. This unloads the compressor by relieving pressure in the cylinders whenever the speed drops below normal. This assures starting at no load.

When running at normal speed, the fly-ball weights are thrown outward by centrifugal force. This pulls the plunger stem against its springs away from the check valve stem, thus closing the check valve. When speed drops below normal minimum (or when the compressor is stopped), the plunger spring force overcomes the fly-hall weight force. This pushes the plunger against the check valve stem, opens the check valve. and permits air from the cylinder to enter the crankcase, which bleeds off the cylinder pressure. The air entering the crankcase then escapes the compressor via the breather tube and suction muffler.

The air compressor can be operated manually from the motor controller or automatically through the pressure switch as described above.

OPERATION

The air compressor motor is energized through a motor controller. Its operation is controlled by a pressure switch actuated by the compressor air pressure. The motor controller applies 240-VAC, 3-phase power to the air compressor motor through the pressure switch when closed. The switch is set to open (stop the motor) when the air pressure reaches 180 psig (pounds per square inch gage), and to close (start the motor) when the air pressure drops to 150 psig. An electrical interlock is provided to prevent air compressor operation when the fire pump is operating.

Before initial start-up–

- Check the crankcase oil. Keep the oil at the full mark on the crankcase.
- Check the belt tension.

Ž Open the receiver drain valve.

Ž Check the direction of motor rotation by momentarily starting the motor. Direction is indicated by an arrow on the flywheel.

Then to start the motor–

- Close the air compressor 30-ampere circuit breaker on the 240-VAC-load center panel (P-203) in the engine room.

Ž Position the HAND-OFF-AUTO control switch to HAND on the air compressor motor controller and depress the START push button. The compressor motor will start running.

When the compressor has reached operating pressure (150 to 180 psig), check all the piping joints for leaks.

After operation has been checked as satisfactory, switch from HAND to AUTO at the motor controller. This will allow air compressor operation to be controlled automatically by the pressure switch. When the air pressure drops down to 150 psig, the air compressor will turn on; it will stop running when the pressure reaches 180 psig.

MAINTENANCE

Preventive maintenance

Based on an eight-hour day, five-day week operation, no major repairs would be anticipated for an average of five years. This asssumes that the unit is adequately maintained and is not operating under adverse conditions, such as a high-temperature or high-dust environment. This compressor running gear is designed to provide 10,000 hours of service before a major overhaul.

The compressor has been designed so that the high oil level is reached when the oil overflows at the oil-filler opening. The low oil level is the bottom thread of the oil-filler opening. The crankcase should be filled with a good grade automotive engine oil before starting. The compressor operating oil level should be between the high and low level marks.

Use SAE 20W oil for the first 25 hours of operation. Following this period, drain the crankcase and refill with the correct oil as shown at the top of the next column.

AMBIENT TEMPERATURE	RECOMMENDED OIL VISCOSITY
4° to 40°F	SAE 20W
40° to 100" F	SAE 30W
100° to 300° F	SAE 40W

For a higher or lower ambient temperature, use the next higher or lower viscosity SAE grade. Oils with an oxidation inhibitor and naphtha base are desirable but not essential. *(NOTE:* Detergent oils should not be used.)

The crankcase should be drained and cleaned monthly or every 300 operating hours. Refill with fresh oil (SAE 30W at 40°) to 100°F ambient temperature). The capacity of the crankcase is 8 1/2 pints.

WARNING: Never use kerosene or gasoline to clean the air compressor. These solvents are dangerous and can result in an explosion or other serious damage.

The ball bearings have been factory-lubricated and require no further lubrication at start-up. Every two years thereafter, relube with Westinghouse 53701RY grease. Do not overgrease, and when adding grease, keep dirt and contaminants out. When regressing the motor, stop the motor, remove inlet and outlet plugs, and add grease with a hand-lever gun. Discontinue as soon as grease appears at the outlet plug. Run motor for about 10 minutes and add more grease if required; then replace the plugs.

Refer to the following table for a preventive maintenance schedule.

Preventive Maintenance Schedule for Air Compressor

FREQUENCY	ACTION
Daily (D):	Check crankcase oil level; keep oil at full mark.
	Drain condensation from air receiver.
Weekly (W):	Clean the cylinder fins and aftercooler fins with compressor air.
	Test all safety valves; lift safety valves by using hand lever.

Preventive Maintenance Schedule for Air Compressor (Continued)

FREQUENCY	ACTION
Monthly (M):	Clean the suction air filter. (If necessary, clean more often.)
	Change crankcase oil monthly or every 300 hours of service.
Bi-monthly:	Inspect belt tension and tighten as required.
	Check all screws and nuts for tightness. Tighten to specified torque settings as required.
Annually (A):	Remove and inspect suction and discharge valves. Clean and lap as required.
	Inspect crankshaft end play; tighten if end play is present.

Corrective maintenance

Consult the following chart fo trouble-shooting hints in maintaining the air compressor.

Troubleshooting Chart: Air Compressor

SYMPTOM	PROBABLE CAUSE
Failure to deliver air.	Suction line blocked by dirty filter.
	Valves improperly installed.
	Suction valve unloader stuck in unloaded position.
	Centrifugal unloader stuck in unloaded position.
	Strips missing from valves.
Insufficient capacity.	Excessive leakage in pipelines, in fittings, and through valves.
	Discharge pressure higher than rating.
	Speed incorrect.
	Suction filter clogged.
	Worn piston and rings.
	Faulty valves.
	Valve strips missing.
	Blown cylinder head gasket.
	Suction valve unloaders holding strips partially open.

Troubleshooting Chart: Air Compressor (Continued)

SYMPTOM	PROBABLE CAUSE
Insufficient capacity (Continued).	Centrifugal unloader stuck partially open.
	Intercooler leaking.
	Belt slipping.
Insufficient pressure.	Demand greater than rated capacity of unit.
	Worn rings.
	Excessive leakage in system and internally.
Excessive oil consumption.	Oil level too high.
	Oil too light in viscosity.
	Worn rings or cylinders.
Compressor vibrates.	Not properly secured to foundation.
	Improper foundation.
	Piping not supported properly.
	Motor rotor out of balance.
	One cylinder inoperative.
Compressor overheats.	Broken valve strips.
	Wrong direction of rotation.
	Suction filter clogged.
	Discharge pressure higher than rated.
	Internal leakage.
	Insufficient lubricating oil.
	Defective main bearings or insufficient piston clearance.
Compressor knocks.	Loose flywheel or pulley.
	Excessive wrist-pin clearance.
	Excessive crankpin-bearing clearance.
	Main bearings need adjusting.
	Loose valve in cylinder.

Troubleshooting Chart: Air Compressor (Continued)

SYMPTOM	PROBABLE CAUSE
Compressor knocks (Continued).	Loose centrifugal unloader.
	Excessive end play in motor rotor.
	Motor rotor shunting back and forth due to belt misalignment or unlevel mounting.
Compressor overloads motor.	Electrical characteristics of power lines not in agreement with the motor characteristics.
	Multi-V-drive belts pulled excessively tight.
	Discharge pressure higher than rated.
	Speed greater than rated.
	Discharge line restricted.
	Low voltage.
	Tight main bearings or insufficient piston clearances.
Receiver safety valve blows.	Defective safety valve.
	Safety valve set below cutout pressure.
	Faulty pressure switch or trigger valve.
Receiver safety valves blow.	Pressure switch or trigger valve set at too high cutout pressure.
	Leak in control line.
	Inoperative suction unloaders.
Intercooler valve blows—	
While running unloaded.	Broken or leaking high-pressure discharge valve strip.
	High-pressure unloader leaking air.
	Defective or stuck low-pressure, cylindrical unloader.
	Blown high-pressure head gasket.
While running loaded.	Broken or leaking high-pressure suction or discharge valve strip.
	High-pressure unloader stuck in unloaded position.
	Blown high-pressure head gasket.
Unit blows fuses.	Fuses too small.
	Low voltage.

Troubleshooting Chart: Air Compressor (Continued)

SYMPTOM	PROBABLE CAUSE
Unit blows fuses (Continued).	Pressure switch differential too narrow.
	Unit starting against full load (faulty centrifugal unloader).
	Defective motor.
	Compressor or motor binding.
Controls not operating correctly:	
Chatter.	Too small a line from receiver to controls.
Fail to unload.	Faulty trigger valve. Faulty centrifugal unloader. Control air line blocked or pinched.
General.	Broken unloader parts, such as springs and fingers.
	Electrical failure, loose connections, broken wires, or incorrect hookup.

CHAPTER 7

FIRE-FIGHTING SYSTEM

This chapter describes the operation and required maintenance of the fire-fighting system and equipment aboard the 100-ton floating crane after its rehabilitation under the PIP.

SYSTEM LAYOUT

FIRE-MAIN SYSTEM

The fire-main system consists of three fixed fire stations, the fire pump, and the necessary piping components. The fire stations are located in the following strategic locations:

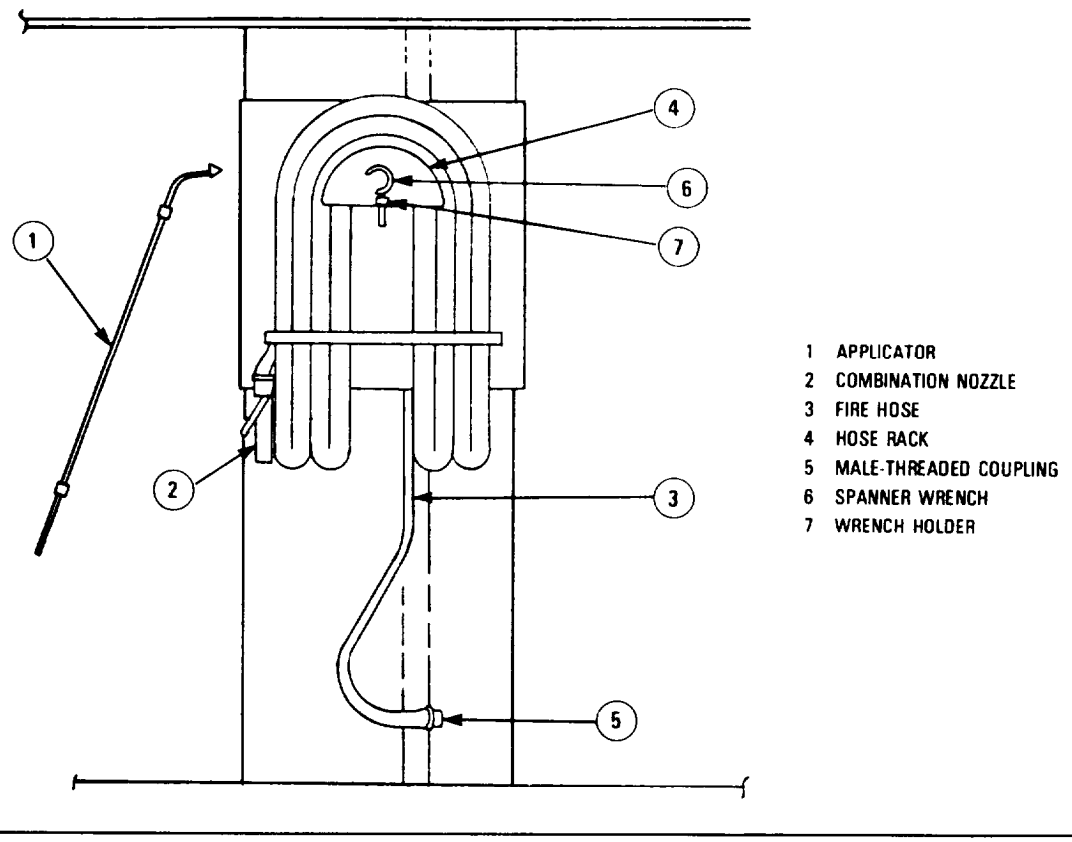
Ž Fire station 1: in the engine room above the fire pump on the starboard bulkhead.

• Fire station 2: in the crew's berthing area, forward of the entrance to the shower and toilet room.

• Fire station 3: on the main deck on the rotary platform base, at about frame 12.

Each fire station is equipped with a 50-foot, 1 l/2-inch hose permanently installed on a hose rack. Each hose has a combination nozzle attached to it. In addition, there is an applicator nozzle located at each station. A spanner wrench of the exact size required is permanently attached to the hose rack. Refer to the following illustration.

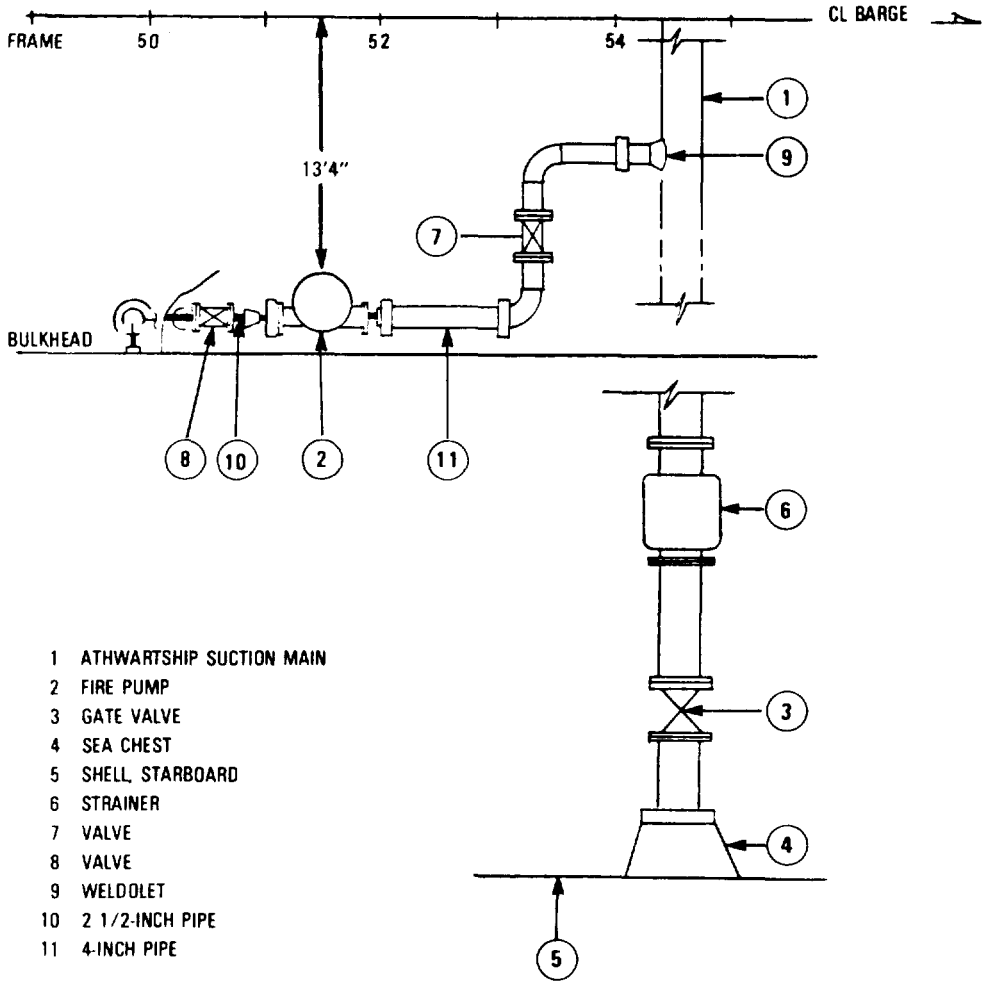
Fixed Fire Station



Seawater is taken from a suction main and pumped under pressure to the fire stations. A weldolet is installed in the suction main, a distance of 8 feet 8 inches outboard to starboard from the barge centerline. The fire pump is connected to the weldolet by a 4-inch pipe. Refer to the following diagram.

The fire-main piping at the fire station in the crew's quarters has a l-inch pressure supply line for pressurizing the galley-quarters area portable eductor. The eductor, operated by pressurized water from the fire pump, is used to drain the galley-quarters area and the storeroom underneath.

Fire Main System



1 ATHWARTSHIP SUCTION MAIN
2 FIRE PUMP
3 GATE VALVE
4 SEA CHEST
5 SHELL, STARBOARD
6 STRAINER
7 VALVE
8 VALVE
9 WELDOLET
10 2 1/2-INCH PIPE
11 4-INCH PIPE

The portable eductor assembly should be stowed in the storeroom underneath the crew's quarters (the eductor assembly can be pressurized from a supply line located in the fire-main piping at fire station 2). The portable eductor assembly consists of–

- Derbyshire 356 low-head eductor, with a 1-inch female pipe thread pressure connection and 1 l/2-inch female pipe thread suction and discharge connections.

Ž25 feet of l-inch pressure supply hose with 1-inch male pipe thread hose fittings.

- 10 feet of 1 1/2-inch suction hose with 1 1/2-inch male pipe thread hose fittings.

- Simmons 406 right-angle foot valve with a strainer and a 1 1/2-inch female pipe thread connection (to be attached to the 10-foot, 1 /2-inch suction hose).

- 50 feet of 1 1/2-inch discharge hose with 1 l/2-inch male pipe thread hose fittings.

ENGINE ROOM SYSTEM

The automatic fire-extinguishing system installed in the engine room is the CO_2 smothering type. This system can also be activated by pulling wire pull handles located at several places in the engine room. This fire-extinguisher system is installed so that it will automatically discharge CO_2 on and around the engines in case of fire. The discharge nozzles are connected by piping to seven 50-pound CO_2 cylinders.

WARNING: Operation of the fire-extin guishing system while personnel are in the engine room could result in injury or death to personnel. Some type of warning should be established to warn personnel when CO_2 is discharging.

The CO_2 smothering system can also be set off from an outside "fire-pull" station located on the main deck on the forward side of the engine house.

PORTABLE EXTINGUISHERS

In addition to the fire-main system, 12 hand-held, portable fire extinguishers are located in brackets at convenient positions. Three types of fire extinguishers are used. Each type is designed to extinguish **a** particular type of fire and is located accordimgly in an area where that specific type of fire is more likely to occur.

The 12 portable fire extinguishers located throughout the barge include five 15-pound CO_2 extinguishers, six 5-pound Halon 1211 extinguishers, and one 20-pound dry-chemical, Purple K extinguisher. Refer to FM 55-501, Chapter 11, for detailed procedures used in fire fighting and the use of portable fire extinguishers.

FIRE PUMP

SPECIFICATIONS

The fire pump motor is supplied with 240-VAC, 3-phase power from the engine room, 240-VAC-load center panel (P-0203). Pump operation is controlled by a motor controller which has low-voltage protection and current-overload features. The fire pump motor is interlocked with the air compressor motor, via the compressor motor controller, to pevent the air compressor from operating when the fire pump is running.

Pump Data

Pump:	
Capacity	165 GPM @ 200 ft TDH
Motor:	
Power requirements	240-VAC, 3-phase, 60-Hz
Current	35 amp
Power output	15 HP
Rotation rate	3,500 RPM

The fire pump can be operated locally from the motor controller or remotely by a push button located on the main deck next to the emergency stations. The local operation is controlled by START-STOP push buttons at the motor controller with the LOCAL-OFF-REMOTE switch in the LOCAL position. The

remote operation is controlled by the START-STOP push buttons located on the main deck with the LOCAL-OFF-REMOTE in the REMOTE position.

OPERATION

Initial inspection

Make the following inspection before starting the pump:

ŽMake sure all wiring connections to the motor (and starting device) match the wiring diagram and produce clockwise rotation as viewed from the top of the motor.

ŽIf the motor has been in storage for an extended time, either before or after installation, refer to the motor instructions before starting.

• Check the voltage, phase, and line-circuit frequency with the motor data plate.

Ž Turn the rotating element by hand to make sure it rotates freely.

• Tighten the plugs in the gage and drain taps; keep the gage cocks closed when not in use.

Ž Check the suction and discharge piping for leaks, and make sure all flange-bolts are securely tightened.

Priming procedure

The pump is not self-priming and must be completely primed (filled with liquid) before starting. The pump operates with a positive suction head.

Prime the pump by opening the suction valve and allowing the liquid to enter the pump casing. Open the air vent at this time and make sure all air is forced from the pump by liquid before closing, Rotate the shaft by hand to free entrapped air from impeller passageways.

CAUTION: Never run the pump dry. Running the pump dry will cause serious damage to the mechanical seal.

Start-up procedure

To start the fire pump, carry out the following steps:

Step 1. Fully open the gate valve in the suction line, and close the gate valve in the discharge line.

Step 2. Fill the suction line with liquid and completely prime the pump.

Step 3. Start the pump locally by depressing the START push button at the motor controller with the LOCAL-OFF-REMOTE control switch in the LOCAL position.

or

Start the pump remotely by depressing the START push button at the station located on the main deck and have the LOCAL-OFF-REMOTE control switch on the controller in the REMOTE position.

Step 4. Open the gate valve in discharge line.

Shutdown

Always close the discharge gate valve before stopping the pump to ensure that the pump is full of water for priming; close the valve slowly to prevent hydraulic shock.

With the control switch at the motor controller in the LOCAL position, depress the STOP push button. If the control switch is in the REMOTE position, depress the STOP push button at the station on the main deck.

For overnight or temporary shutdown periods under nonfreezing conditions, the pump can remain filled with liquid for priming. Make sure the pump is fully primed before starting.

For short or frequent shutdown periods under freezing conditions, keep fluid moving within pump casing and insulate or heat pump exterior to prevent freezing.

MAINTENANCE

To lubricate the motor, remove the grease drain plug (if any) and filler plug on grease fitting. Grease with clean lubricant until grease appears at drain hole or along motor

shaft; 1 1/2 to 3 cubic inches of grease is sufficient. If the pump is operated under standard conditions, the motor should be lubricated every six months.

Periodically inspect the–

- Grease fittings and drain plugs. Grease fittings and drain plugs should be inspected every 30 days for leaks.

ŽMechanical seals. Inspect all mechanical seals every 30 days for indication of leaks. If evidence of seal failure is observed, the seals must be replaced.

ŽWear rings. Wear rings should be inspected every 90 days if the operation of the pump is confined to pumping seawater or fresh water. Rings must be replaced when the diametric clearance between impeller and wear ring exceeds 0.040 inch.

Refer to the following chart for troubleshooting causes and remedies in the maintenance of the pump and its motor.

Troubleshooting Chart: Fire Pump and Motor

SYMPTOM	PROBABLE CAUSE	REMEDY
Pump does not deliver any liquid.	Lack of prime.	Repeat priming as previously described; make sure pump is completely primed with liquid. Make sure all air is bled from pump and suction piping and piping is completely filled with liquid.
	Speed too low.	Make sure power is directly across the line and motor is receiving full voltage. If frequency is too low or if motor has an open phase, make necessary correction; make sure generator is running at full speed.
	Wrong rotation.	Make sure the pump motor is rotating in a clockwise direction, as viewed from top of motor. Check rotation arrow on top of pump volute casing.
	Discharge head too high.	Check piping for friction losses; make sure discharge head matches conditions for which pump was selected (pump rating). Larger diameter piping may correct conditions of excessively high discharge head. Make sure that no obstructions exist in discharge piping.
	Suction lift too high.	Check for obstructions at suction inlet. Check for possible friction losses in suction piping (use a friction table). To determine if static lift is too great, measure suction pressure with a mercury column or gage while pump is operating. Static lift can be reduced either by raising the surface level of liquid being pumped or by lowering the pump.

Troubleshooting Chart: Fire Pump and Motor (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
	Inlet not deep enough in liquid source.	If inlet cannot be lowered or if swirling eddies are created which permit air to enter suction line, chain a board to the suction piping (near inlet). Board will be drawn into whirlpool, smothering the vortex and preventing air funnels from entering line.
	Impeller clogged.	Disassemble pump volute casing, and completely clean impeller passageways.
Pump does not deliver enough liquid.	Suction piping leaks air.	Make sure all flange and valve connections in suction line are airtight. Make sure all leaks are completely sealed.
	Speed too low.	(See above.)
	Discharge head too high.	(See above.)
	Suction lift too high.	(See above.)
	Impeller partially clogged.	(See above.)
	Insufficient pressure to suction head for hot water.	Condition can be determined by connecting pressure gage to suction piping or to gage tap on pump suction nozzle. Gage indicator will oscillate if water is flashing to steam in suction line.
	Wear ring excessively worn.	Inspect case wear ring for excessive wear. If wear ring is defective, replace.
	Impeller damaged.	Inspect pump impeller. If impeller is excessively damaged or impeller vanes are badly worn (eroded), replace with new impeller.
Pump does not produce enough pressure.	Speed too low.	(See above.)
	Air or gases in liquid.	To determine whether gases are present in liquid being pumped (such as marsh gas in swamp water), test liquid in laboratory by simulating suction-line pressure and checking for bubble formation. It may be possible to overrate pump to a point where it will provide adequate pressure, despite existing conditions. A better solution is to install a gas-separation chamber in the suction line near the pump and periodically exhaust accumulated gas.
	Impeller damaged.	(See above.)
	Wear ring excessively worn.	(See above.)
	Impeller diameter too small.	Check with manufacturer's representative to determine if large impeller can be used. Otherwise, reduce pipe friction losses, or increase speed of impeller rotation. (Make sure motor is not seriously overloaded.)

Troubleshooting Chart: Fire Pump and Motor (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Pump operates briefly, then stops.	Improper priming.	Repeat priming procedure.
	Suction lift too high.	(See above.)
	Suction piping leaks air.	(See above.)
Pump uses too much power.	Suction head less than pump rating.	Reduce outside diameter of pump impeller. Impeller diameter may be turned down on a lathe and rebalanced or replaced with smaller-diameter impeller.
	Liquid too heavy (viscosity or specific gravity).	Use motor with greater horsepower rating or reduced RPM.
	Wrong rotation.	Reverse any 2-phase connections of the motor 3-phase connections.
	Volute casing distorted by piping stress.	Check pump alignment. Examine pump interior for excessive or unusual friction between impeller and casing. Check wear ring and rotating elements, and replace worn or damaged parts.
	Misalignment.	Realign pump and motor, and clean all mating surfaces.
Pump motor won't start (no hum).	Loss of power.	Check fuses; reset thermal protector.
	Open connection.	Check for broken wiring, improper connection.
Pump motor hums, but fails to start.	Excessive overload.	Check for equipment jams, clogging, or freezing.
	Open in starting circuit.	Check starting capacitors for open or short.
	Open in running circuit.	Check running capacitors for open or short.
		Check winding continuity.
	Grounded windings.	Check starting and running windings for grounds.
	Switch contacts not closing.	Check switch operation.
Pump motor fails to accelerate normal load to running speed.	Starting winding remains in circuit.	Switch contact points may be stuck together. Switch actuator may be defective.
	Defective starting.	Check for open, leaking, or dried-out capacitors.
Pump motor starts and accelerates load, but is rough and noisy. Draws very high current (motor not switching out starting capacitors).	Faulty rotating switch actuator.	Check rotating switch-actuator operation.
	Improper location of rotating switch.	Check location of rotating switch actuator.
	Faulty switch.	Check switch operation.

Troubleshooting Chart: Fire Pump and Motor (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Pump motor starts properly, but will not come up to full speed. Motor speed cycles between the cycles between the switch dropout and cut-in speeds.	Switching speed too low because of faulty or improperly located rotating switch actuator.	Check rotating acutator operation. Check location of rotating switch acutator.
Bearing overheating.	Improper lubrication.	Relubricate motor.
	Worn bearings.	Inspect bearings and replace if necessary.
Pump motor vibration.	Misalignment with equipment.	Check alignment of motor with equipment, and realign if necessary.
	Possible overload.	Check to see that load is not excessive, if so reduce load.

NOTE: For detailed instructions on installation, maintenance, and repair refer to the applicable TM or manufacturer's manual (Reliance Motor's *Instruction Manual,* B-3620-11 for induction motors).

CHAPTER 8

CRANE OPERATION PROCEDURES

This chapter presents standard procedures for preliminary inspection, operating maneuvers, and operations under varying conditions, and deactivation/reactivation procedures.

PREOPERATIONAL INSPECTION

Certain preliminary checks and procedures are necessary to prepare a crane for operation. The specific operating instructions and maintenance manuals for the type and make of equipment installed should be available and carefully followed. The installation and starting procedures for the various engines may differ slightly. Therefore, the following procedures are general and will not specifically apply in all cases.

First, check the main panel board to be sure that the main circuit breakers and field switches are engaged before starting either generator.

Lubricate all machinery on the crane according to lubrication instructions and schedules. Check the levels of the fuel oil, lubricating oil, and freshwater hull tanks; refill if necessary. Be sure tank vents are not plugged or clogged.

Check the following locations and equipment for leaks and repairs as necessary:

- The engine compartment and interior of hull.
- All water connections and valves.
- Crankcase, oil tanks, oil coolers, oil filters, and oil lines.
- The fuel system, with particular attention to the connecting hose.

Remove all fuel and oil drippings found during inspection.

Prepare the air reservoir as follows:

- Inspect the tank for security and damage; be sure that air lines are tight.

ŽDrain condensation from tank.

- Be sure that all petcocks are closed.

Check that the boom is free from boom cradle and that the blocks and sheaves are properly suspended and attached to hoisting cable. Inspect for correctness of assembly, security of boom, broken or loose sheaves, and frayed or kinked cables. Operate boom and falls to the extreme limits to be sure that the limit switches are functioning properly. Give special attention to correct reeving of the cables.

Inspect the hoist to be sure that the hoist drums are free of obstructions and debris and that the cables are wound in smooth layers and adequately lubricated.

Inspect all accessories, such as fans and water pumps, for loose connections and mountings. Check pulley belts for proper tightness, and check for proper water circulation to the heat exchangers. On the 60-ton crane, check for proper ventilation of the main diesel engine radiator.

Prepare the main and auxiliary diesel engines as follows:

- Check the oil level in the crankcase.
- Open the valves in the fuel supply and return the lines between the engine and day tank.

Ž Bleed the air from the fuel system.

- Check to see that the circuit breaker on the switchboard is disengaged.
- Ensure that the engine and generator are clear of tools, waste, or other foreign matter.
- Check the oil level of the main engine cylinder-lubricating reservoir and turn the hand crank approximately 50 turns if the engine has been secured for a long time.
- If the engine is battery-started, make certain that the battery is fully charged, that the battery plates are covered with 1/8 to 1/4 of an inch of water, and that all battery terminals are tight and clean.

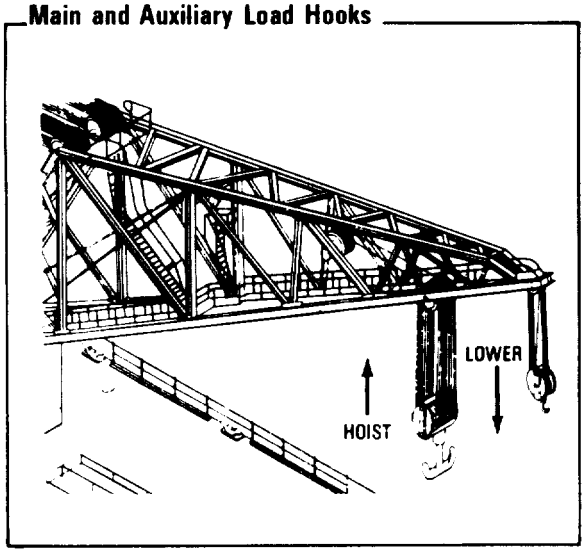
Ž If the engine is air-started, open the drain valve on the air supply line; drain all condensation from lines.

- Set all engine controls according to instructions given under applicable starting procedures.

USE OF LOAD HOOKS

The following procedures are used to operate the main (heavy-load) and auxiliary (whip or light-load) hooks under routine and emergench conditions. The following illustration shows the load hooks.

Main and Auxiliary Load Hooks



HOISTING AND LOWERING OPERATIONS

Hoisting consists of raising a load vertically on either the main or auxiliary load hook. Procedures for operating each hook are identical. Power is applied to the drum that, through the cable and sheave-block arrangement, lifts the respective hook. Each hook has its own hoisting drum with separate controls. On the 100-ton crane, a separate master switch is provided for the operation of each hook. The master switch is pulled back to hoist the hook. A foot-brake pedal located in the floor of the operator's cab is provided to stop the movement of each hook at the desired position.

On the 60-ton crane, place the master switch in the neutral position. Operate the clutch control to engage the clutch on the drum used for hoisting. Simultaneously release the foot-brake pedal and increase the engine speed to prevent stalling. To raise the hook, pull the master switch back to the desired position. To stop movement when load or tackle has reached the desired height, place the master switch in the neutral position. Simultaneously release drum clutch, depress and lock foot-brake pedal, and throttle the engine to approximately half speed. If the load is to be held in raised position for an extended time, engage the dog pawl into its drum ratchet.

Consult the operational load chart before hoisting a load. On heavy lifts, inch the load slightly, stop and test brakes to see if they are functioning properly, and then complete the hoisting operation. Do not lift heavier loads than those specified at the selected operating radius.

During hoisting operations, the operator should strive to coordinate control movement for the smoothest operation possible. This practice will minimize strain on equipment as well as prevent rough and jerky operation.

Many times during operation of the crane, only a slight hoisting or rotating movement is required. This type of movement is known as “inching” and is accomplished by a series of brief motions in which the hoist master switch handle is moved from the OFF position to the first speed point and returned, each time allowing only a momentary operation of

the machinery. Only a momentary time lag is required for releasing the electric brake by means of the hoist switch. With a little practice, the operator will learn to estimate the time required for the inching movement.

The lowering operation consists of lowering the main or auxiliary load hook to the desired position. The hooks on the 100-ton crane are lowered by pushing the respective master switch forward. A foot-brake pedal is provided to stop the movement of the hooks at the desired position. On the 60-ton crane, the load hook is lowered by the weight of the empty hook blocks or the load. Cable is thus unwound from its respective drum and is controlled by the braking action on the drums.

With the engine throttle at approximately half speed and the selected clutch control in neutral position, release the foot-brake pedal or motor dynamic brake controller, and control lowering by brake resistance. When a load is partially lowered and left hanging for an extended time, engage the dog pawl into its drum ratchet.

ROTATE AND HOIST CONTROL

Load swings

One of the principal difficulties encountered by an inexperienced crane operator is controlling a load which tends to swing while transporting. Unusual load swings result from sudden stops and starts of the swinger gear, as well as from high winds and heavy seas. A slow, deliberate operation of the swinger control and smooth brake operation help reduce loads wings. If a load develops an undesirable swing, neutralize it by quickly moving the boom tip directly over the center of the load and stopping the swinger gear at that point. With diligent practice, the operator will soon become adept at controlling load swings.

Heavy lifts

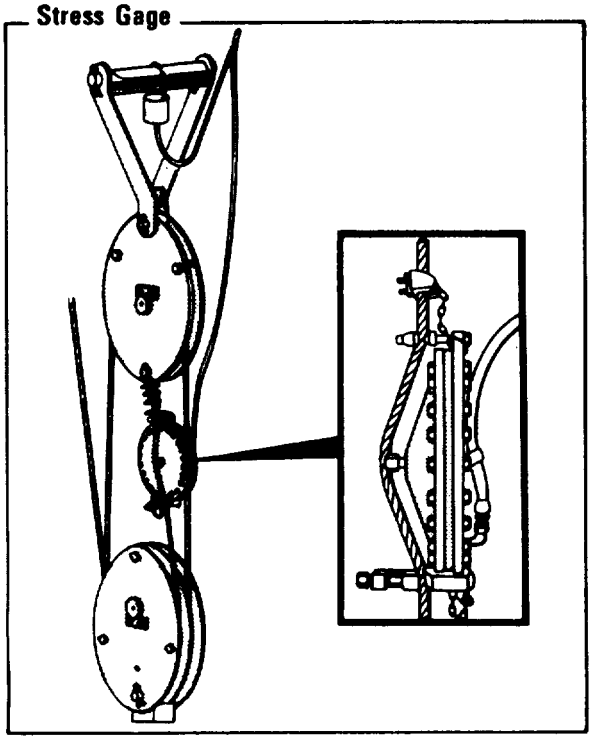
At times, the crane will be lifting at almost capacity tonnage and, in such operations, there may be a great deal of rotating. The operator should be very careful when swinging the load. Unless experienced and accustomed to the crane, the operator should make the swing very slowly. The load should have tag lines attached to prevent it from swinging.

When the load is lifted, remember that the barge will list in the direction of the lift. When transporting the load, the barge will be pulled slowly up this incline until the crane is level. As the crane begins to list in the opposite direction, the load will travel faster because of gravity. An experienced operator will compensate for this condition by the proper use of the controls. Stress on the legs of slings varies according to the angle of the sling and load. When making heavy lifts with a sling, it is advisable during normal operations to have an angle of 60 degrees or more at the point where the sling joins the load.

The crane may also be used to lift equipment or supplies onto or off other vessels. This can be done with the crane anchored offshore or at dockside. Heavy loads can be picked up from the deck of a vessel and deposited on barges or piers across the vessel or to barges across the crane barge. However, cranes cannot lift a capacity or near-capacity load and the boom across a vessel to unload on a dock or pier. This exceeds the crane's safety capacity and could result in damage to the crane or cargo.

The use of a stress gage on the 60-ton crane enables the crane operator to lift loads within the safe limits for which the crane is designed. Without the use of this gage, the load may exceed the maximum capacity, serious damage may result, and the lives of workmen may be endangered. The stress gage is received from the manufacturer as a self-contained unit. It includes hose, reservoir diaphragm, gage, and clamps for installation. It is loaded and sealed with the proper amount of fluid when manufactured and, after installation, can be used with minor adjustments. The unit also includes instructions for proper installation.

Stress Gage



MULTIPLE LIFTING MANEUVERS

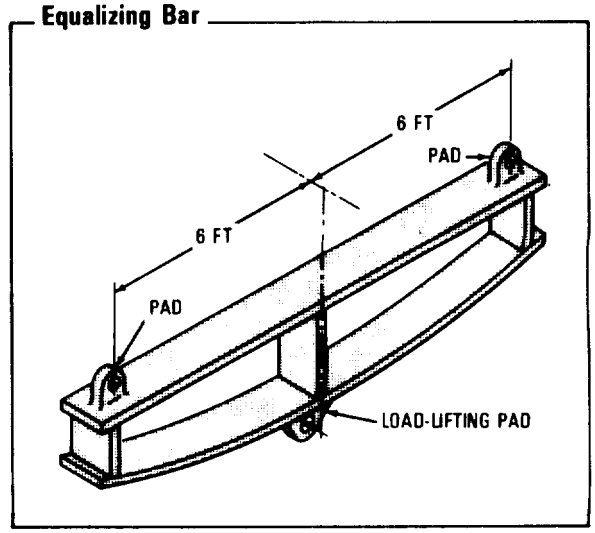
Two cranes may be combined to lift a load that is heavier than the capacity of one crane but not more than the combined capacity of the two.

If a 65-foot tug weighing 100 LTONs is to be lifted from the deck of a cargo vessel and set in the water, two cranes will be required to make the dual lift if the capacity of the largest crane is only 89 LTONs. The capacity of each crane need not be the same. In making the lift, the two cranes are lashed together with the stems of the cranes facing toward the cargo vessel. The cranes are also securely moored to the cargo vessel. If tugboats are used, two are needed-one on the side and one at the bow of the cranes. The bow tug will move both cranes out from the vessel after the load is lifted clear of the deck. The tugs on each side will steady the cranes and the lift. The lift is made from the stem of the cranes to allow sufficient boom reach over the deck of the cargo vessel. A dual lift is not good practice, but occasionally becomes necessary.

Equalizing bar

An equalizing bar, similar to that shown in the following illustration, should be used when the two cranes making the lift are of unequal capacity. The equalizing bar is constructed in various lengths and lifting capacities. It is provided with a crane hook shackle and pad at each end and a load-lifting pad underneath the center. The load-lifting pad is usually provided with several off-center adjusting holes. This permits two cranes of unequal capacities to share the load proportionally.

Equalizing Bar



Hand signals

Operators and signalmen should have a definite understanding of signals before making dual lifts. The signalman should have sufficient knowledge of crane operations to coordinate all movement of the two cranes. He should face the cranes and use both hands in signaling, indicating to the operators that his left hand applies to one crane and his right to the other. He should indicate the desired hoisting speed by raising one, two, or three fingers of each hand. When the speed of each hoist is the same, the same signal can apply to both cranes. When hoist speeds vary, the signalman may indicate one speed to one crane and a different speed to the other. Refer to the section on signals in Chapter 1.

The signalman may have to stop one hoist and allow the other to continue upward to keep the load level. The crane operator must continually observe the signals which apply to him and disregard any other signals or movements that would tend to distract his attention from the signalman.

CAUTION: The load must remain level at all times. If the load tilts, one crane is not carrying its load. This may damage the crane carrying the load or capsize one of the cranes.

Load transport

After the lift has been raised high enough to clear all obstructions on the deck, the crew drops the mooring lines, the tugs move out to clear the vessel, and the cranes lower the load at the place selected for unloading. In all of these operations, timing is of prime importance. The success of loading and unloading operations depends very much upon the signalman, who must be in view of the crane operator at all times.

SALVAGE WORK

When planning for this type of operation, the crane master or salvage officer in charge must remember that, while somewhat buoyant underwater, the same objects above water become dead weight. For example, an 18-ton boat will weigh only half that weight under water, but out of water it will weigh 18 tons, plus the weight of any water it may contain (35 cubic feet of water weighs 1 ton). This difference in weight is an important factor in salvage operations.

Most lifts are made with the crane barge moored to a wharf, vessel, barge, or any structure from which the crane is making the lift. Occasionally it is necessary to make a lift in open waters where there is no moorage. This is especially true in salvage operations. Under these conditions, use anchors to steady the crane while making the lift. Anchors must be well set (dug in) before attempting to make the lift.

The correct length of anchor line depends on several factors. These include the radius of the crane's swing on its anchor, the number of anchors used, and the condition of the sea at the time of anchoring. If the sea is calm, only a short length of line needs to be payed out. In a rough sea enough line should be payed out to ensure easy riding without dragging the anchor.

Mooring with two anchors is a procedure used when the crane is to be anchored where the allowance for swinging is limited, such as in a congested harbor. Two anchors may be used when doing salvage work; they are set in the following manner:

Step 1. The crane barge approaches the anchorage and drops the weather anchor.

Step 2. While veering cable, the crane barge moves back to the point where the leeward anchor is to be placed.

Step 3. The leeward anchor is then dropped. The cable is veered as the weather anchor chain is hove in and until the crane rides on an equal span between the two anchors.

SAFETY MEASURES

Operational precautions

A thorough knowledge of the limitations of a crane is necessary for safe and efficient operation. Diligent observance of operating precautions will reduce wear and damage to equipment and minimize the danger of inj ury to operating personnel. Some of the more important precautions to be observed in the operation of a crane are listed below:

ŽDo not lower the boom too far. The length of cable on the boom hoist drum may be only enough to lower the boom to its rest. Since there is no limit switch on the 60-ton crane to stop lower limit of boom travel, the operator must guard against completely unwinding the boom hoisting cable, especially if boom rest has been removed from deck. Lowering the boom too far may snap the cable at the drum and cause the boom to fall. This could result in injury or death to crane personnel, damage or destruction of boom, or damage to barge and any deck equipment in the boom's path.

- Be sure that all dog pawls not in use are engaged in their respective drum ratchets.
- Never rely on the brakes to hold a suspended load for an extended period. Brakes and drum may be hot from continued use and after cooling may contract and release the load.
- On the 60-ton crane, never release the boom hoist clutch before gaining control with the brake or the drum will tend to turn backwards. Failure to comply with this procedure will cause the boom to fall.
- Avoid prolonged periods of slow operation with electric, motor-driven hoists, both in hoisting and lowering loads.
- Avoid sudden stops. Sudden stops are unsafe and decrease crane lift.
- Never lift a load on the hook higher than necessary to slue safely over obstacles in its path.
- Do not use the auxiliary or main load hook to lift loads in excess of recommended weights shown on the radius indicator.
- Do not under any circumstances clutch more than one hoisting drum to the hoist-driving mechanism at the same time on the 60-ton crane.
- When a heavy lift is being handled with the crane, raise the lift only a few inches and then stop to check whether the electric brake or foot brake will hold. If brakes fail to hold properly, load should be set down and defective brakes adjusted.
- When setting it down, stop the load just before reaching the final position and then inch down onto supporting surfaces.
- On the 60-ton crane having no drum limit switches, the operator should never allow the hoist cable to unwind completely from the cable drum and then rewind in the opposite direction. This is likely to break the cable at its drum anchorage.
- Avoid unsteady acceleration or deceleration of the crane at the wrong point in the load's swing.
- If crane is to be rotated while the load is swinging rotate just after the load swings past the center of oscillation and is pulling the boom in direction of desired rotation.
- When approaching desired position, stop the boom rotation momentarily just before final point is reached. Then, as the load swings ahead, resume rotation, stopping just as load reaches end of its forward swing.
- In handling any load with the crane, raise the hoist hook at low speed until all s ackin hoisting cables and slings has been taken up.
- When restarting a motor-driven hoist to raise a suspended load heavier than 20 percent of the full load, move hoist master-switch handle quickly at least two or three notches. Otherwise, the load will go down instead of up. It is better yet to move the hoist master-switch handle to the last notch after load is suspended and then move it back to the notch which will provide proper hoisting speed.
- On a motor-driven hoist unit equipped with a magnetic brake for holding the boom and hoisting drums, be prepared at all times to use the drum brakes in case of magnetic brake failure.
- Before a lift, always check operation of controls to see that they respond properly.
- Always select controls suitable for the operation intended.
- Be sure there is adequate movement area for the intended operation of the crane.
- Perform all crane movements as directed by the signalman.
- Keep the swinger foot brake pedal depressed and locked when the crane is not swinging.

After operations and when readying the crane for sea, lower the boom onto the boom cradle and secure it with locking dogs. The locking dogs are located on the boom cradle The blocks are secured on deck.

Safety equipment

The crane operator must be informed of his working limitations at all times while lifting loads at various boom radii. This information is provided by a weight indicator, a boom-radius indicator, and a chart calibrated to show the combined results and limitations of hook loads and boom radii.

The weight indicator on a 60-ton crane is for all practical purposes a weighing machine or scale. It is essentially a cable stress gage mounted on the load line. In installation, the cable is deflected from a straight line over a plunger which operates against a diaphragm in the enclosed chamber of the instrument. Loads of different weights cause the deflection in the line to straighten out in varying degrees. Any additional force of the deflected cable against the diaphragm is transmitted to the operator's cab through a flexible liquid hose.

The radius indicator consists of a mechanical arm and linkage arrangement between a fixed pivot on the operator's cab to the boom. When the boom moves up or down, the radius is changed in varying degrees. Since the operator's cab remains stationary as the boom moves, the radius change can be calibrated on the chart. The radius and weight shown by the weight indicator can be combined into one calibration on the weight and radius indicator.

EMERGENCY CONDITIONS

The operation of a crane in rough water and high winds requires special handling procedures. Extreme care and skill should be used under these conditions.

Operating a crane in rough water demands careful maneuvering by the crew, especially the crane operator. If the water is rough or running a ground swell, the load must be lifted at just the right moment. Hesitation may shift the lift and endanger the crew. Movements of the 100-ton crane are too slow for operation under these conditions.

During crane operations in rough water, the lines leading from the vessel to the crane should have enough slack to allow for the rise and fall of the crane with the motion of the water.

During such conditions, the deck crew should be sure that enough lines are made fast to prevent the crane from breaking away. Sufficient fenders should be placed between the crane and the vessel to prevent damage. As a safety precaution, only necessary slings or other gear should be on deck. Any gear not in immediate use should be stowed and secured.

POWER GENERATION

OPERATOR'S CAB

To operate the crane efficiently and safely, the crane operator must be familiar with all the various controls in his cab. All operational hand levers, foot pedals, emergency switches, and pressure and operational instruments are located within easy reach and sight of the operator when he is seated. The crane weight indicator and radius indicator are easily visible to the operator for contant reference during operation.

Other controls and instruments are on or near the component which they control or gage. The oil pressure gage for the electrical generating unit is installed at a convenient place on the engine. All controls for starting the main diesel engine are usually located on the engine itself and are readily accessible. An instrument panel containing a lubricating oil pressure gage, fuel pressure gage, and pyrometer is usually mounted with a bracket to the main diesel engine.

After the main engine is functioning properly, all movements of the crane are controlled through the coordinated operation of the various controls, levers, and foot pedals in the operator's cab. The operational controls in the operator's cab of the 100-ton crane are the boom hoist master switch, main hoist master switch, auxiliary hoist master switch, rotate master switch, electromagnetic brake lever, boom swinger hand-brake lever, boom hand-brake lever, relay release button, and hydraulic brake pedals.

AUXILIARY DIESEL ENGINE

For initial operation, the auxiliary engine must be started first to supply starting air to the main diesel engine. During daily operations, starting air for the main diesel engine is stored in the air reservoir tank.

Starting procedure

Since several different makes of auxiliary diesel engines are used on the crane, the following is the general procedure to be used. For detailed information on a specific engine, refer to the technical manual for that engine.

Step 1. Check oil level in the crankcase.

Step 2. Check cooling water level in the engine and radiator.

Step 3. Open valves in fuel supply and return lines between the engine and day tank.

Step 4. Check battery for proper water level and for tight terminal connections.

Step 5. Make certain that the auxiliary generator circuit breaker is open and that the field rheostats are turned to the full-resistance position.

Step 6. Set throttle to about one-half open.

Step 7. Press starter button; the engine should start.

Step 8. Release starter button as soon as the engine begins to fire.

Step 9. Adjust throttle so that the engine will idle until warmed up.

CAUTION: The engine will pull at about 80 to 90 percent load immediately upon starting, but it is much better to allow 1 or 2 minutes at not over half load to prevant too rapid expansion of parts.

Step 10. If the engine does not start. varv the throttle setting while continuing to depress the starter button.

CAUTION: The engine should not be cranked for longer than 30 seconds at a time or the starting motor may become overheated.

Operating inspection

After the engine has started, the following inspection of the entire unit should be made to make sure all parts are functioning properly:

- Observe the lubricating oil pressure gage. If no pressure shows after the engine has run for 10 to 12 seconds, stop the engine and determine the cause.
- Check the cooling water temperature. Normal water temperature should be approximately 180°F. If the reading exceeds this temperature, stop the engine and determine the cause.

CAUTION: Do not operate the engine with the water boiling. The resultant heat rise on the cylinder walls will break down the oil film and also cause considerable water loss due to steaming.

- Observe the engine operation for smoothness, quietness, and exhaust condition.
- See that enough fuel is in the tank and that the fuel is being delivered to the fuel pump.
- Be sure there are no oil or water leaks.

Stopping procedure

The following steps outline the general procedure for stopping:

Step 1. Turn off all electric motors on the line.

Step 2. Open the auxiliary generator circuit breaker.

Step 3. Gradually slow engine speed to idle by adjusting the throttle; allow the engine to idle for approximately 10 minutes.

Step 4. Stop the engine by closing the throttle.

MAIN DIESEL ENGINES

Carefully follow the operating instruction manual for the specifc type and make of engines installed on the crane. Each different make of engine has certain features specific to that engine and its installation.

NOTE: Before starting the AC power-generating system, refer to Chapter 3 for operating procedures.

Starting procedure

The following procedure for starting diesel engines is general and will not apply in detail in all cases.

Step 1. Check the oil level in the crankcase.

Step 2. Check the water level in the engine cooling system.

Step 3. Open all the fuel oil valves in the supply and return lines from the engine to the day tank.

Step 4. Open the drain valve on the air supply line to drain all condensation.

Step 5. Check to see that the fuel pressure regulating control mounted on the engine or in the operator's cab is set at full throttle.

Step 6. Check to see that the main generator circuit breaker on the control panel is open and that the rheostats are turned so that all the resistance is in the circuit.

Step 7. Open the two vents on top of the high-pressure fuel oil pump, and operate the hand-priming pump until fuel oil flows from both of those points. Then close the vents and pump up the fuel oil pressure to approximately 1,500 psi with the priming pump handle on the high-pressure fuel oil pump.

Step 8. Set the governor control for approximately half speed.

Step 9. Set the fuel pressure-regulating valve at the third or fourth notch.

Step 10. Open the main starting air valve.

Step 11. Raise the starting air lever to the START position. Engine will then turn over on air.

Step 12. As soon as the engine begins to fire, return the starting air lever to RUN position.

Step 13. Run the engine slowly at first, adjusting the speed with the governor handwheel or lever.

Step 14. Adjust the fuel oil pressure to about 2,500 psi.

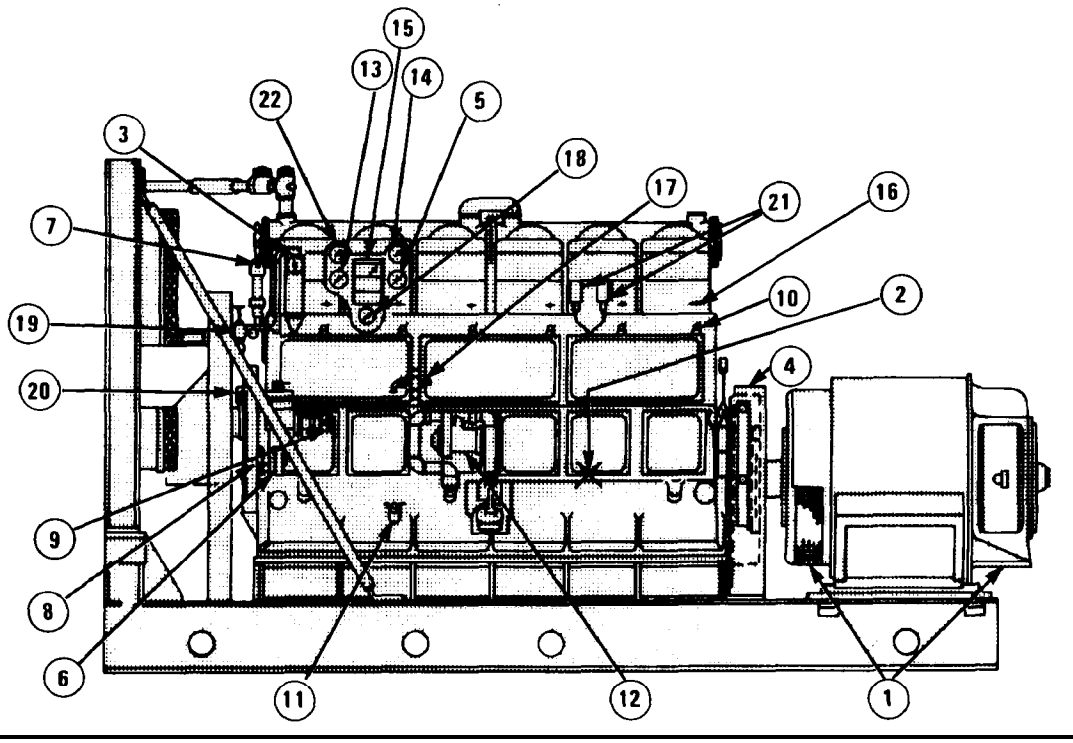
Step 15. Check the engine gages to see that all readings are normal.

Step 16. After the engine has warmed up, bring the speed up to full with the governor lever or handwheeL

Step 17. Start operation of the generators.

Refer to the following illustration for the locations of the engine controls and instruments on a typical diesel engine.

Typical Main Diesel Engine Controls and Instruments



1 AIR INLETS (SCREENED)
2 CENTER OF GRAVITY
3 DAY TANK AND FUEL FILTER
4 FLYWHEEL GUARD
5 FUEL OIL PRESSURE
6 FUEL OIL SUCTION CONNECT TO MAIN TANK
7 FUEL PRESSURE REGULATING VALVE
8 FUEL TRANSFER PUMP
9 GOVERNOR SPEED CONTROL
10 ISOLATING VALVES
11 LUB OIL DEPTH GAGE
12 LUB OIL PRESSURE PUMP
13 LUB OIL PRESSURE
14 LUB OIL PRESSURE
15 PYROMETER
16 SNIFTER VALVES
17 SPRAY VALVE TEST VALVE
18 STARTING AIR
19 STARTING AIR INLET
20 STARTING AIR LEVER
21 WATER TEMPERATURE ALARM AND LUB OIL PRESSURE ALARM SWITCHES
22 WATER TEMPERATURE

Operating inspection

During normal operation, observe the cooling water temperature, fuel oil pressure, lubricating oil pressure, and exhaust temperature. These readings should be kept within the limits given in the manual for that particular engine.

The feed from the mechanical lubricator should be adjusted to 15 to 20 drops per minute per feed. Observe the exhaust appearance. If it is smokey, investigate the cause. In most cases, faulty fuel injectors are responsible for smoke.

Stopping procedure

The following steps give the general procedure for stopping:

Step 1. Open the circuit breaker and main line switch before slowing down the engine. This will prevent the operation of electrical equipment on low voltage, which can damage motors, and the possibility of reversing the polarity if another generator is on the line.

CAUTION: Do not open the main line switch before opening the circuit breaker.

Step 2. Turn the load-limit control knob on the governor until the engine idles. Let the engine idle for about ten minutes, then turn the knob toward zero until the engine stops. The turning should be done slowly to prevent damage to the governor mechanism. Usually, it is unnecessary to turn the knob all the way to zero to stop the engine.

If desired, the engine maybe stopped without disturbing the governor setting. This is done by pulling the link connecting the governor linkage to the wedge shaft in the push-rod compartment of the cylinder block. This pulls out the fuel wedges directly, without recourse to governor action. A collapsible link in the mechanism permits this action without damage to the governor.

MAIN GENERATOR

The cranes are equipped with several types of main generators. The operation of these generators is generally the same. For specific instructions on one particular generator, check the operation manual for that generator.

Starting procedure

The following steps give the general procedure for starting the main generators:

Step 1. Before starting the diesel engine driving the generator, open the main and load circuit breakers.

Step 2. Open all control, field, and power switches.

Step 3. Turn the field rheostats until all resistance is in the circuit.

Step 4. Start the main diesel engine.

Step 5. Turn the voltage transfer switch to the 150-kilowatt generating position, and check to see that the voltmeter indicates a slight residual voltage.

Step 6. If the voltmeter reads backwards, the polarity is reversed in the generator field coils. To correct this, raise (disconnect) the brushes from the armature commutator and apply an external DC current of the correct polarity to the field coils.

CAUTION: It is important to isolate the armature to prevent its being damaged due to its low resistance.

Step 7. Close the field switch and gradually turn the field rheostat; note that the voltmeter reading increases.

Step 8. Continue to raise the voltage until the meter reads 240 volts.

Step 9. Close the main circuit breaker by turning the manually operated handle clockwise.

Step 10. Close the main line switch.

Step 11. Press the reset button to close the line contractors; recheck the voltage and reset to the proper value. Power is then applied to the hoist and slue controls.

Step 12. Place the lighting transfer switch to the 150-kilowatt generating position to feed power from the main generator to the lighting panel and air compressor motor.

Stopping procedure

The following steps give the general stopping procedure:

Step 1. Open the main circuit breaker by means of the manual trip on front of the circuit breaker.

Step 2. Open the main line switch.

CAUTION: Do not open the main line switch before opening the circuit breaker.

Step 3. Turn the field rheostat as far as it will go; note that the voltage decreases to a low value.

Step 4. Open the field switch.

AUXILIARY GENERATOR

Starting procedure

Before starting the auxiliary generator, refer to the operation manual for that particular generator. The following is a general procedure for starting an auxiliary generator:

Step 1. Before starting the auxiliary generator, open the auxiliary generator circuit breaker.

Step 2. Turn the auxiliary generator shunt field rheostat to put all of the rheostat resistance in series with the shunt field.

Step 3. Start the auxiliary diesel engine.

Step 4. Turn the voltmeter selector switch to position 4 so as to read the auxiliary generator line voltage on the panel voltmeter. When the auxiliary diesel engine comes up to rated speed, turn the auxiliary generator shunt field rheostat in the direction marked RAISE VOLTS until the the voltmeter indicates the rated voltage. Auxiliary generator power ON light should illuminate. The auxiliary generator is then ready to put across the line.

Step 5. Close the auxiliary generator circuit breaker. The auxiliary generator is now ready to deliver power to the barge auxiliary electrical equipment.

Step 6. Close the lighting transfer knife switch in AUXILIARY position. Auxiliary generator power can now be delivered to the immersion heater and air compressor controls by closing the knife switch for each. The switches are connected across the 240-VDC output of the generator.

Step 7. Close the lighting power knife switch to connect the lighting distribution panels to 240/120-VDC; 3-wire generator output (plus-to-minus, 240 VDC; plus- or minus-to-neutral, 120 VDC).

Stopping procedure

The following is a general stopping procedure:

Step 1. Open the auxiliary generator circuit breaker.

Step 2. Turn the auxiliary generator shunt field rheostat to put resistance in series with the generator shunt field.

Step 3. Shut down the auxiliary generator diesel engine.

GENERATOR CONTROL PANELS

Auxiliary generator panel

Operation of the auxiliary generator control is similar to that of the main generator. The exception is that the load circuit breakers are closed and the voltage transfer switch must be turned to the 10-kilowatt generating position. No field switch is used in the 10-kilowatt generator field. To supply the lighting panel and the air

compressor from the auxiliary generator, close the lighting transfer switch to the 10-kilowatt generating position.

For *overcurrent protection,* a trip coil is provided in each pole of the circuit breakers. The trip units are of the dual-magnetic type which are provided with an oil film timer. The tripping time decreases as the overload increases until, at currents of 10 times the circuit breaker rating and higher, the circuit breaker trips instantaneously.

In addition to the circuit breakers, main and auxiliary overcurrent relays are provided in the neutrals of the main auxiliary generators. These relays should be adjusted so that contacts close when the neutral current exceeds the maximum unbalance current rating of the generator. This unbalance is considerably less than the full-load rating of the generators. Therefore, the relays should be checked against the generator's neutral rating.

For *undervoltage protection,* a voltage device mechanically trips open the circuit breaker. To close the circuit breaker after it has been tripped, turn the manually operated handle counterclockwise toward RESET position until it stops. Then turn clockwise again to close circuit breaker. Circuit breakers are trip-free so that they cannot be closed unless the undervoltage device is energized and will trip instantly if closed with a short in circuit.

Main generator panel

A set of *ground detection lights* is provided for each generator. With the use of these lights, a ground between the generator and generator control panel can be detected before the generator is placed on the line.

The main generator should be tested for a ground before placing it across the line. This is done by closing the main generator circuit breaker, but allowing the main generator power-disconnect switch to remain open. This connects ground lights across the generator, and any detected ground must therefore be between the generator and generator control panel. When this test is completed, open the main generator circuit breaker.

The same test can be performed on the auxiliary generator. This is done by closing the auxiliary generator circuit breaker, but allowing the lighting transfer knife switch to be in either the open position or closed in the main generator position. A ground so detected must be between the auxiliary generator and auxiliary generator control panel.

When the main and auxiliary generators are placed on the line, any ground that shows up after performing the preceding tests must be either at the generator panel or on a circuit fed by the panel.

A ground is indicated when one of the ground lights dims and the other gets brighter. The light that is dim is on the grounded side of the line. The degree of dimming indicates the degree to which that side of the line is grounded, with total darkness indicating a complete ground. If both lights are dark, one of the ground lights may be burned out.

Ground lights on the auxiliary generator are protected against short circuit by a pair of 3-ampere, 250-VDC-rated fuses, one on each side of the line.

Ground lights on the main generator are also protected against short circuit by a pair of 3-ampere, 250-VDC-rated fuses, one on each side of the line.

Two white indicating lights mounted on the generator control section of the control panel indicate, when lighted, that power is available on the particular generator specified by the nameplate. These lights are connected from the positive side of the line to the neutral line for each generator.

Each generator has an *ammeter* and a *line ammeter* mounted on the generator control section of the control panel. The two ammeters for the main generator have a 0- to 800-ampere scale and for the auxiliary generator, a 0- to 150-ampere scale. On the 60-ton crane, the auxiliary generator has a 0- to 50-ampere scale on the ammeters. On either

generator, the difference between meter readings indicates the current flow in the neutral wire. On the main generator, this difference must not exceed 13 amperes. If this difference is exceeded, an alarm bell warns of an excessive unbalanced condition which needs to be reduced to a safer limit.

A 0- to 300-volt *voltmeter* is mounted on the generator control section of the control panel. This meter measures the supply voltage of both generators by means of a six-position selector switch, also mounted on the generator section of the control panel. The voltmeter is protected against short circuits from the auxiliary generator and the main generator by 3-ampere, 250-VDC fuses.

The *neutral alarm control circuit* on the 60-ton crane is connected across the 240-VDC transfer poles of the lighting transfer knife switch. It is protected by control fuses.

When the neutral wire is in use (only when the lighting transfer knife switch is in either the MAIN GENERATOR position or the AUXILIARY GENERATOR position), the neutral alarm control circuit is connected to the 240-VDC supply of the generator in use. When the current in the neutral wire exceeds 10 percent of the rated output of the generator (for the main generator, this current is 80 amperes and the auxiliary generator, 13 amperes), a series current relay becomes energized and closes its control circuit contact in the alarm control circuit.

The neutral alarm relay closes its control circuit contact on a neutral line overload. This energizes the auxiliary alarm relay, and the two control contacts of the auxiliary alarm relay close. One contact energizes a red light marked AUXILIARY GENERATOR NEUTRAL or MAIN GENERATOR NEUTRAL, as applicable, on the generator section of the control panel. The other contact energizes an alarm bell. To turn out the light and also shut off the bell, either open the lighting transfer knife switch which disconnects the neutral from its load or balance the load on the 120-VDC service.

Balancing the 120-VDC load on either the main or auxiliary generator can be done by removing the load that sounded the alarm or by adding additional load to balance out excess current in the neutral line.

AIR COMPRESSOR

Before starting the air compressor, check the oil level in the crankcase of the compressor according to lubrication orders. Check the motor bearing for proper lubrication.

Air compressor rotation must be the same as shown by the arrow on the flywheel. When starting the compressor with the pressure tank, the load on the motor is reduced by unloading the compressor. This permits the compressor to start without working against a load, thus guarding against overloading the motor and belts.

An automatic pressure switch is used to start and stop the air compressor. It is connected to the air pressure tank, and it starts and stops the motor at pressures stamped on the nameplate. Do not change the setting except to reduce pressure.

Operation of the air compressor should include a check of system pressures at all air gages. This is to ensure proper air service supply for both high-pressure starting of the main engine and low-pressure operation of the hoist and clutches on the 60-ton crane. Actual operating supply pressures should be approximately 250 psi and 110 psi for the respective systems. Operation of the electric-air interlock switches should be checked. In addition, blowoff valves in all airlines should be momentarily operated to remove entrained condensate from the lines. This includes the valves at the air separator and main diesel engine, three valves at the air clutches, and two valves in the operator's cab.

When the compressed air system is ready for service, the main diesel engine may then be started to supply power for crane operation. In normal crane service, compressed air stored in the air bottle provides for immediate starting of the main diesel generator and eliminates the necessity of starting the auxiliary diesel generator unit.

HOIST/ROTATE OPERATION

Once the main generator is operating satisfactorily and placed on the line, the crane is ready for load-handling operations. The hoisting functions for which the crane has been designed are raising and lowering the boom, main hoist block, and auxiliary block. Assuming that the crane machinery has been checked and readied for service, the following procedures should be observed in actual engagement and operation of the hoist machinery by means of the operator's cab controls. In all explanations, the terms aft and forward, when used in relation to manipulation of the operator's controls, will mean toward the rear or the front of the cab respectively.

CAB CONTROLS

It is necessary that both the hoist and rotate master switches be in the NEUTRAL position before attempting to engage the RESET button for crane operation. This prevents accidental starting of either the hoist or rotate motor before the RESET button is closed. With the master switches set, push the reset button to complete the power circuit to the main panel board contractors. Hoist and rotate motor operation is then possible by manipulating the respective master switches.

The proper fuel pressure for the main diesel engine should be set to handle the intended load operation, using the maximum setting for the very heavy load conditions. From experience the operator determines the best position of the control in relation to the operation of both the diesel engine and its generator. To increase the fuel oil pressure to the main diesel engine injectors on the 60-ton crane, move the control handle toward the left of the operator's cab. This control is effective, however, only when the similar control installed on the main diesel engine is set in the FULL THROTTLE position. The fuel oil pressure to the main diesel engine injectors is set on the engine of the 100-crane and cannot be controlled manually.

BOOM

Precautions

Before any crane operation or use of the hoist brakes. the boom hoist hydraulic brake is disengaged and the boom is held in position by engaging the boom hoist pawls and the boom hoist electic brake. On the 60-ton crane, prior to any crane operation or use of the main or auxiliary hoist on the 60-ton crane, the boom hoist air clutch is disengaged. The boom should then be held in position by having boom hoist pawl engaged in top position and boom hoist mechanical brake set in aft position.

Before the boom may be lowered or raised, release the boom hoist hand-brake lever. This leaves the boom hoist drum secured by the hoist electric brake and boom hoist drum pawl. During hoisting make sure that the hoist blocks do not come in contact with the block limit switch weights. This condition would prevent operation of the hoist controller circuit. On the 60-ton crane, move the boom hoist air clutch lever toward the rear of the cab and leave it in this position. This permits compressed air to inflate the air clutch built onto the boom hoist cable drum and thus engage that drum with the driving mechanism.

Hoisting

The boom may now be raised to the desired operating position by lowering and latching the boom hoist pawl lever and drawing the handle of the hoist master switch toward the operator. These latter movements always are associated, since the pawl will remain engaged to the drum ratchet as a result of tension developed by the load and will be released only when tension is relieved by a hoisting movement of the drum. This tension engagement of the pawl is a desirable feature, since it ensures positive hoisting control of the drum prior to pawl release. Raising of the boom can then be stopped by returning the hoist motor and automatically allows the hoist electric brake to be set. At this time, the operator should always be ready to engage the hoist drum brake in the event of failure of electric brake. The boom hoist pawl should then be reengaged by raising and latching the boom hoist pawl lever and, if necessary,

by inching the boom down until the pawl engages the drum ratchet. Engagement of the pawl with the ratchet can be felt by the operator when inching if the pawl lever is held just short of the top seating position for the lever handle. After the pawl is engaged, the boom hand brake should be set to lock the boom host drum in position.

On the 60-ton crane, the boom air clutch control valve lever may then be pushed forward, past the center of its NEUTRAL position. This releases the air from the boom hoist air clutch, which in turn disengages the boom hoist drum from the driving mechanism. The clutch lever can then be returned to its neutral position. Under no circumstances should the boom hoist air clutch be released on the 60-ton crane until the boom hoist mechanical brake has been applied to lock the drum. Application of this brake and engagement of the pawl are positive actions designed to prevent the possibility of dropping the boom. This could occur if the hoist master switch was accidentally operated when the clutch had been released and the mechanical brake and pawl had not been engaged.

The hoist master switch has five operating speeds for both hoisting and lowering operations. Each step is progressively faster as the switch is moved away from the OFF or CENTER position. It is possible to move the handle of the switch to any position immediately without danger to the control equipment, and at times it may be desirable to do so. However, the operator should not resort to such switch operation at high speeds when there is slack in the hoist block cables, since this will cause jerky movement of the load.

Lowering

The boom should be lowered only when both the main and auxiliary hoist drums have been secured. To lower the boom on the 60-ton crane, engage the boom air clutch in the same manner as described in raising the boom and release boom hoist mechanical drum brake. Operate hoist master switch handle to raise the boom slightly while lowering and latching the boom hoist pawl lever to disengage the boom hoist pawl. The hoist master switch handle may then be moved forward past the OFF position to lower boom to the desired operating position. When such position has been reached, return the master switch to the OFF position. Secure the boom hoist drum by engaging the boom hoist pawl (setting the boom hoist mechanical brake before releasing the boom hoist air clutch on the 60-ton crane), and setting the hydraulic brake before releasing the electric magnetic brake. The same precautions relating to use of the various controls in raising the boom apply to boom lowering operations.

Limit switches

On the 60-ton crane, a limit switch installed at the foot of the boom is set to limit upper travel of the boom just short of contact with the A-frame bumper. Limit switches are also installed on the boom adjacent to the block sheave assemblies. This is to prevent both the hoisting of blocks into the boom and the drawing of blocks into the boom while lowering it.

The block limit switches on the 60-ton crane act only to open the hoisting circuit during block hoisting operations, and the blocks may be lowered under power by reversing the hoist master switch. However, when the boom is lowered and draws either block in sufficiently to actuate its limit switch, both the hoisting circuit and lowering circuit are disconnected. This situation is due to the installation of a boom hoist air interlock switch. This switch is actuated by the boom clutch air pressure to reverse the setting of its contacts and thus transfer the lowering circuit through the block limit switches when the boom is operated. When a block limit switch is tripped in a boom-lowering operation, secure the boom hoist drum, release its clutch, and lower the block that has actuated its limit switch before resuming crane operation. These switches should be tested and adjusted at the time of initial crane operation and checked once daily afterwards.

MAIN HOIST BLOCK

Precautions

Before raising or lowering the main hoist block, the hydraulic brake should be released and all pawls engaged. On the 60-ton crane, all clutches should be released and all pawls and mechanical brakes engaged before raising or lowering the main hoist block. Operational control of the block is then similar to that used for boom hoisting and lowering.

Hoisting

To hoist the main block, move the main hoist master switch aft. This releases the electric magnetic brake and begins the hoisting operation To hoist the main block on the 60-ton crane, move the air clutch control-valve lever toward the rear of the cab. and leave it in this position to engage the main hoist drum clutch. Then release the main hoist drum mechanical brake bv depressing the main hoist foot-brake pedal and simultaneously moving it toward the rear of the cab. This disengages it from its dog plate and then allows it to rise under its own tension. To raise the main block, lower and latch the main hoist paw] lever and move the hoist master-switch handle toward the rear of the cab. These operations are performed together for the same reasons outlined under boom-hoisting operations.

The block may then be stopped at any operating position by returning the hoist master switch handle to the OFF position. The main hoist drum pawl and mechanical brake should then be reengaged. Use of the pawl lever in this operation is similar to the pawl-engagement operation described for securing the boom hoist drum. The main hoist drum mechanical brake on the 60-ton crane is engaged by pressing down and forward on the brake pedal to the extent of its travel. The ratchet face of the pedal lever should automatically remain engaged with the dog plate when foot pressure is removed. The clutch control lever is then moved forward past its center position to release the main hoist drum clutch. The main hoist drum electric magnetic brake is engaged when the main hoist master switch is placed in the NEUTRAL position.

Lowering

The main hoist may be lowered when both the boom and auxiliary hoist drums have been secured and the brake released. To lower the hoist, engage the main hoist drive motor and release its brake. Then operate the hoist master switch handle to raise the block slightly while lowering and latching the pawl lever to disengage the drum pawl. The hoist may then be lowered by reversing the hoist master switch. Secure the hoist at the end of the lowering operation by reengaging the pawl and brake and then disengaging the drive motor.

The precautions previously stated for boom-hoist operations relative to master switch handling, electric magnetic brake, and hydraulic brake (preparedness for emergency operation of the mechanical brake) apply equally to main hoist operations. The operator should also prevent the main hoist from contacting the block limit switch.

AUXILIARY HOIST BLOCK

On the 100-ton crane, raising, stopping, and lowering the auxiliary hoist block are controlled by the auxiliary hoist master switch, the electric magnetic brake, and the hydraulic foot brake. On the 60-ton crane, the same operations are controlled by the hoist master switch, auxiliary hoist air clutch-control lever, pawl lever, and foot-brake pedal. This is done in a manner similar to that described for operation of the main hoist. All previously stated precautions in the operation of the controls apply to the use of the auxiliary hoist.

BOOM AND HOIST BLOCKS

In handling any load with the crane, it is extremely important that the hoist blocks be raised at low speed, or by inching, until all slack in the hoisting cables and slings has been taken up. Such care prevents the cables from whipping (by not tightening them too suddenly) and strains them less than is probable by any other movement. The load on the hook should not be raised higher than is necessary to pass safely over obstacles. Loads in excess of the weights shown on the radius indicator should not be lifted on either

the main or the auxiliary hoist. Under no circumstances should more than one hoisting drum be engaged for operation at the same time.

A heavy load should always be raised only a few inches and then stopped to check whether either the electric brake or respective drum mechanical or hydraulic brake will hold it. If brakes will not hold, the load should be set down and the brakes adjusted or replaced.

In hoisting, the first point on the master switch provides only enough power to lift about 20 percent of the full load. When the load is heavier than 20 percent of full load and is suspended entirely on the hook, the hoist master switch control handle must be moved quickly to at least the second notch to prevent the load from descending. Usually, it is best to move the master switch handle to the last notch after the load is suspended and then move the handle back to the notch which will provide the desired hoisting speed. In hoisting operations, the auxiliary block travels much faster than the main block but can handle only about one-fourth as heavy a load.

Limit switches on the shaft of each hoist drum are set at the beginning of each hoisting operation and remain set throughout the operation. A limit switch override relay button can be actuated to bypass the limit switch if the hoisting blocks or boom must be moved beyond the limits of the switch.

Since there is no lower limiting control for boom or hoist travel on the 60-ton crane, always prevent the bottom of the boom from being lowered below the top of the boom cradle. For example, sufficient cable is provided for hoist block operations to allow the main hoist block, when at a 73-foot radius, to be lowered to 50 feet below the hull deck level. The auxiliary block, when at a 100-foot radius, may be lowered to 75 feet below the hull deck level. Lowering either the boom or blocks below these defined points might allow their respective cables to unwind completely and rewind in the opposite direction or to part from the drum, thus allowing the boom or respective block to fall.

Prolonged perids of slow-speed operation should be avoided, both in hoisting and lowering the load. Such operation wastes power and time and overheats the motor and the resistors. The load should be moved as rapidly as safety and other circumstances permit, allowing ample time for slowing down smoothly before the final stop. For safety and maximum crane life, quick stops should be avoided except in cases of emergency. The operator should always be prepared to operate the mechanical brake in any emergency during all load-handling operations.

The boom generally should be stored in the boom cradle during inoperative periods of the crane, with crane tensions eased from carrying the full weight of the boom.

ROTATE MACHINERY

The rotate machinery rotates the entire crane structure upon the whirler base to move a load laterally after it has been hoisted. This motion of the crane is controlled from the operator's cab by manipulating six control units. These are the rotate master switch, rotate brake pedal, rotate brake parking push button, spud lock lever, spud lock bypass push button, and the spud limit switch.

Presuming that the crane structure is locked in the fore and aft position relative to the barge hull with the boom in the forward boom cradle, the procedures for rotate operation are described as follows.

Before any rotate operation, the boom must be lifted from the cradle. It is also advisable to hoist the main and auxiliary blocks sufficiently to clear any obstruction in the intended rotate path of these units. However, this operation generally is not necessary since blocks usually are fully hoisted when boom is in the cradle.

On the 100-ton crane, the rotate hydraulic brake and the electric magnetic brake are set when the rotate swinger is in the parked position. Releasing the hydraulic hand brake releases the rotate swinger from the parked position. Placing the rotate swinger master

switch in the NEUTRAL position releases the electric magnetic brake and allows the crane to rotate right or left, as desired. On the 60-ton crane, the rotate hydraulic brake spring is set in its parked position when contractors on the main panel board are opened. It must, therefore, be released before rotate operation. One full depression of the rotate brake pedal releases this brake from the parked position, at which time the parking push-button light is illuminated. Further operation of the foot-brake pedal will then slow or stop the crane in rotate operation.

The rotate spud lock must be disengaged by raising and latching the spud-lock lever in its top position. This causes the spud limit switch, located just below the handle, to close its contacts and complete circuit to the rotate master switch.

Wind pressure or listing of the crane may cause the spud to become bound in its locking notch. This prevents its immediate release by the spud lock lever control. The spud lock bypass push button should then be engaged to bypass the contacts of the spud limit switch, which will remain open since the spud lock lever cannot be raised. This bypass permits control by the rotate master switch of the first speed point, and the crane structure may then be inched in either direction of rotation to free the spud. A steady upward pressure on the spud lock lever should be maintained during this procedure so that the lever may be lifted and latched the moment the spud is free.

The crane structure and boom may now be rotated to the left by moving the rotate master switch handle forward from the OFF position, or to the right by moving the handle toward the rear of the cab. This motion may be carried out in either direction at any of the five speed points of control provided by the master switch. The switch handle may be moved immediately to any speed point without danger to the rotate motor, since acceleration is automatically timed by the control panel for rotate operation. In a rotate operation the operator should be aware of any obstacles or structures which must be avoided in the load-transfer path. The rotate brake pedal should be used to slow the rotate operation when desired or to assist in bringing the rotate motion to an emergency stop. In the event of power failure, the crane will automatically be brought to a gradual stop by the parking action of the brake. Stop rotation of the crane by placing the rotate master switch in the NEUTRAL position to set the electric magnetic brake and, at the same time, depressing the rotate swinger hydraulic brake pedal. On the 60-ton crane, crane rotation is stopped by letting it drift with the master switch off and by using the foot brake, regulating the stopping time as desired by varying the foot pressure on the pedal.

Excessive load swinging may be caused by unsteady acceleration or by starting and stopping while the load is swinging slightly. If rotation must be accelerated while the load is swinging, accelerate just after the load swings past the central position and is pulling the boom in the direction of desired rotation. This uses the energy of the swinging load to aid acceleration and also reduces swinging of the load. When approaching desired final position, boom rotation should be stopped momentarily just before the final point is reached. Then, as the load swings ahead, rotation should be started again and stopped just as the load reaches the end of its forward swing. With some practice in timing these movements, the operator can stop the load and boom in a vertical line over the spot where load is to be set down. Also, he can go through the entire rotating motion with a single forward swing of the load.

Once the rotate motion has been stopped, the crane may be parked in any position by operating the rotate brake-parking push button. This will activate the solenoid on the magnetic brake and thus hold the crane in the position where it has been stopped. The indicating light associated with the push button will go out when the crane is parked. In securing the crane for an inoperative period, the opening of the contractors on the rotate panel will also activate the solenoid on the magnetic brake.

To secure the crane with the spud, orient the crane with the boom centered over the forward boom cradle, In this position, the spud is approximately over the spud catch lock. Then unlatch and lower the spud lock lever, and relatch it in its bottom position. This will engage the spud in its catch lock and at the same time open the contacts of the spud limit switch, preventing rotate operation of the crane. If the spud lock lever cannot be latched in its lower position, the spud is not quite in line **to** enter the catch block. Rotating the crane slightly, using the spud bypass push button, is then necessary to orient the crane structure with the engage spud properly. The spud catch block is sloped on both ends to raise the spud as it approaches, and the spud is partially counterweighted to aid in lifting. With one hand on the spud lock lever, the operator should exert a little downward pressure so that he can feel the spud action and make sure that the spud is properly seated. After this, the boom can be lowered onto the boom rest and the cables slightly slackened.

It is possible to lower the spud while the crane is in full rotate motion. However, to do so would place undue strain upon the entire crane structure, perhaps damaging some of the crane's equipment or injuring personnel. Therefore, the operator should never attempt to lower the rotate spud while the crane is in full rotate motion.

Controlled from the cab, the remote-control bleeder allows the operator to remove air from the fluid line when necessary. He simply presses a push button and pumps the control cylinder foot pedal. One person can quickly bleed the hydraulic system with the remote control bleeder. Maximum braking efficiency is maintained by keeping the lines constantly full of fluid,

UNUSUAL ENVIRONMENTAL CONDITIONS

COLD WEATHER

Cooling system

If the engine will be subjected to temperatures of 40°F or lower, either while running or shut down, an antifreeze as prescribed by appropriate instructions must be added to the cooling system. Before adding antifreeze solutions, make sure that the cooling system is free from rust or other foreign matter. Tighten all water connections, inspect water pumps for leaks, and adjust the fan belt to proper tension.

Refer to the technical manual for engines installed on the crane for special cold weather starting procedures.

Fuel oil

Condensation of moisture in the air will cause freezing of the fuel lines unless the following precautions are taken:

ŽUse filter paper or strainers when filling fuel oil tanks or when transferring fuel.

ŽRemove ice or snow from fuel tanks and fuel-handling equipment.

•Tighten caps on fuel oil tanks.

ŽKeep tanks filled if possible.

•Use only authorized grades of diesel fuel oil.

Electrical system

Clean and inspect all wiring, giving special attention to battery terminals and connections. Make sure that ice is removed from all wires and connections.

WARNING: Do not use a sharp instrument to remove ice form electrical components. Failure to observe this rule may result in damage to the equipment and injury to personnel.

Make sure there are no short circuits in the wiring due to ice seepage. Fully charged batteries can withstand temperatures as low as -35° F before freezing. During operations in extremely cold weather, take frequent hydrometer readings to check the battery charge.

CAUTION: Always charge the battery when water is added during cold weather.

Barge hull

When operating in northern waters, take necessary precautions to prevent the barge hull from being damaged when traveling through heavy ice. If moored in only one place, the crane can be used in extreme cold to the same extent as any similar piece of equipment. Make certain that all wire rope, lines, and blocks are free from ice and snow before operating.

CAUTION: If there is any danger of a solid freeze, the barge should be moved to warmer waters, since the hull plating may be crushed and the barge sunk.

EXTREME HEAT

When operating under conditions of extreme heat, pay particular attention to the cooling systems of both the main and auxiliary diesel engines. Check the cooling systems frequently for leaks, and make certain that circulation is not impaired. Check fan belts for condition and adjustment. Check air cleaners to make certain that they are well supplied with oil. Make sure that the proper lubricating oil has been added to the engine; consult the applicable lubrication orders for the proper grade of oil. Check and replace oil filter element at more frequent intervals when operating in hot weather.

ROUGH WATER

The barge is vulnerable to high winds and rough water due to its shallow draft. These elements make special handling of the load necessary. If the wind velocity exceeds 20 miles per hour (MPH), be careful when picking up or setting down loads to prevent bounce. Rough water, which usually accompanies high winds, may cause rough landings and pickups, resulting in damage to cargo. Extreme care and skill should be used under these conditions.

MOORAGE AND SECURITY

ANCHORING PROCEDURES

Most lifts made by a crane are done while the crane is moored to a wharf, vessel, barge, or any structure from which the crane is making the lift. Occasionally it is necessary to make a heavy lift in open waters where there is no moorage. This is especially true in salvage operations. Under such conditions use anchors to steady the crane while making the lift. Anchors must be well dug in before a lift is attempted.

The scope or length of the line from the anchor to the crane depends on such factors as the radius of the crane's swing on its anchor, the number of anchors used, and the condition of the sea at the time of anchoring. If the sea is calm, only a short length of line needs to be payed out, but in a rough sea, enough line should be payed out to ensure easy riding without dragging the anchor.

Mooring with two anchors is the procedure used when the crane anchorage has only limited allowance for swinging, such as in a congested harbor. Two anchors may also be used for mooring alongside a wreck or while doing salvage work. To do this, the crane approaches the anchorage and drops the weather anchor. While letting out the cable, the crane moves back to the point where the leeward anchor is to be placed. The leeward anchor is then dropped. As the cable is let out, the weather anchor chain is hove in until the crane rides on an equal span between the two anchors.

Anchor, 315-pound

The forward, hand-operated deck or motor-driven anchor windlass, with 350 feet of 7/8-inch, 6-by-12 improved plow steel cable, is

used for the forward, 315-pound anchor. To lower and raise anchor, proceed as follows:

Step 1. Position the davit arm in the port davit socket and secure the blocks, tackle, and vang lines to the davit.

Step 2. If a hand-operated windlass is used, place the anchor windlass operating handles in position on the windlass. These handles normally are stowed in brackets on the side of the windlass.

Step 3. Release the windlass brake and disengage the pawl at the bottom left side of windlass. Operate windlass to pay out sufficient cable to engage socket of the cable to the end link on the anchor; then secure brake and pawl. Securing the brake and pawl is very important, as the windlass will turn rapidly if the anchor is accidentally dropped with the brake and paw] released. This creates a dangerous situation with the operating handles in place. The cable should lead from the bottom of the windlass reel and below the preventer bar of the double roller on the head log before connecting to the anchor.

Step 4. Engage the trip hook on the davit blocks to the eye anchor shank, making sure that the trip line is engaged and held by one of the deck crew.

Step 5. Raise and swing the anchor overboard and lower below deck level until the cable can be reeled in to support the weight of anchor.

Step 6. With brake and pawl engaged, the trip hook can then be released by pulling the trip hook line.

Step 7. Lower the anchor by disengaging the pawl and releasing the brake.

Step 8. After lowering the anchor, secure the wire rope stopper to the anchor cable to supplement the holding power of the windlass brake.

Step 9. Check to see that the windlass pawl is engaged.

Step 10. Disconnect the wire rope stopper and release the windlass brake.

Step 11. Operate the windlass to raise the anchor to a position just below deck gunwale, and engage trip hook of block in eye on anchor shackle.

Step 12. Hoist anchor with the davit block, tackle, and swing inboard. Secure all equipment in its proper stowed position.

Anchor, 770-pound

The 350 feet of l-inch, 6-by-12 improved plow steel cable, stowed on the cable reel immediately forward of the crane base, is intended for use with the 770-pound anchor. To lower and raise the anchor, proceed as follows:

Step 1. Mount the operating handles on the cable reel. These normally are found stowed on the forward end of the crane base.

Step 2. Disengage the hand brake and paw] pin on the cable reel. Unwind slightly more than sufficient cable to connect the socket of the cable to the end link of the anchor; then reengage the cable reel brake and pawl pin. The cable should lead from the bottom of reel in this operation.

Step 3. Place the davit arm in the forward starboard davit socket, and handle the anchor as described in Steps 4 through 8 for the 315-pound anchor. In this instance, the cable should fall in the bosom of the open chock on the head log that is in direct line with the cable reel.

Step 4. Hoist the anchor with the deck winch. With the cable reel brake and pawl pin engaged, disconnect the deck bridle connections of the wire rope stopper, leaving the stopper gripped to the cable. Secure the free ends of the stopped bridle with the 2-inch Manila hawser (provided with the vessel's equipment), and reeve the free end of the hawser through the forward deck snatch block.

Step 6. With several wraps of hawser engaged to the deck winch, operate the winch to haul in the anchor cable. At the same time, operate the cable reel to secure any slack in the cable and then secure the reel to hold the slack.

Step 6. The wire rope stopper should then be removed form the cable, carried forward with the hawser still engaged, and reapplied to the cable for further hauling operation.

Step 7. When the anchor is fully raised, stow and secure all equipment in its proper position.

Stern anchor

No cable or reel is provided specifically for use with the stem anchor on the 60-ton crane. The 2-inch Manila hawser and aft deck winch can raise and lower the stem anchor when no other cable is available. To lower and raise the anchor, proceed as follows:

Step 1. Engage the hawser to the end link of the anchor; reeve the free end through the stern deck snatch blocks and around head of winch.

Step 2. With the davit arm placed in position, raise, swing, and lower anchor overboard until winch can be operated to hold the weight of the anchor.

Step 3. With proper control of winch and hawser established, trip the release hook until the davit falls, and lower the anchor by operating the winch.

Step 4. The free end of the hawser should then be secured to one of the deck bitts on the aft deck.

Step 5. To hoist anchor, reverse the preceding steps.

Warping lines

The following Manila warping lines are provided and are normally stowed in the forward hull stowage compartment when not required for vessel operation:

- 600 feet of 2-inch-diameter Manila rope
- 300 feet of 1 1/2-inch-diameter Manila rope
- 300 feet of 3/4-inch-diameter Manila rope

MOORAGE

A floating crane is moored when it is secured alongside a pier or vessel, when made fast to a mooring buoy, or when lying at anchor. Mooring involves bringing the crane alongside or to any location without damage to the crane or the landing. It also involves securing the crane or the landing so that it will lie there safely despite changes in wind and tide.

Equipment

Names and uses of lines in mooring should be thoroughly understood. The following mooring lines are generally used when making fast to a pier or vessel:

ŽThe bow line is routed forward through a bow chock to prevent the crane from moving astern or away from the pier or vessel.

ŽThe breast line leads at an angle of approximately 90 degrees with a fore-and-aft line of the crane. It is used to prevent the moving of the crane away from the pier or vessel.

Ž A spring line leads at an angle with the fore-and-aft line of the crane to prevent fore-and-aft movement.

ŽThe stern line leads aft from the stem of the crane to the pier or vessel. It is used to prevent the movement of the crane forward or away from the pier or vessel.

The term “ground tackle” refers to the equipment used in anchoring the crane. It includes anchors, cables or chains, and connecting devices. It is associated with the windlass or winch and is provided only on those cranes intended to be taken to advance bases or unequipped harbors. At these bases or harbors, ground tackle is important to the safety of the crane and must be given the best of care.

Environmental precautions

When docking or moving a crane close in to shore, extreme precaution must be observed to prevent damage by underwater obstructions. This precaution is especially important

when operating at strange beachheads or improvised ports. Little force is required to damage a crane enough to put it out of operation. When in doubt about the underwater obstructions, make necessary soundings from a rowboat to determine safe entry before proceeding to dock or before working close to shore.

The current will sometimes move the crane away from or toward the dock or vessel. When this condition exists, the deck crew must make the crane secure. Extra lines should be placed at the section of the crane meeting the current.

The wind will greatly affect proper handling of the crane because of the crane's shallow draft, its freeboard, and its high and heavy superstructure. When the crane is alongside a dock or vessel, care must be taken to secure it. High winds also tend to force the load into uncontrollable swings. This is especially true when large bulky loads are being handled. Heavy, bulky lifts should not be attempted in high winds.

When a crane is tied alongside a vessel, the tide will usually have little effect on the crane, but in a fast-flowing tide, extra lines maybe needed to resist the strain. When the crane is made fast to a wharf, the crane lines will have to be slacked off or taken up to adjust the crane to the rise or fall of the tide. This adjustment of lines is important at night when most of the crew will be ashore.

Handling precautions

Lines properly handled greatly assist in making or clearing a dock. Lines are named to prevent confusion and add to the efficiency of line handling. Before bringing the crane alongside, the lines required to go ashore should be available, through the proper chocks, and clear of all obstructions on the deck. A heaving line should be made fast near the eye splice, not at the end of the bight where it will become jammed when the eye is placed over the bollard on the pier. Heaving lines should be passed as soon as possible. The heavy lines, the bights of which are hard to handle, maybe run later when the crane is in position.

Use fenders to prevent damage to the crane and the vessel or shore structure to which the crane is being moored. Fenders are made of cordage, rubber, or wood in various shapes and sizes. Fenders should be large enough to distribute the pressure over a wide area. Fenders are also used while hoisting boats when, due to the roll, there is danger that the boat will swing against the crane side. Having fenders routinely ready for use is of utmost importance. An adequate number should be placed at convenient points along the deck before going alongside. When it is apparent that the crane is about to touch, a fender should be put over the side at the point nearest to the striking point. Wooden spars or floats (camels) may also be used.

To move a crane by "warping" is to change the position of the crane with respect to a wharf, dock, or vessel. This is done by manipulating a common line attached to both objects. A winch on the crane provides the force to change the position of the crane. One end of a line is attached to a fixed point on a wharf or vessel and extends to the winch on the crane. The line is wound around the head of the winch, and the loose end of the line is held by the operator. As the loose end is pulled, the line grips the surface of the head and winds in, thus pulling the crane toward the other end of the line. When the operator on the crane slacks the line, it loses its grip on the winch head. In the above operation, the line is led through a fairlead, which may be a chock, bollard, cleat, snatch block, or similar device.

SECURITY

Under normal conditions, the crane crew works only during the day. After operations have ceased, the rigger in charge should make sure that the crane is made fast to a wharf or moored off. The crane's rotating gear should be secured by engaging the rotate brake and spud lock, and the boom should be resting on and secured to its cradle. All gear should be returned to its proper place. When conditions require, the engineman in charge of the engine room should detail sufficient personnel in the engine room to operate any

auxiliary equipment which may be needed for lights or heat. The normal watch should be maintained at all times when the crane is not in use.

Before towing the crane to waters outside the harbor or to other ports for salvage or similar work, secure the barge by–

- Battening down all hatches, manholes, and inspection covers.

ŽEngaging the rotate lock.

ŽSecuring the boom in its cradle.

- Making sure the bilge pumping system is in good operating condition.

Before towing the crane barge overseas, the crane must be deactivated according to the deactivation procedures in the following section.

DEACTIVATION

FOR WET STORAGE

This section describes the procedure to deactivate the floating crane for wet storage or an oversea tow. The deactivation procedure requires the constant supervision of the crane master and boatswain. TB 740-97-4 is the guide for the detailed specifications, sequence of procedures, and specific preservatives to be applied to the components and equipment. Preservation, security of loose gear and equipment, and watertight integrity are the main objectives in the deactivation process. Prepare the components and equipment of the crane according to the following steps:

Step 1. Install bracing for the machinery house rotate machinery.

Step 2. Remove the floodlights, warning horn, and anchor lights.

Step 3. Close all hatches, manholes, and stair wells in the bilge compartment, engine room, and crew's quarters.

Step 4. Erect a temporary boom support.

Step 5. Install deck reinforcement angles.

Step 6. Engage the rotate lock and secure the boom.

Step 7. Install blocking for the A-frame and boom hanger.

Step 8. Install rope hood covers.

Step 9. Secure the main and auxiliary hoist blocks with metal supports. Install covers over blocks and tie down with ropes.

Step 10. Assemble and secure the boom and A-frame guy ropes to the shroud straps.

Step 11. Remove the engine exhaust stacks, air exhauster, and ventilator extension; replace with covers.

Step 12. Seal all gooseneck vents with caps.

Step 13. Install bracing for the operator's cab and the machinery house.

Step 14. Install timber bracing in the machinery house.

Step 15. Anchor the boom luffing and main and auxiliary hoist ropes in the machinery house.

Step 16. Install a switchboard enclosure support assembly.

Step 17. Install sash covers for the operator's cab, engine room, crew's quarters, and machinery house windows and doors.

Step 18. Assemble the towing bridle.

Step 19. Install metal boarding ladders.

Step 20. Install a guardrail post, using guardrail clips and brackets.

Step 21. Install towing and navigation lights.

Step 22. Seize the lines to prevent chafing on sheaves.

Step 23. Cover and lash down the bilge pump.

Step 24. Drain the lubricating oil from the gear housing of the winch, capstan, and windlass; apply the proper preservative.

Step 26. Install crating around the winch, capstan, and windlass.

Step 26. Install covers over the winch, capstan, and windlass controllers. Make sure that access places on the covers are securely tightened and that the gaskets are in good condition.

Step 27. Secure the lifting gear in the storage area such as slings, lines, shackles, and davits.

NOTE: If dry-docking is required for either the 60- or 100-ton crane, refer to the docking plans in Appendix C.

FOR OVERSEA TOW

Additional preparations

Additional preparations must be made before the floating crane is ready for an oversea tow. The floating crane must be well preserved and found seaworthy according to good marine practice. In addition to the preceding deactivation procedures, the following preparations must also be made:

Step 28. Fill the cooling systems with 50 percent antifreeze, conforming to MILA-46153.

Step 29. Fog the engine cylinders with Type P-10, Type 1, Grade 30 preservative oil.

Step 30. If so equipped and feasible, seal off spaces containing electronic equipment and navigational gear and place under static dehumidification.

Step 31. Coat weather-exposed machine surfaces with Type P-1 or P-2 preservative. In the absence of these preservatives, other petroleum or grease-based preservative compounds are acceptable.

Step 32. Secure all onboard equipment and supplies to prevent movement or shifting during rough seas while in transit.

Step 33. Lock all access doors.

Step 34. Install and activate the towing lights and day shapes required by the Navigation Rules (International-Inland). Hoist the day shapes so as to be visible all around the horizon. The towing lights and day shapes are kept in the "boat kit," which can be obtained through the harbormaster or normal supply channels.

The 100-ton floating crane barge, as prepared for towage, will not require overpacking. All basic-issue items, loose and fixed components, and accessories will be packed to assure acceptance and safe delivery from source to destination. Running and navigational lights will be installed. The boom will be nested and secured in its cradle. The hook block will be secured against movement. Sea valves and overboard discharge valves will be shut and gagged. Doors, hatches, portlights, windows, and any other openings that could permit the entry of seawater will be closed and gagged. When deemed advisable by the shipping activity, the crane house window and door glass will be blanked with hardboard or other suitable material. Basic-issue items, loose components, and accessories, except anchors and other ruggedized items, will be stowed and secured in the engine room, crane house, and crew's quarters. Ruggedized components, such as anchors, reels of wire, rope, and rigging, will be stowed and secured on the deck. Electrically driven windlasses and winches will be protected against deck wash with suitable shelters.

The 100-ton floating crane barge does not fall under the category of protected cargo (controlled, pilferable, or sensitive) and no special handling is required.

NOTE: Refer to docking plans in Appendix C for both the 60- and 100-ton crane.

Final acceptance inspection

Prior to the final turnover of the crane to the tug master for the oversea tow, a final acceptance inspection must be made. This inspection is made by the crane master and the senior tug master. The inspection is to ensure that the crane has been prepared for the tow in accordance with good marine practice. The crane must be prepared to the satisfaction of the tug master. These specific items must be inspected and accepted:

ŽAll loose items are packaged and secured in place.

ŽThe boom is nested and secured in place.

•Both the main hoist block and the auxiliary block are secured in place.

ŽAll sea valves and overboard discharge valves are closed and sealed.

•All doors, hatches, portholes, windows, and ventilator openings are closed, plugged if necessary, dogged down tight, and sealed to prevent the entry of seawater.

' The windows and door glass on the machinery house and operator's cab must be blanked with hardboard or marine plywood.

Ž All deck-stowed items and equipment must be secured to the deck.

' The spillpipe on the anchor windlass must be cemented to prevent flooding of the chain locker.

Ž All the moving parts of deck machinery should be grease-coared with P-1 or P-2 preservative and protected with a suitable shelter.

ŽThe day shapes and towing lights must be displayed; the towing lights must be operating.

ŽTowing pendants are properly attached to the crane, and the securing attachments must be "moused" so that they cannot work free during the tow.

When the senior tow master is satisfied with the preparation and seaworthiness of the crane, he will then sign for and accept the crane. Refer to FM 55-501-2 for a more detailed definition of changes in responsibility and command in preparation for an oversea tow.

REACTIVATION

Reactivation of the crane consists of the procedures necessary to make the crane ready for operation. All components and equipment secured during deactivation must be prepared for operation. Components and equipment of the crane must have all preservatives removed and be inspected and tested for operational condition before reactivation is complete. Preservatives must be removed as outlined in TB 740-97-4.

Components and equipment must be prepared for operation as outlined below:

Step 1. Remove the crane's lifting gear from the storage area and secure in the normal operating position.

Step 2. Remove the access plates and covers from the winch, capstan, and windlass controllers.

Step 3. Remove crating from the winch, capstan, and windlass. Drain preservative from the gear housings and fill with the proper, operating lubrication oil.

Step 4. Remove the sash and cover from the bilge pump.

Step 5. Release the seized sheave lines.

Step 6. Remove the towing and navigation lights and stow in signal locker.

Step 7. Remove the guardrail post, clips, and brackets.

Step 8. Remove the metal boarding ladders.

Step 9. Remove the towing bridle.

Step 10. Remove the sash covers from the operator's cab, machinery house, engine room, and crew's quarters. Clean all the windows.

Step 11. Remove the switchboard enclosure support assembly.

Step 12. Remove the anchor from the boom luffing and the main auxiliary hoist ropes from the machinery house.

Step 13. Remove the timber bracing from inside the machinery house.

Step 14. Remove the bracing from the operator's cab and the machinery house.

Step 15. Remove the caps from all gooseneck vents.

Step 16. Remove the covers from the air exhauster and ventilator outlets and install the air exhauster and ventilator extensions.

Step 17. Remove the covers from the engine exhaust outlets and install engine exhaust stacks.

Step 18. Remove the shroud straps from the boom and A-frame guy ropes.

Step 19. Remove the metal supports, ropes, and covers from the main and auxiliary hoist blocks.

Step 20. Remove the rope hood covers from the deck-mounted rope reels.

Step 21. Remove the blocking from the A-frame and boom hanger.

Step 22. Remove the deck reinforcement angles.

Step 23. Release the boom and remove the temporary boom support.

Step 24. Open all hatches, manholes, and stair wells for ventilation of the bilge compartment, engine room, and crew's quarters.

CHAPTER 9

RIGGING AND REEVING

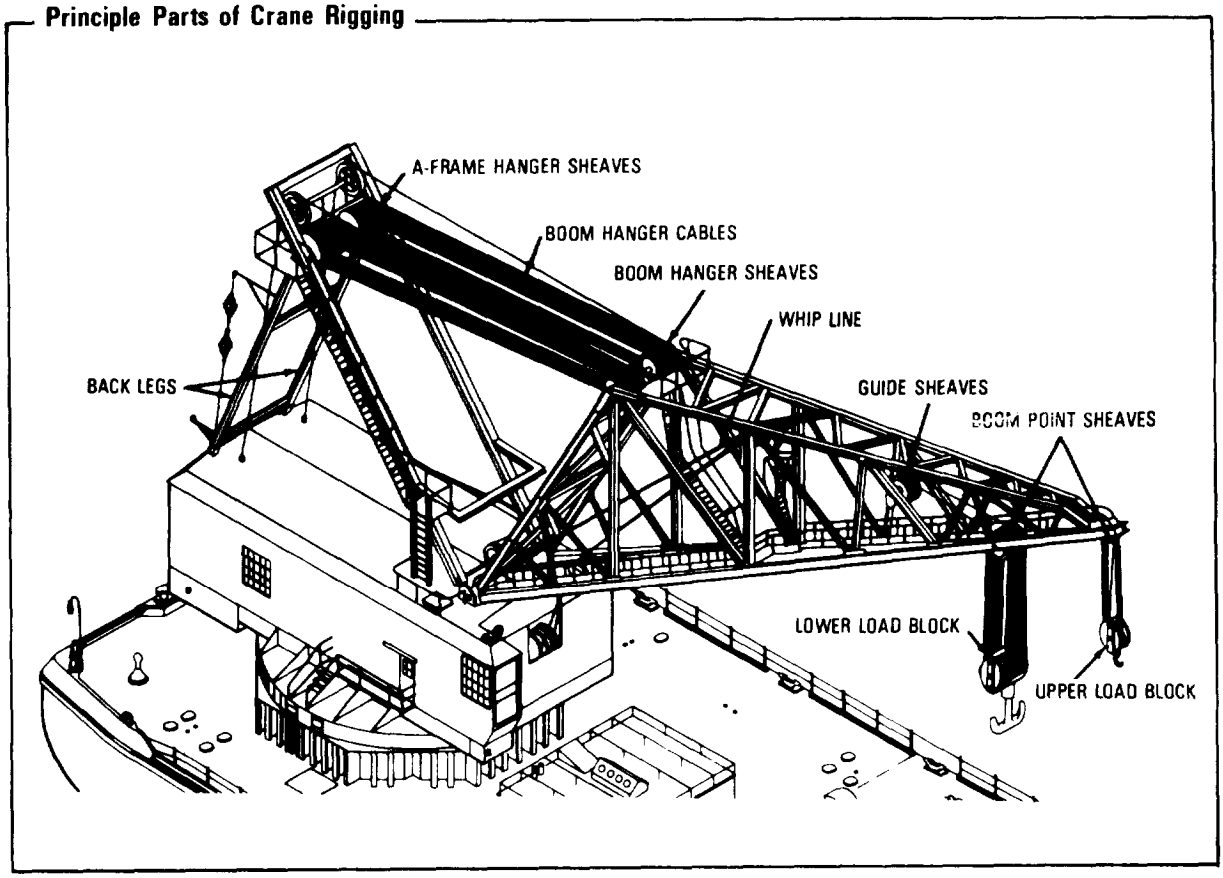
This chapter sets out the procedures for rigging and reeving on both the 60- and 100-ton floating cranes. It also covers the types and size wire used in rigging, as well as maintenance of the wire cable.

RIGGING

Crane rigging consists mainly of lines, sheaves, cables, and blocks. Included are load lines, A-frame hanger sheaves (pulleys), boom hanger sheaves, boom point sheaves, guide sheaves, boom hanger cables, whip block, upper load block, and lower load block. See the following illustration.

All blocks and the cables running from near the midsection of the boom to the top of the boom are known as the "topping lift." This rigging supports the boom, With a series of cables and blocks, this rigging enables lowering or raising of the boom to increase or decrease the radius of its reach. The topping-lift cable is reeved with more parts than the load line, since the topping-lift cable must support the weight of both the boom and load.

Principle Parts of Crane Rigging



LOAD LINES

For the main or heavy-load hoist, a series of cables runs through sheaves from-the load block up to the peak of the boom and down to the main hoist drum in the machinery house. The size and number of cables vary with the lifting capacity of the crane.

For the auxiliary or whip hoist line, the series of cables runs through the sheaves from the light load hook to the sheaves at the tip of the boom and back to the auxiliary hoist drum. The size and number of these cables also vary with the lifting capacity of the light load hook.

BLOCKS

A block consists of a shell (frame) which supports the ends of a pin around which one or more grooved sheaves revolve. The pin serves as the axle for the sheaves. A hook, usually of the swivel type, is attached to one end of the block. Block sizes are determined by the length (in inches) of the shell and by the number of sheaves it contains. Blocks with one, two, three, and four sheaves are called single, double, triple, and quadruple blocks respectively. The largest wire rope that can be used on a block is determined by the diameter of the sheave, depth of the groove, and size of the opening through which the wire rope passes. The recommended size of line or cable on a block is the largest diameter possible that will fit the groove in the sheave and have clearance between pthe frame or shell and the sheave. The diameter of the sheave must be at least 20 times the diameter of the wire rope.

Grooves in sheaves should contact the sides of a wire rope up to almost one-half its circumference. When the groove is too large, the rope tends to flatten under tension. Use a groove gage to determine proper size rope to be used in the groove.

LIFTING POWER

The use of multiple sheave blocks increases the weight that can be lifted. This increase depends upon the number of sheaves in the sheave blocks and the number of rope parts between the blocks. However, the size and construction of wire rope, diameter of sheaves, score (uneven wear) on wire rope sheaves, size of sheave pins, and friction at the sheave pins are all factors that reduce lifting efficiency. The sum of all these factors increases with the number of sheaves and ranges from 10 to 40 percent.

The load on the hauling part of a one-part line is theoretically the same as the supported load, if friction loss and inefficiency factors are disregarded. However, friction is always present where ropes run over sheaves. The amount of friction increases proportionally with the number of parts or sheaves.

In a two-part line, the load on the hauling part is one-half the supported load plus friction. It is one-third for a three-part line, one-fourth for a four-part line, and one-fifth for a five-part line.

To estimate the lifting power gained through the use of multiple-sheave blocks, multiply the weight on the hauling part of the purchase by the number of parts of rope between the blocks and make deductions for inefficiency factors as done in the following example.

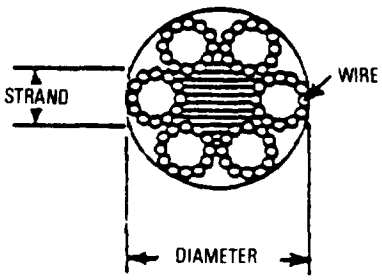
Calculate the weight that can be lifted with a power winch of 7,600-pound capacity, using a five-part line and a 3/4-inch wire rope. For this calculation, assume that the inefficiency of a five-part line is 25 percent and that the breaking or tensile strength of a 3/4-inch rope is 23.7 tons. The safe load for crane wires equals the safe load for one wire. Therefore, the breaking or tensile strength of a 3/4-inch wire rope (23.7) is divided by a safety factor of 5, which equals 4.74 tons, the safe load for one wire. The safe load for a five-part line should be 5 times 4.74 or 23.7 tons. The 25 percent reduction for inefficiency will reduce the safe working load of the tackle to 17.8 tons.

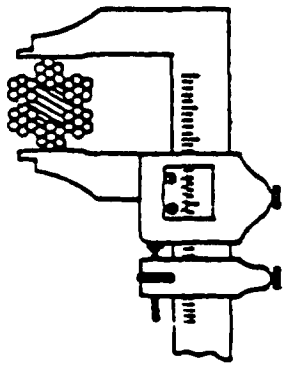
WIRE ROPE

The diameter of a wire rope is the diameter of the circle which will compactly enclose all of the strands. The diameter of a strand is the

diameter of the circle which will enclose all of the wires in the strand. The correct diameter of a wire rope or strand is its greatest diameter and is measured from its outer extremities as shown in the following illustration.

Wire Rope Measurement





CORRECT METHOD

The wire rope used in crane operations is subjected to several kinds of stresses. The most frequently encountered stresses result from direct tension, acceleration, sudden or shock loads, bending, and the action of several forces at one time. For the most part, these stresses can be converted into terms of simple tension, and a rope of approximately the correct strength can be chosen. Since the strength of a wire rope depends on its size, grade, and construction, these three factors should be considered.

The safety factor of wire rope is the ratio of the strength of the rope to the working load. For example, a wire rope with a strength of 10,000 pounds and a total working load of 2,000 pounds would be operating with a safety factor of 5. However, it is not possible to set accurate safety factors for the various types of equipment using wire rope, since these will vary with conditions on the individual units of equipment. The proper safety factor depends on the—

- Loads to be lifted.
- Speed of operation.
- Type of fittings used for securing the rope ends.
- Acceleration and deceleration.
- Length of rope.
- Number, size, and location of sheaves and drums.
- Factors causing abrasion and corrosion.
- Facilities for inspection.
- Possible loss of life and property in case of failure.

Wire rope is designated by how it is manufactured, its circumference, the number of strands in the wire rope, and the number of wires in each strand. The more wires in a strand, the more flexible the wire rope. The wire rope recommended for the floating crane is improved plow steel wire rope, 6 x 37 (6 strands, 37 wires per strand), of varying circumference. The following table shows the recommended size of wire rope to use for the 60- and 100-ton crane.

Cable Dimensions (Improved plowsteel wire rope)

	CIRCUMFERENCE	CONSTRUCTION	LENGTH
60-ton crane:			
Luffing cable	1 1/8 inch	6 x 37	1,400 feet
Main hoist	1 1/8 inch	6 x 37	1,400 feet
Auxiliary hoist	7/8 inch	6 x 37	730 feet
100-ton crane:			
Luffing cable	1 1/4 inch	6 x 37	*1,984 feet
Main hoist	1 1/8 inch	6 x 37	2,530 feet
Auxiliary hoist	7/8 inch	6 x 37	1,100 feet

*Luffing cable is in two pieces: starboard wire is 1,004 feet long, port wire 980 feet long.

REEVING

METHODS

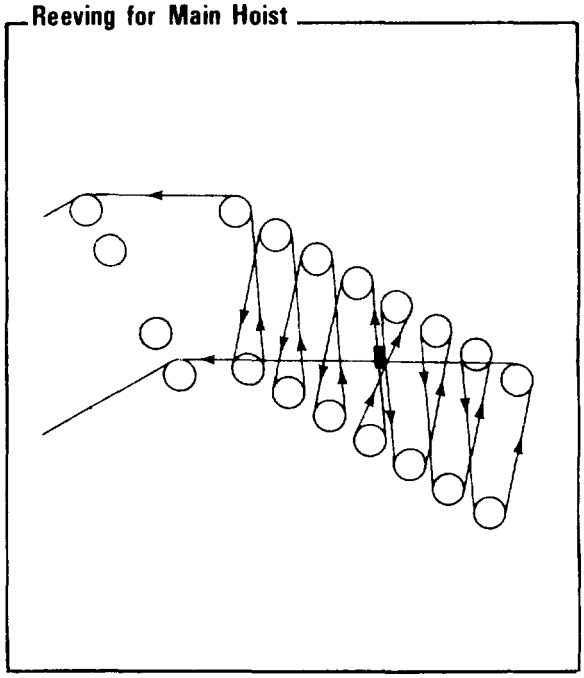
Two basic methods are used in reeving a floating crane. One method is to start the reeving operation from the fully wound drum. This method is used mostly on rotating-type cranes which have boom foot pins located at the top of the cab. Thus, when the boom is secured in its cradle, all parts of the boom are accessible. The cable is run directly from the hoist drum and reeved through its respective guide sheave blocks.

The second method is to begin the reeving process at the load end where the cable is threaded through the sheave blocks and the necessary fleeting sheaves before it is wrapped onto the respective hoist drums. This method is used on rotating cranes where the boom foot pins are located at considerable distance above deck and the boom resting in its cradle is too high to be reached from the deck. The reeving operation is started from the sheave blocks. The cable is unreeled from the supply reel, and the reeving operation is started by threading the cable through the load end of the sheave blocks. A stationary or swinging scaffold will have to be used for one person to work from, and the heavy cable will need to be lifted by a block and tackle of Manila rope.

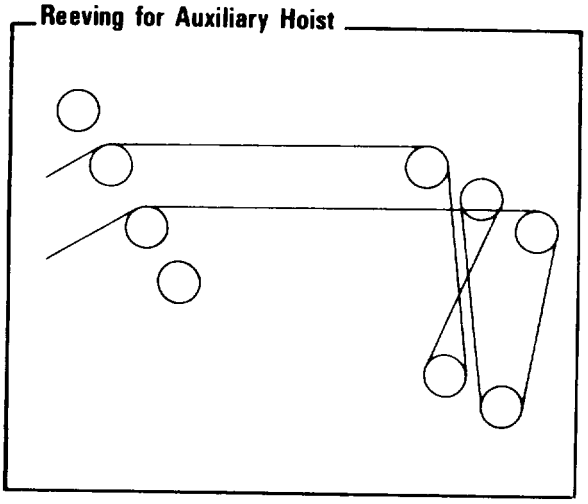
BLOCKS

Shown in the following illustrations are reeving diagrams for the main hoist, auxiliary hoist, and boom hoist (luffing) of the 100-ton crane.

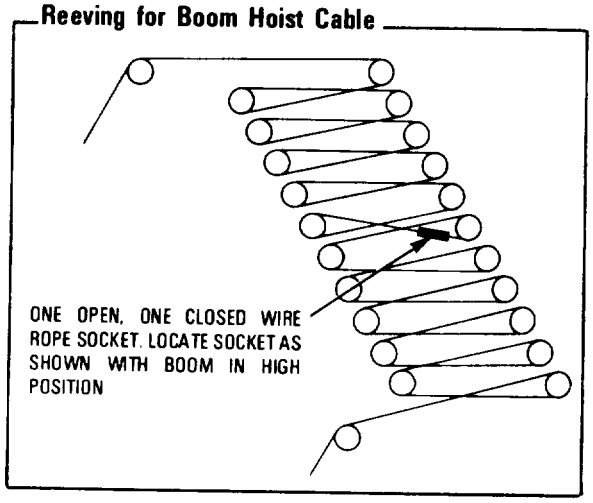
Reeving for Main Hoist



Reeving for Auxiliary Hoist

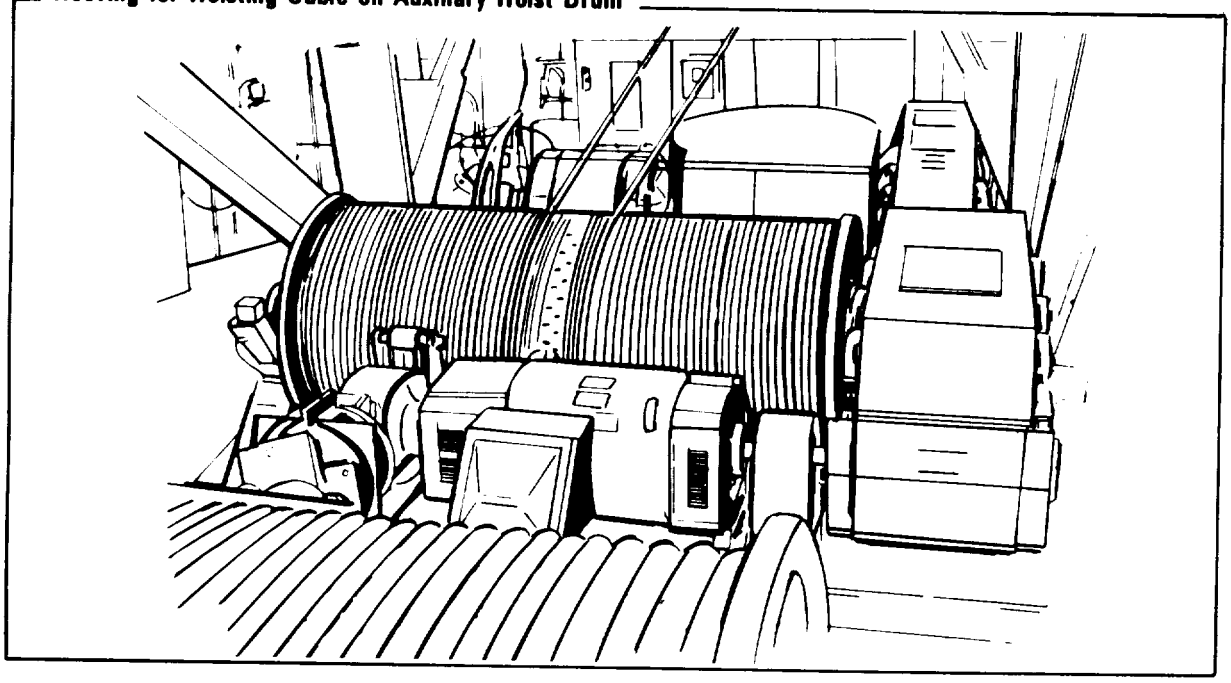


Reeving for Boom Hoist Cable



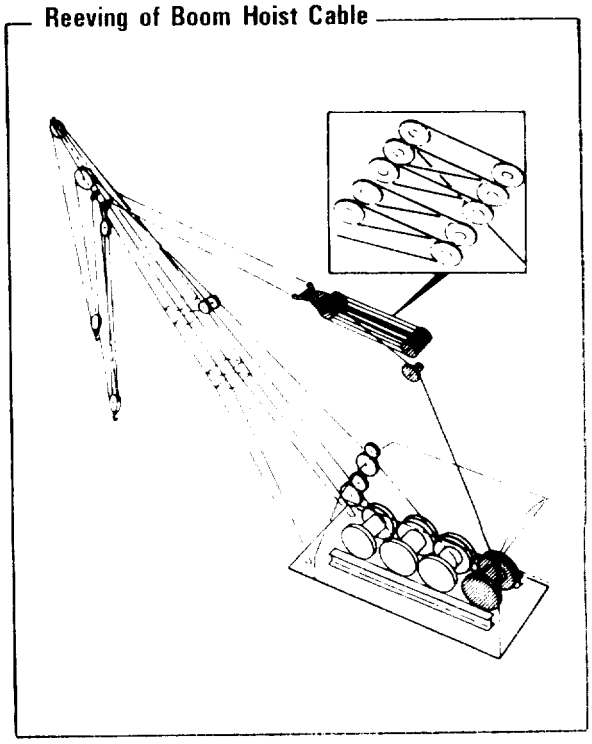
As seen in the diagrams, there are two bitter ends to the hoisting wire. These bitter ends are fair lead back to their hoist drum, reeved from the center of the drum, and wound outward to the respective outboard ends of the drum. The bitter ends are then made fast in the securing socket on the outside edge of the drum.

Reeving for Hoisting Cable on Auxillary Hoist Drum



The following reeving diagram is for the boom hoist (luffing) cable on the 60-ton crane. The cable for hoisting the boom extends from the boom drum, through the top of the machinery house, through the boom line guide sheave located at the top of the A-frame, and around the boom hanger sheave arrangement which is attached to both the A-frame and the boom. Each time cable is run around a sheave, all the slack should be taken up. The dead end of the cable should be attached to the boom hanger sheave assembly and secured with a clamp.

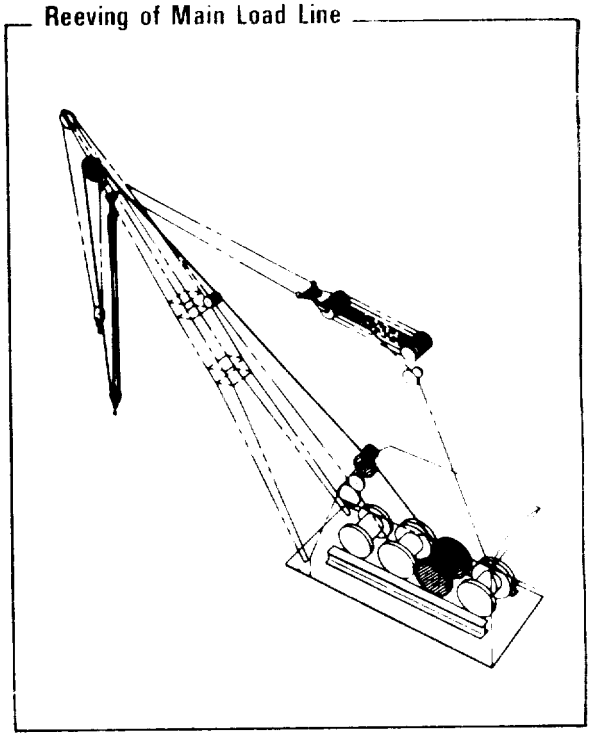
Reeving of Boom Hoist Cable



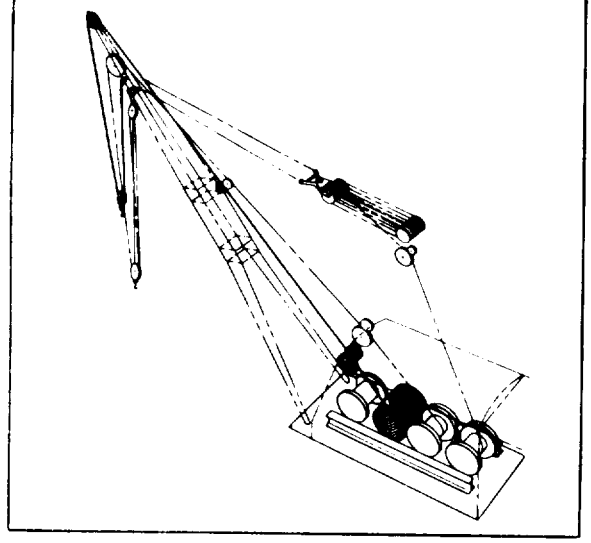
The procedures for reeving the main hoist cable on the 60-ton crane are shown in the following diagrams.

The main load line extends from the main load drum and through the machinery house opening, the bottom fleeting sheaves on the A-frame, the boom guide sheave, the inner boom point sheave, and the lower and upper load blocks. The dead end is attached to the boom.

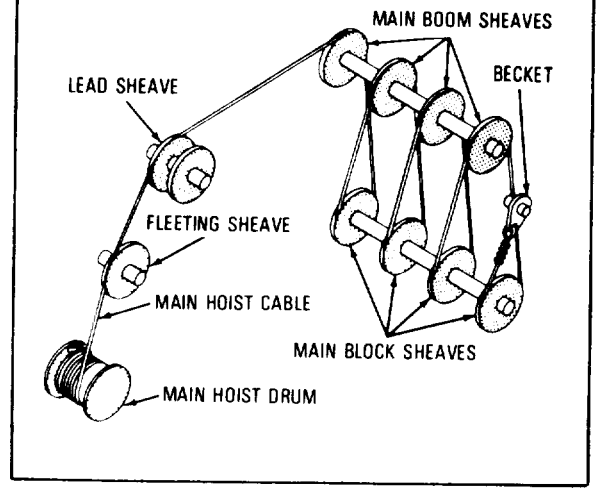
Reeving of Main Load Line



Reeving of Whip Line

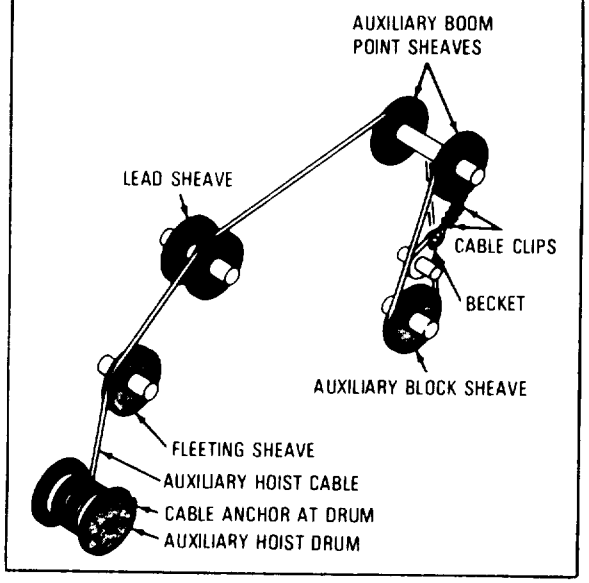


Reeving of Main Hoist Cable (Exploded view)

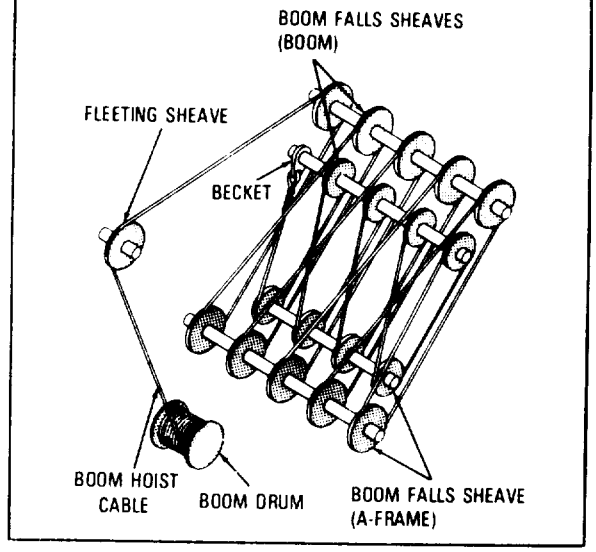


The following illustration is a reeving diagram of the auxiliary hoist cable on the 60-ton crane. The whip line extends from the whip drum through the machinery house, the whip-line fleeting sheaves, the boom guide sheave, the outer boom point sheave, and the whip block sheave. The dead end is attached to the boom point bail.

Reeving of Auxiliary Hoist Cable



Reeving of Boom Topping Hoist Cable
(Exploded View)



MAINTENANCE

Wire rope should be visually inspected daily. Conditions that require special attention are kinks, flattening of the wire, strands bent out of shape, excessive dirt, or broken wires in a strand (fish hooks). Semiannually, the cable should be laid out and cleaned. The wire rope should be carefully cleaned so that new lubricant will adhere properly.

Spot-check different areas of the wire for damage, and measure the circumference of the wire rope to see if it has been stretched out. If after cleaning and inspection, the wire rope is satisfactory, lubricate (slush) it with Gulf Gulflex Moly or its equal. Lubricate all of the sheaves, blocks, and associated parts of the hoisting system. All lubrication should be done with a pressure gun using Gulf Oil Supreme Cup Grease 2 or its equal. The auxiliary hoist hood trunnion assembly should be brush- or smear-lubricated.

CHAPTER 10

MAINTENANCE OF DC-POWERED MACHINERY

The maintenance described in this chapter applies to the crane's DC-powered motors and related machinery. Although various manufacturers' equipment is installed, the same inspection and maintenance procedures are to be followed. The maintenance instructions described in this section are to be used along with the instructions contained in TB M-1900-202-12/1. The various maintenance procedures required for the AC-powered equipment are covered in Chapters 3 through 7.

PREVENTIVE MAINTENANCE SCHEDULE

Preventive maintenance includes both operational and physical equipment checks designed to control scaling and corrosion and detect any performance deterioration. The preventive maintenance schedule lists the required periodic maintenance requirements. The checks most critical to continual crane operation are as follows:

Ž Lubrication. Observe carefully all lubrication instructions that are furnished with the equipment and provided herein. Be sure to lubricate, but do not overlubricate.

Ž Operating limits. Become familiar with loading capacity and operating limits of the crane, and do not exceed them.

Ž Wear points. Inspect the wear points of the crane at regular intervals, and take action at once when maintenance is indicated.

Ž Moisture. Moisture is a constant threat, especially to motors and switch gear. Check for it at regular intervals. Also see that motor ventilation ducts do not accumulate moisture. Load blocks and sheave housings should be checked at regular intervals to see that the weep holes are draining properly. The machinery house and door should be kept weather-tight. Condensation. especially in a humid climate, must likewise be guarded against.

Ž Switch and contact points. Check for erosion and pitting at regular intervals.

Ž Painting. Keep all exposed gear and housings properly painted according to Army standards. Refer to TB 43-0144.

- Tightness of bolts and nuts. In the first few weeks of operation especially, check all bolts, nuts, and fastenings for tightness. Follow up these checks at regular intervals. This applies to rigging items as well as machinery and equipment.
- Wire rope. Keep lubricated and check condition at regular intervals. All wire ropes will stretch with use. The operation of the limit switches for hoisting and topping depends on the amount of wire rope payed out. Check at intervals to see that these limit switches are not affected by wire rope stretch.

Ž Voltage regulation. Check at intervals to see that the 240-VDC power supply is held within the prescribed limits.

ŽCrane operation. When the crane is operated in humid climates, or when it is operated infrequently, it is advisable to run through the motions of hoisting for at least half an hour once every two to four weeks.

> *NOTE:* Personnel conducting these procedures should have experience at the journeyman level and a working knowledge of crane components pertaining to their inspection. The lead inspector must be knowledgeable in all phases of the crane operation. Safety precautions must be taken at all times to prevent injury to personnel or damage to equipment in the event of crane failure.

Following is a table showing a schedule of preventive maintenance actions.

Preventive Maintenance Action Schedule

FREQUENCY	MAINTENANCE ACTION
Daily (D):	Record readings of all indicating instruments, such as gages, thermometers, meters, and pyro. meters, at intervals designated in DA Form 4993 (Harbor Boat Engine Department log for Class A and C-1 Vessels).
Weekly (W):	Inspect, test, and adjust operation of drum limit switch.
	Lubricate (see lubrication chart).
Monthly (M):	Check magnetic controllers and controller cabinets for corrosion, loose connections, insulation breakdown, and general cleanliness.
	Check contractors and relays for discoloration, charred insulation, other evidence of overheating, condition of contacts, loose connections, or collection of dirt and gum.
	Check fuses, wiring, and buses for evidence of arcing, overheating, corrosion, or loose connections.
	Check brakes and inspect brake drums, linings, hand releases, and security of mountings.
	Check wire ripe for abrasion, crushing, broken strands, dirt or abrasive material. and slippage of dead ends.
	Check oil level of speed reducer for evidence of leaks. Check internal condition as required.
	Lubricate (see lubrication chart).
Quarterly (Q):	Clean and inspect DC motors.
	Measure insulation resistance of DC motor.
	Check resistor banks for loose connections and cleanliness.
	Inspect structural and mechanical points.
	Collect oil sample.
	Lubricate (see lubrication chart).
Semiannually (S):	Lubricate motor bearings.
	Check out control circuits.
	Check master switch.
	Check wire rope sheaves, mast, booms, load blocks, and bridle for correct alignment, scoring. nicking, or any condition that would abrade ropes.
	Check drum bearing for looseness and noise when turning.
	Lubricate (see lubrication chart).
Annually (A):	Carry out complete maintenance inspection.
	Lubricate (see lubrication chart).
After overhaul; every 4 years:	Perform load test on crane.

INSPECTIONS, TESTS, AND ADJUSTMENTS

Drum limit switch

An operational inspection, a test, and an adjustment of the drum limit switch is carried out weekly. After testing and adjustment steps are completed, return the boom to its stowage position and secure the crane.

WARNING: During operation, 240-VDC current is present in this equipment. Do not clean or inspect live equipment.

The following equipment is required to inspect, test, and adjust the drum limit switch:

Ž Flashlight

Ž Flat-tip screwdriver, 12-inch

Ž Sound-powered phones (2)

Ž Adjustable wrench, 12-inch

Before inspecting the drum limit switch, carry out these preliminary procedures:

Step 1. Establish telephone communication between the crane operator and signalman before beginning any operational tests.

Step 2. Inspect the area and rigging to ensure that there is no interference with crane operations throughout the entire range of all movements—hoisting, lowering, topping, rotating, and stopping.

Step 3. Ensure that the area is clear of all personnel not engaged in the test.

Step 4. Free boom and load blocks from stowage.

CAUTION: Do not operate master switch while boom is in stowed position.

Step 5. Start the crane.

CAUTION: Operate the crane at slow speed when approaching the limit-switch trip point; observe crane position when the limit switches trip the circuit.

Step 6. Raise the boom to its minimum radius, 64 feet, and rotate the boom over the deck or pier.

Step 7. Place the canvas tarpaulins on the deck or pier.

First, test the lower set point. While doing this test, be cautious not to lower the block into water as this action may contaminate the bearings. Lower the hook onto tarpaulins and reeve out approximately 25 feet of rope. The limit switch should activate, de-energizing the hoist and causing the brake to set when approximately 25 feet of rope is payed out.

If the limit switch actuates, return the master switch to OFF. Verify that the hoist will not lower by moving the master to LOWER. Now move the master switch in the hoist direction, and observe that the hoist raises the hook.

If the limit switch fails to actuate, reset the switch as follows (refer to the diagram of the drum limit switch):

Step 1. Reeve in the rope so that approximately 25 feet is left payed out.

Step 2. Remove the cover from the limit switch.

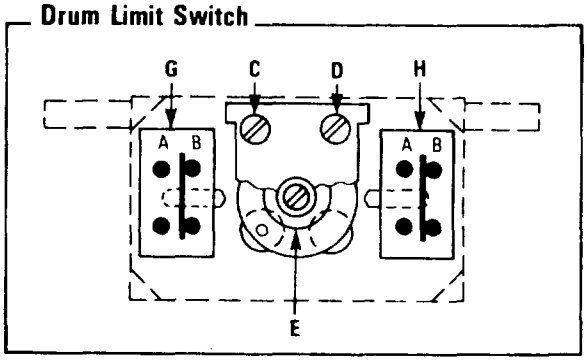
Step 3. Loosen the clamping screw (E).

Step 4. Turn the cam gear screw (D) until the cam trips the switch (H).

Step 5. Retighten the clamping screw (E) and replace the cover.

Step 6. Recheck the limit switch function by repeating the test.

Drum Limit Switch



Next, test the upper set point. Be cautious not to raise the block into the boom sheave to prevent structural damage. Raise the boom to its minimum radius of 64 feet. Run the hook up. The limit switch should actuate before the block contacts the boom block limit switch weight, de-energizing the hoist motor and causing the brake to set.

If the limit switch actuates, return the master switch to OFF. Verify that the hoist will not raise the block by moving the master switch to the HOIST direction. Now move the master switch to the LOWER direction, and observe that the hoist lowers the block.

If the limit switch fails to actuate, reset the limit switch as follows (refer to the drum limit switch diagram):

Step 1. Move the block to within 1 foot of the boom limit switch weight.

Step 2. Remove the cover from the limit switch.

Step 3. Loosen the clamping screw (E).

Step 4. Turn the cam gear screw (C)until the cam trips the switch (G).

Step 5. Retighten the clamping screw (E) and replace the cover.

Step 6. Recheck the limit switch function by repeating the test.

Brake

The brake is inspected and adjusted monthly. The following equipment is required:

Ž Flashlight

Ž Wrench set

Ž Rags

Ž Feeler gage

Ž Safety tags

Ž Steel rule, 6-inch

Before inspecting the brake, ensure that it is not under any load. For instance, the crane boom is to be stowed in the boom cradle.

WARNING: Shut off the power at the main panel and make sure it stays off; tag "Out of Service."

Remove the cover from the brake and carry out the following procedures:

Step 1. Clean the brake linkage and inspect for corrosion. Lubricate the linkage, taking care not to get oil on the brake lining.

Step 2. Check the attachment to the drive shaft for looseness, and tighten as necessary.

Step 3. Inspect the brake wheel for scoring, uneven wear, or corrosion. Remove the glaze from the shoes and wheel with emery cloth or fine-grit sandpaper.

Step 4. Measure the brake lining and replace if worn to 1/16 of an inch above the rivet head. The lining thickness is approximately 3/16 of an inch.

To adjust the torque on the brake set, carry out the following steps referring to the illustration on the facing page:

Step 1. Verify that the main spring setting is proper for torque setting (1,000 foot-pounds for this application):

Torque	Spring Setting
1,000 foot-pounds	1 21/32 inches

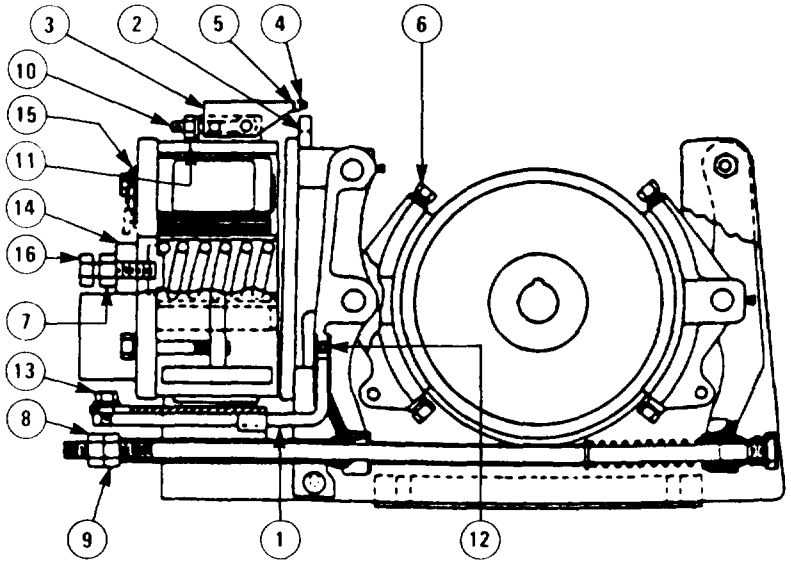
The spring setting is read on the torque gage (7). If the length is incorrect, continue with Steps 2 and 4.

Step 2. Loosen the screw locknut (10).

Step 3. Turn the torque-adjusting screw (9) in or out until the distance from the head of the screw to the spring block (8) is the proper length per the torque gage (7).

Step 4. Tighten the screw locknut after adjustment.

Cutaway View of Magnetic Brake



1 ADJUSTABLE PIVOT ARM
2 ARMATURE INDICATOR
3 GAP INDICATOR
4 INDICATING POINT
5 INDICATING POINT
6 LINING BOLTS
7 LOCKNUT
8 LOCKNUT
9 MAGNET GAP ADJUSTOR
10 MANUAL RELEASE BOLT
11 NUT
12 PIVOT IN YOKE
13 SHOE-CLEARANCE CLAMPING BOLT
14 SPRING BLOCK
15 TORQUE GAGE
16 TORQUE-ADJUSTING SCREW

To adjust the wear on the brake lining, follow the steps while referring to the preceding illustration:

Step 1. Check the magnet gap indicator (4) for lining wear. If the edge of the armature indicator lies between the indicating points (2 and 1), no adjustment is required. If the edge (3) extends beyond the indicating point (l), a lining adjustment is required. Continue with Steps 2 through 4.

Step 2. Loosen the shoe-clearance clamping bolt (14).

Step 3. Loosen the locknut (11) and turn the adjustor (12) until one edge (3) lines up with the other edge (2).

Step 4. Retighten the locknut(11) and shoe-clearance clamping bolt (14).

Step 5. Recheck the torque adjustment.

When the adjustments are complete, return the brake to operation.

Step 1. Remove the safety tag and turn on the power.

Step 2. Operate the hoist motor and verify that the brake does not overheat.

Wire rope

Wire rope should be inspected monthly. Where practical, wire rope should be inspected with all wire rope payed out. For more details on wire rope specifications, refer to FM 55-501, Chapter 12.

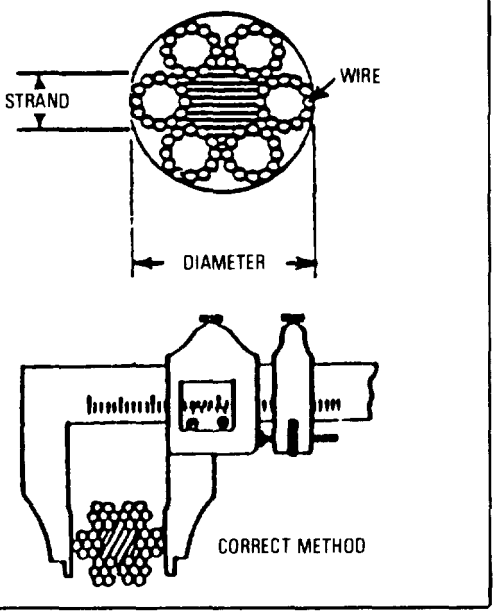
Remove the wire rope dressing from those running lengths exposed to maximum wear, exposure, and abuse. Wire rope that has been exposed to or immersed in salt water must be flushed with fresh water and cleaned with a suitable solvent prior to inspection. Abrasive materials on the wire rope must be removed with an approved solvent and the area relubricated.

Inspect the wire rope for corrosion, wear, broken wires, and physical damage to the rope structure. Examine, in particular, sections in contact with the equalizer sheaves and saddles or areas where corrosion may develop because of poor drainage. Wire rope tends to stretch in service. An appreciable amount of stretch will affect the up-stop and down-stop limits of the hoise. If necessary, reset the drum limit switches.

Inspect the end fittings, sockets, and connections for indications of cable slippage, wear, deformation, and damage. Inspect the eye splices for kinks, wear, broken wires, flattening, and slipped splices.

Measure the wire rope diameter at six or more places with vernier calipers, and compute the average diameter. See the following illustration for the measurement technique.

Wire Rope Measurement Technique



Speed reducer

With the unit operating, check monthly for unusual noise, vibration, or heat. Additional instructions for servicing and inspecting the speed reducer are contained in the manufacturer's manual and in corrective maintenance section of this chapter.

DC motor

The DC motor requires cleaning and inspection quarterly. The following equipment is needed:

Ž Towel, machinery-wiping, lint-free.

Ž Electric vacuum cleaner, hand model, Type LVU.

Ž Paintbrush, sash and trim, nylon bristle, No 6.

Ž Screwdriver, flap-tip, normal duty, 8-inch.

Ž Flashlight, industrial, straight type.

Ž Inspection mirror with telescoping handle, Style B, 1 l/4-inch diameter.

Ž Wrench, adjustable, forged steel, heavy-duty, 6-inch.

Ž Hand commutator, slotter, and scraper.

Ž Marking chalk, general purpose.

Ž Tongue depressor.

Ž Thickness gage, Type 8, Class 1, 13-blade feeler.

Ž Steel rule, machinist's, 6-inch.

Ž Safety tag.

Ž Line voltage indicator (SCAT-4075 or equivalent).

WARNING: Make sure circuit is de-energized and tagged "Out of Service." Test with voltage meter to verify that circuits are de-energized.

CLEANING AND INSPECTION. Carry out the following cleaning and inspection procedures:

Step 1. Remove access covers.

Step 2. Vacuum all accessible parts. Brush out hard-to-reach areas, or blow out dirt with vacuum cleaner in blower mode. Clean vent screens and openings.

Step 3. Use rag to remove grease or oil deposits from motor windings.

Step 4. Match-mark brushes and holders to aid in reassembly.

Step 5. Remove brushes from holders; wipe brushes, holders, and rigging with rag.

Step 6. Inspect surface of each brush for good contact area; contact surface should be highly polished and free of scoring, pitting, chipped areas, and embedded particles.

Step 7. Check brush length. The bush pigtails are provided with wear-indicator markers. When the marker reaches the top of the brush, the brush should be replaced.

Step 8. Ensure that brush holders are the same distance from the commutator/slip rings. Distance whould not be more than 1/8 of an inch or less than 1/6 of an inch. Adjust as necessary.

Step 9. Clean commutator surface with a wiping towel.

Step 10. Clean commutator slots with a slotter tool.

Step 11. Clean between commutator risers with a tongue depressor wrapped with a wiping towel.

Step 12. Inspect commutator surface for streaking, threading, grooving, copper drag, pitch bar-marking, and slot bar-marking. Surface should be highly polished, free of scoring, pitting, grooving, and corrosion.

Step 13. Reinstall brushes in associated brush holders. Brushes worn more than one-half of their original length should be replaced.

CAUTION: Do not snap brush springs in place as this may crack or chip the brushes.

Step 14. Ensure that brushes travel freely in the holders.

Step 15. Inspect all electrical and mechanical fastenings, and tighten loose connections. Use lock washers or jam nuts where necessary to keep connections tight.

Step 16. Inspect wiring for evidence of over-heating, chafing, and frayed and chipped insulation.

Step 17. Inspect attached ventilation fan for cracked, nicked, and bent blading and for loose or missing rivets, bolts, keys, pins, and setscrews.

Step 18. Remove tools and cleaning materials from interior of motor housing.

Step 19. Inspect access cover gaskets for dry rot, cuts, tears, deformation, and foreign matter.

Step 20. Measure insulation resistance of the windings to ground as described in the next paragraph. Insulation resistance should read above 0.5 megohm.

Step 21. Reinstall access covers.

Step 22. Remove safety tag and energize circuit.

RESISTANCE MEASUREMENTS. Insulation resistance measurements are made quarterly; the following equipment is required:

- Safety tags.
- Screwdriver, normal duty, 6-inch.
- Voltage tester.
- Megger, 500-volt.
- Plastic sealer, NIL-I-3064 (NSN 9N-5970-00-295-7658).
- Thermometer, 0° to 180° F.
- Insulation (polymide paper) (NSN 5970-00-016-3367 or equivalent).
- Flashlight.

Before taking measurements the following preliminary steps are required:

Step 1. Open switches LSW and CPSW, the 240-VDC power supply to the motor and control panel respectively.

Step 2. Place safety tag on switches.

Step 3. Open terminal box on motor.

Step 4. Test electrical circuits with voltage tester to ensure that circuits are de-energized.

Step 5. Disconnect incoming power cables at the terminal box.

Step 6. Use plastic sealer to attach thermometer to motor case. Allow 10 minutes for thermometer readings to stabilize.

Make the initial insulation resistance measurements with the DC motor cold, referring to the table following for allowable insulation resistance. The nomograph allows for resistance-temperature correction.

Step 1. Connect one megger lead to the power-input terminal and the other megger lead to an electrical ground.

Step 2. Operate the megger for 60 seconds.

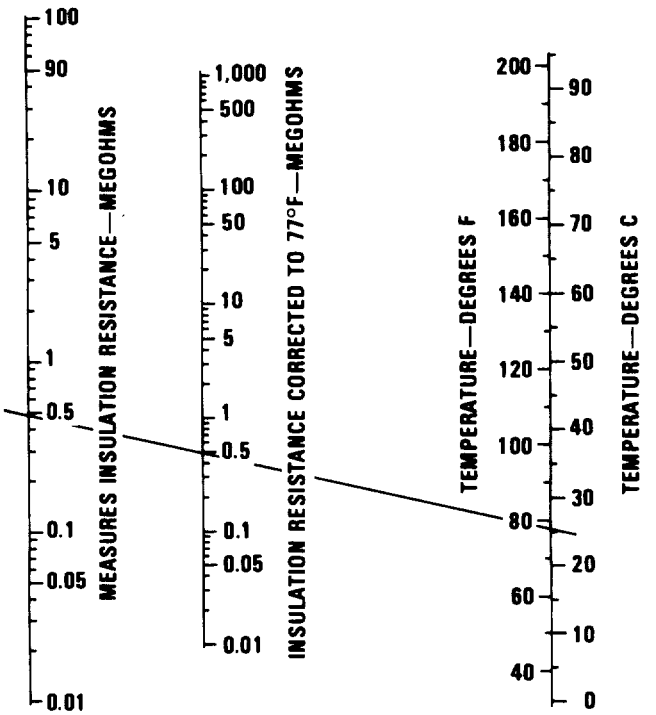
Step 3. Record the megger reading and temperature. If the corrected insulation resistance is less than 0.1 megohm at 77°F, the cause for a low reading must be determined and corrected prior to further operation of the motor.

Step 4. If insulation resistance is greater than 1.5 megohms at 77°F, no further measurements are required. Proceed with the following measurement.

Allowable Insulation Resistance (Megohms)

CIRCUIT	BEFORE CLEANING	AFTER CLEANING	NEW OR RECONDITIONED
Complete armature circuit	0.1	0.5	1.5
Armature alone	0.2	1.0	1.5+
Field circuit	0.5	1.25	1.5+

Resistance-Temperature Nomograph



Next, measure the insulation resistance of the DC motor while hot:

Step 1. Reconnect the power cables to the motor terminals, and reinstall the terminal box cover.

Step 2. Pull the safety tags and energize the motor circuit by closing switches LSW and CPSW.

Step 3. Run the DC motor for 30 minutes.

Step 4. De-energize the motor circuit by opening switches LSW and CPSW.

Step 5. Place safety tags on switches.

Step 6. Remove terminal box cover, and disconnect power cables from motor.

Step 7. Connect one megger lead to the power-input terminal and the other lead to an electrical ground.

Step 8. Operate the megger for 60 seconds.

Step 9. Record the megger and temperature readings.

Step 10. If the temperature-corrected insulation resistance of the complete armature circuit is less than 0.5 megohm at 77°F, perform the following steps to isolate the armature and fields to ground. If insulation resistance is above 0.5 megohm, proceed to steps for restoring motor to operation.

To measure the insulation resistance of the armature, carry out the following steps:

Step 1. Remove the access covers.

Step 2. Isolate the armature by inserting insulation between the commutator and all brushes, ensuring that no brushes are touching the commutator.

Step 3. At the motor, connect one megger lead to the commutator and the other lead to the electrical ground on the motor.

Step 4. Operate the megger for at least 60 seconds.

Step 5. Record the meger and temperature readings.

Step 6. If the insulation resistance measurement corrected to 77°F is less than 1.0 megohm, clean the motor as previously described. The acceptable value for insulation resistance of the armature above is 1.0 megohm at 77°F according to the table.

The following procedures should be followed to measure the insulation resistance of the motor field circuit windings less the armature circuit:

Step 1. At the motor, connect one megger lead to the field-connection terminal and the other lead to the electrical ground.

Step 2. Operate the megger for 60 seconds.

Step 3. Record the megger and thermometer readings.

Step 4. If the insulation resistance is less than 1.25 megohms at 77°F, clean the motor. The acceptable value for insulation resistance of a complete shunt field circuit less armature after cleaning in place is 1.25 megohms.

Return to operation as follows:

Step 1. Remove any brush isolation insulation if applicable.

Step 2. Remove the thermometer and plastic sealer.

Step 3. Replace all covers on the motor.

Step 4. Restore the system to readiness condition by closing switches LSW and CPSW.

Resistor banks

Resistor banks need cleaning quarterly. Use plastic-tipped vacuum attachment or dry, low-pressure air to remove dirt. This applies also to the brake resistors mounted on top of the control panel.

Structural and mechanical points

Structural and mechanical points are inspected quarterly. The following equipment is required:

- Flashlight
- Step-joint pliers, 8-inch
- Ball peen hammer, 1 1/2-pounds

Ž Adjustable wrench, 12-inch

Ž Safety tag

Ž Chipping hammer

Ž Safety belt and line

Before carrying out the inspection procedure, be sure to cradle the boom and de-energize and tag circuits "Out of Service." Then carry out the following inspection steps:

Step 1. Inspect the boom for bent, cracked, or corroded members and cracked or corroded welds.

Step 2. Inspect the hoisting for loose bolts, pins, keepers, bushings, shafts, and gears.

Step 3. Inspect the sheaves for binding, loose pins, and worn bearings.

Step 4. Inspect the auxiliary hoist control in the crane cab for loose pins, bolts, and nuts.

Step 5. Inspect the boom block limit switch for damaged or corroded wire rope supporting switch weights.

Step 6. Inspect the drum limit switch for general condition of contacts, loose connections, and security of mounting.

Step 7. Inspect the hoisting block (sheaves, pins, hooks, and trunnions) for bending, loose and worn parts, and corrosion.

Step 8. Inspect the drum grooves for scoring, nicking, grooving, or any condition that would abrade the wire rope.

Step 9. Inspect the drive couplings for evidence of grease being thrown from seals and for freedom from vibration when turning.

Remove "Out of Service" tag and energize circuits.

Chemical analysis of oil

Oil samples are taken quarterly from the auxiliary hoist and sent for chemical analysis. Have the following equipment on hand:

Ž Rag

Ž Bottle, 1-quart, with lid

Ž Hand sump pump

Ž Identification tags

The procedure for sampling the oil is as follows:

Step 1. Obtain oil samples from the auxiliary hoist.

Step 2. Tag the samples to identify barge number and equipment. Label the oil sample for date and operating hours. Send the samples to the testing activity for analysis.

Step 3. Ensure that the physical properties of the oil conform to the manufacturer's data on the applicable manufacturer's data sheet.

Water contamination and unexplained changes in viscosity and acidity warrant an immediate oil change. See the paragraph on replacing the oil in the speed reducer for oil change procedures under Corrective Maintenance. Unexplained increases in metal traces warrant gear inspection to determine cause. See the paragraph on internal inspection of the speed reducer.

Control circuits

The control circuits for the drive system should be checked semiannually to ensure that the system is functioning within the allowable limits. While conducting the checkout procedures, visually inspect the components in the controllers for the following defects:

Ž Resistors for blistering, discoloration, and other evidence of overheating.

Ž Wiring for cut, cracked, or frayed insulation.

Ž Printed circuit boards for cracks and breaks.

Ž Fuse receptacles for evidence of corrosion.

Ž Capacitors for swelling, discoloration, or other evidence of breakdown.

Ž Loose components and poor solder connections.

Master switch

A semiannual inspection should be made to ensure that all moving parts are free, assembly bolts and nuts are tight, and all connections are secure.

The contacts should normally require no servicing during their useful life. Should they become severely pitted, dressing with a fine file is advised. They should be replaced when severely worn.

Complete maintenance inspection

This inspection procedure provides the minimum requirements for an annual maintenance inspection and proof of repairs resulting from the inspection. In general, the inspection consists of observing the functioning of the specified components and parts before, during, and after operation.

Crane components should be repqired and adjusted promptly, subject to material availability, before proceeding to the next phase of the inspection.

PREOPERATIONAL INSPECTION. Inspect the magnetic brake system for binding or wear in the linkage, pins, springs, bearings, and brake linings. Check the coils and leads for proper electrical connections.

If oil analysis indicates excessive metal traces in the oil or if there has been excessive noise or vibration, inspect the speed reducer for evidence of chipping, excessive tooth wear, and improperly fitted keys. Refer to the paragraph on the internal inspection of the speed reducer.

Inspect the wire rope sheaves for worn or damaged sheaves. Inspect for worn bearings, pins, lubrication, and damaged or missing lubrication fittings. Inspect sheave grooves with radius gages for wear.

To clean, inspect, and lubricate hoist wire rope, the following equipment is required:

- Work gloves (2 pairs)
- Rags
- Safety belt and line
- Safety tags
- Bucket of diesel fuel
- Sash brushes (2)
- Grease, MIL-G-18458
- Wire brushes (2)
- Canvas tarpaulin, 6-x 10-foot
- Vernier caliper

WARNING: Ensure that the circuit is de-energized and tagged "Out of Service." Wear gloves when handling wire rope. Exercise extreme caution around operating equipment.

The procedure for cleaning, inspecting, and lubricating the hoist wire rope follows:

Step 1. Lower the auxiliary hook to the down-stop limit with the boom at minimum outreach, Lay out the hook and wire rope on a tarpaulin on the deck or pier. (The hook, if suspended overside, will reach the waterline before the limit is reached.)

Step 2. Clean the wire rope drum surfaces with diesel fuel.

Step 3. Apply a thin coat of grease to the drum surfaces.

Step 4. Wire-brush accessible hoisting wire ropes in the machinery room.

Step 5. Clean the hoisting wire ropes; inspect for corrosion and broken wires.

Step 6. Replace the wire rope when one or more of the following conditions exist:

- Evidence of pitting due to corrosion.
- Six broken wires in one lay length or three broken wires in one strand per lay. (NOTE: A lay or pitch of wire rope is the linear length of rope within which a spiral strand completes one full turn about the axis.)
- Kinking, crushing, birdcaging, or any physical damage resulting in distortion of the wire rope structure.

- One broken wire within one lay length of any end fitting. (In this case, an alternate to replacement is to cut off the damaged rope and replace the fitting.)
- Reductions of the nominal diameter exceeding 1/16 of an inch for 7/8-inch rope.

Step 7. Apply a thin coat of grease to the cleaned portion of the wire rope.

Step 8. Energize the circuit.

WARNING: Use extreme caution around operating equipment.

Step 9. Reel in the wire rope in 6-foot increments.

Step 10. De-energize the circuit.

Step 11. Repeat Steps 4 through 10 for the remaining wire rope.

Step 12. Inspect the wire rope sockets for any indication of looseness; resocket cables when the sealer shows evidence of movement or looseness in the socket basket.

Step 13. Energize the circuit.

Step 14. Return the boom to stow position.

Step 15. Remove the safety tag.

Check the *wire rope fastening and terminal hardware* particularly the wire rope sockets, eyes, swivels, trunnions, stays, pendants, and securing hardware for wear, cracks, corrosion, and other damage.

Inspect the *hoisting block* for cleanliness, damaged or worn sheaves, broken bolts, or worn cheek plates. Inspect the hook for damage, wear to hook housing device, hook swivel trunnions, bearings, and securing nuts, broken or missing lubrication fittings, and lubrication.

Inspect the *wire rope drum* for distortion, cracked welds, worn wire rope grooves, and lubrication. Inspect the bearings for wear, lubrication, and discoloration due to heat.

Inspect the *hold-down bolts* for hoist package components, pounding gently with a hammer. Tight bolts should not be disturbed. Loose bolts are to be removed, cleaned, and tightened to the torque values indicated in the following table.

Bolt Torque Values

COMPONENTS	NO	BOLT DIMENSIONS	GRADE STEEL	TORQUE (Dry) (In ft-lb)
Bed frame	22	1 1/4" x 7" x 4 1/2"	Grade 2	500
Reducer	6	1 1/4" x 7" x 4"	Grade 2	500
Motor	4	7/8" x 9" x 3"	Grade 2	165
Brake	4	1" x 8" x 5"	Grade 2	250
Pillow block	4	1" x 8" x 4"	Grade 2	250
Limit switch	3	10" x 24" x 1 3/4"	Stainless	5

Inspect complete *structure* for damaged, broken, bent, cracked, and loose or missing support members. Check boom stowage saddle for damage and proper alignment.

Inspect complete *boom assembly* for broken or damaged parts and cracked, corroded, or missing members. Inspect for indications of loose fasteners, rivets, bolts, welds, and corrosion. Inspect the support pins, bushings, retainers, mounting brackets, and lubrication.

On the *auxiliary hoist controller,* check the enclosures for—

- Cleanliness. Remove any dirt or foreign matter. Use a plastic-tipped vacuum attachment or dry, low-pressure air.
- Moisture or salt accumulation. Remove moisture with a hot air dryer or heat lamps. Removing salt accumulation may require disassembling components, washing with clean fresh water, drying, and reassembling.

Check the wiring, fuses, and buses for—

- Insulation deterioration.
- Sign of overheating. Look for discoloration of insulation and exposed copper conductors.
- Grounds. Check circuitry using a 500-VDC megger. Circuits that may be damaged by the high voltage of the megger will be tested using a high-impedence (10,000 ohm/volt minimum) Multimeter. Minimum acceptable value is 1 megohm.
- Breakdown or arcing of components. Make sure there is adequate clearance between the ground and all components.
- Loose connections. Tighten any loose connections. Replace any stripped or missing studs, screws, or nuts. Replace any broken wiring.

To check the relays and contactors—

- Operate manually to locate loose hardware, weak springs, and parts that are developing excessive friction. Tighten loose hardware and replace worn or defective parts.
- Inspect each pair of contacts for signs of wear, adequate overtravel, and proper contact pressure. If contact wear has reduced overtravel to the minimum acceptable level (1/8 inch), replace both the stationary and moving contact.
- If copper contacts become severely pitted or burned, dress them with a fine file. Do not use emery cloth or sandpaper since abrasive granules may become embedded in the contact surface.

Blacking of silver contacts is not an indication of high-contact resistance. Normally, dressing is not necessary. If the surfaces are deeply pitted or burned, some dressing with a fine file is advisable.

Inspect the *resistor assembly* for cleanliness, broken insulators, loose connections, and evidence of overheating.

Inspect the *motor* for loose electrical connections, loose bolts or mechanical fastenings, and wear resulting from loose bolts or mechanical fastenings. Check the commutator for evidence of sparking, chips, cracks, and uneven brush wear. Check the brush length and replace if worn. Check the pigtail connections for looseness. Replace chipped brushes. Check to see that brushes move freely in holders. Check the insulation for damage and deterioration.

On the *limit switches* remove covers and inspect all electrical and mechanical components for malfunction including contacts, springs, ratchets, pins, arms and insulators, rollers, cams, and dogs. Inspect the cover gaskets, counterweights, and guides.

To check the *flexible couplings,* the following equipment is required:

- Allen and socket wrenches
- Safety tag
- Portable light
- Rags
- Zerk grease fitting, 1/4-inch
- Grease gun
- Grease, MIL-G-18709

Before inspecting, remove the guard cover. Rotate the motor with power until the coupling fill and drain plugs are accessible. De-energize circuit and tag “Out of Service.”

Visually inspect the flexible coupling for leaking grease seals. If replacement of seals is necessary, perform the following:

Step 1. Remove the bolts from the coupling.

Step 2. Remove the fill and drain plugs.

Step 3. Separate the coupling halves.

Step 4. Remove the gasket.

Step 5. Remove the old grease.

Step 6. Clean all parts.

Step 7. Inspect the gears for pitting, corrosion, and chipped or cracked teeth.

Step 8. Reassemble the coupling and check alignment.

Step 9. Install the Zerk grease fitting in the filler plug hole.

Step 10. Fill with grease until grease comes out of the drain hole.

Step 11. Remove the Zerk filling.

Step 12. Reinstall the fill and drain plugs.

Step 13. Reinstall the topping and auxiliary hoist coupling guard covers.

OPERATIONAL TEST. Make the following operational tests with no load (the operational boundaries are the crane's specified operating limits):

- Operating requirements. Raise the top of the boom to the minimum outreach with the hook outboard. Raise and lower the auxiliary hook from the near upper limit to near the waterline at rated speed for three complete cycles.
- Operation limit switches. Test switches according to the procedure for testing the limit switch.
- Magnetic brake system. Check for delay, overheating, or restrictions in the brake operation.
- Wire rope sheaves, drum spooling, wire rope fastenings, and terminal hardware. Check for proper operation, freedom of movement, unusual noises or vibration, and satisfactory operation of sheave guards and wire rope spooling. Check for correct length of installed wire rope.
- Machinery drive components. Check for proper operation or abnormal chatter, noise, or vibration.
- Electrical controls. Check for proper operation and response.

LOAD TEST. The crane should be load-tested after an overhaul or every four years. First test at 125 percent rated capacity. The operating boundaries for the test are as follows:

- Keep the suspended hook loads outboard and clear of the barge at all times.
- Keep the suspended loads clear of facilities and equipment located within the crane's operating limits to avoid damage in case of crane failure. The facilities and equipment should be moved where practical.
- Do not exceed the crane's specified operating limits.
- Do not lift auxiliary and main hook loads simultaneously.

Then apply a load of 70,000 pounds (125 percent of rated capacity) to the auxiliary hook with the boom topped outboard. The load will then be moved clear of obstructions and raised and lowered through three cycles at no specified speed. During this load test, check the—

- Magnetic brake system for delay, overheating, or restriction in brake operation. During the last cycle of lowering the auxiliary hoist, demonstrate the ability of the brakes to set and hold the load.
- Structural and operating components for evidence of binding, warping, permanent deformation, or cracking or malfunction of components.
- Machinery drive components for proper operation, abnormal chatter, noise, or vibration.
- Look for wear in swivels and pins, wear cracks, or gouges in hook throat. Where material or section loss is excessive or where hooks are severely twisted or distorted, hooks shall be discarded.

Take base measure of throat dimension before loading the hook for 125 percent load test. Install two tram points; measure and record the distance between them as shown in the following illustration.

After completion of the load test, measure and record the distance between the two tram points. A hook showing an increase in the throat opening of more than 5 percent shall be discarded.

Next, test at working load capacity. The operating boundaries are as follows:

Ž Do not exceed the crane's specified operating limits.

Ž Do not lift auxiliary and main hook loads simultaneously.

Top the boom to the minimum outreach outboard, and apply a load of 56,000 pounds to the auxiliary hook. Hoist and lower the load at rated operating speed between the limits for three complete cycles. Stow and secure the crane.

Hook Inspection for Load Test

Throat Dimension:

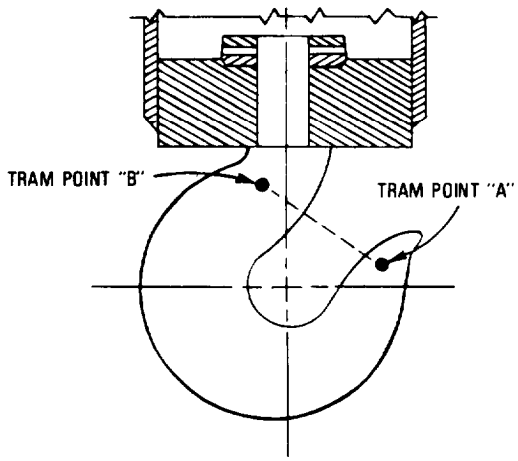
Before load test _____

After load test _____

Increase _____

Remarks: _____

_____



LUBRICATION

Lubrication is a regularly scheduled part of preventive maintenance which serves to minimize breakdown of equipment. Lubrication requirements are given in the lubrication chart. The following precautions should be observed when performing the lubrication actions:

Ž Do not overlubricate. Excess grease or oil might spread into adjoining equipment and cause failure.

Ž Apply lubricant as received. It does not have to be heated.

Ž Keep lubricant fluids in closed containers to prevent evaporation, dilution, or contamination.

The intervals listed in the following lubrication chart are based on the normal operating hours for the crane. Frequency of lubrication should be governed by the number of operating hours and ambient temperature. Under normal operating conditions and for most applications, grease should be applied every month; motor oil and grease should be changed every six months.

Lubrication Chart

FREQUENCY	COMPONENT	LUBRICANT	REMARKS
Weekly (W):	Gear reducer.	Oil.	Splash; check for contamination; check oil level; add if necessary.

Lubrication Chart (Continued)

FREQUENCY	COMPONENT	LUBRICANT	REMARKS
Monthly (M):	Auxiliary hoist idler sheaves, boom tip sheave, block sheave, and drum pillow block bearing.	Grease. MIL-G-18709.	Use grease gun; fill.
	Magnetic brake.	Oil. MIL-L-17331.	Use hand oiler in all pivot points.
	Auxiliary hoist wire rope.	Grease. MIL-G-18458.	Brush on.
	Wire rope on drum.	Grease. MIL-G-18458.	Brush on.
Semiannually (S):	Auxiliary hoist electric motor. pressure fittings.	Grease. MIL-G-18709; alternate, 000-G-24508.	Use grease gun.
	Flexible coupling.	Grease. MIL-G-18709; alternate, DOD-G-24508.	Use grease gun.
Annually (A):	Wire rope.	Grease. MIL-G-18458.	Do as part of annual inspection.
As required: (R)	Speed reducer.	Oil, manufacturer's data.	Remove oil.

The following equipment is required for the *weekly lubrication:*

Ž Rags

Ž Oil (refer to manufacturer's data)

Ž Flashlight

Ž Screen funnel with 3/4-inch-diameter spout

Observe standard safety precautions during lubricating procedures. Inspect oil level in speed reducer gearcase. If oil lever is low, remove filler plug from gearcase and replenish with oil.

The following equipment is required for the monthly lubrication:

Ž Grease gun

Ž Oil can with MILL-17331 oil

Ž Grease, MIL-G-18709

Ž Safety tag

Ž Grease, MIL-G-18458

Ž Safety belt and line

Ž Flashlight

Ž Rust preventive compound, MIL-C-16173, Grade 2

Ž Rags

Ž Adjustable wrench, 8-inch

Ž Paintbrush, l-inch

Ž Bowl brush

Ž Sash brush

Observe standard safety precautions. De-energize the circuits and tag "Out of Service." Comply with crane barge regulations when working aloft.

Apply MIL-G-18709 grease with the grease gun to the hoist drum pillow block (one point) in the machinery house and to the following exterior points: the block sheaves (three points), the hook (one point), and the boom tip sheave (one point). Apply five to six drops of

MIL-L17331 oil with an oil can to all pivot points of the brake. Apply a thin film of rust preventive compound with a brush to the motor shafts and couplings, and apply MIL-G-18458 grease with a brush to the auxiliary hoist wire rope. Remove the tag and energize the circuit.

The following equipment is required for the *semiannual lubrication:*

Ž Flashlight

• Grease gun

• Safety tag

Ž Rags

Ž Allen wrench, 3/16-inch

• Combination wrench, 9.16-inch

Ž Zerk grease fitting, 1/4-inch

Ž Pipe (tube)

Ž Hammer

• Grease, MIL-G-18709, 5 pounds

• Bars (2), 1-inch diameter

Before lubrication—

Ž Remove the auxiliary hoist motor coupling guard cover.

Ž Rotate the motors with power until the coupling fill-and-drain plugs are accessible.

• De-energize the circuit and tag "Out of Service."

To lubricate the flexible coupling, observe the following procedures:

Step 1. Remove the fill and drain plugs.

Step 2. Install a Zerk grease fitting in the filler plug.

Step *3.* Pump grease into the coupling until grease appears at the drain hole.

Step 4. Remove the Zerk fitting.

Step 5. Reinstall the fill and drain plugs.

Step 6. Reinstall the topping and auxiliary hoist coupling guard cover.

Step 7. Remove the safety tag and energize the circuit.

The following equipment is required for the *speed reducer oil change:*

Ž Oil, manufacturer's data (AGMA 5), 62.5 gallons

Ž Buckets (2)

Ž Screened funnel with 3/4-inch filling tip

Ž Pipe wrench, 14-inch

Ž Adjustable wrenches, 4-inch and 10-inch

Ž Flashlight

Ž Hand-operated suction pump

Ž Rags

Ž Safety tag

To renew the oil in the reduction gearcase, observe this procedure:

Step 1. De-energize circuits and tag "Out of Service."

Step 2. Remove the filler cap.

Step 3. Remove the drain plug and drain the oil.

Step 4. Reinstall the drain plug.

Step 5. Replace the oil.

CORRECTIVE MAINTENANCE

Troubleshooting of the crane machinery may be divided into two major areas: mechanical and electrical. Therefore, to efficiently maintain the crane, maintenance personnel must be qualified to perform both electrical and mechanical repairs.

A working knowledge and complete understanding of the operating characteristics of the overall equipment and its major components are essential to assure rapid fault isolation. A number of logical choice faults can normally be made by a thorough and knowledgeable observation of the malfunction. Based on the operational features of each functional assembly, it can be determined whether the fault is electrical or mechanical. Once the faulty functional assembly has been isolated, it is often necessary to locate the faulty part or make adjustments within that assembly.

Failure of the crane to respond properly to controls will most often be due to an electrical malfunction. In most cases, faults of a purely mechanical nature are easily recognized.

CRANE CONTROLLER

The controller comprises a number of electrical circuits. To troubleshoot these circuits, the first step is to localize the fault, tracking it to the major area responsible for the malfunction. The second troubleshooting step is to pinpoint the fault, tracking it within this area to the defective part or improper adjustment which is causing the trouble. To properly perform the first step, maintenance personnel must understand the functional operation of the control circuits. Use the following controller troubleshooting charts as an aid when troubleshooting the controller.

Troubleshooting Chart: Contacts On Crane Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Contact chatter.	Poor contact in the control relay.	Clean the relay contact.
	Broken shading coil.	Replace.
	Excessive jogging.	Caution the operator to avoid excessive jogging.
Overheated contact.	Dirty contact tips.	Clean and dress.
	Sustained overloads.	Find and remedy the cause of the overload.
	Insufficient tip pressure.	Clean and adjust.
	loose connections.	Clean and tighten.
Weak tip pressure.	Wear allowance gone.	Replace contacts and adjust.
	Poor tip adjustment.	Adjust gap and wipe.
	Low voltage, failure of magnet to seal in.	Correct voltage condition.
Short tip life.	Excessive filing or dressing.	Follow the manufacturer's instructions.
	Excessive jogging.	Instruct the operator as to correct operation.
Welding or fusing of contacts.	Abnormal starting currents.	Operate the manual controller more slowly. Check the automatic controller for correct starting resistors and proper functioning of timing devices or accelerating relays.
	Rapid jogging.	Instruct operator as to correct operation.
	Short circuit currents on contacts.	Find and remedy causes of short circuits. Check the feeder fuses for proper size and replace if required.
Failure of the flexible conductors between fixed and moving parts of contactor.	Improper installation.	See the manufacturer's instructions.
	Worn out mechanically by large number of operations.	Replace.

Troubleshooting Chart Contacts On Crane Controller (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Failure of the flexible conductors between fixed and moving parts of contactor (Continued)	Moisture or corrosive atmosphere.	Replace with flexible conductors suitable for application.
	Burned by arcing or overheating from loose, oxidized, or corroded connections.	Clean and tighten the connections.

Troubleshooting Chart: Coils On Crane Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Coil failure, not overheated.	Moisture, corrosive atmosphere.	Use correctly insulated coils.
	Mechanical damage.	Avoid handling the coils by the leads.
	Vibration or shock damage.	Secure the coils properly.
Coil failure, overheated.	Overvoltage or high ambient temperature.	Check the current and application.
	Wrong coil.	Use only the manufacturer's recommended coil.
	Too frequent use or rapid jogging.	Use the correct operating procedure.
	Undervoltage, failure of the magnet to seal in.	Check the circuit and correct the cause of low voltage.
	Used above current rating.	Install the correct coil for the application.
	loose connection to coil; corrosion or oxidation of connection surfaces.	Clean and tighten the connection.
	Improper installation.	See the manufacturer's instructions.

Troubleshooting Chart: Magnets and Mechanical Parts on Crane Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Worn or broken.	Heavy slamming caused by overvoltage or wrong coil.	Replace the part and correct the cause.
	Chattering caused by broken shading coil or poor contact in control circuit.	Same as above.
	Excessive jogging.	Same as above.
	Mechanical abuse.	Same as above.
Noisy magnet.	Broken shading coil.	Replace.
	Magnet faces not true, result of mounting strain.	Correct the mounting.
	Dirt or rust on magnet face.	Clean.

Troubleshooting Chart Magnets and Mechanical Parts on Crane Controller (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Noisy magnet (Continued).	Low voltage.	Check the system voltage and correct.
	Improper adjustment, magnet overload.	Check and adjust according to the manufacturer's instructions.
Broken shading coil.	Heavy slamming caused by overvoltage, magnet underload, or weak tip pressure.	Replace coil and correct the cause.
Failure to dropout.	Gummy substances on the magnet faces.	Clean with an approved solvent.
	Worn bearings.	Replace.
	Nonmagnetic gap in the magnet circuit.	Replace the magnet.
	Voltage not removed.	Check the coil voltage.
	Not enough mechanical load on the magnet, improper adjustment.	Adjust according to manufacturer's instructions.

Troubleshooting Chart: Overload Relays on Crane Controller

SYMPTOM	PROBABLE CAUSE	REMEDY
Magnetic, instanteneous type, high or low tip	Wrong cod.	Install correct coil.
	Mechanical binding, dirt, or corrosion.	Clean with an approved solvent and adjust.
	Shorted turns (high trip).	Test the coil; replace if defective.
	Assembled incorrectly.	Refer to the manufacturer's instructions for correct assembly.
	Wrong calibration.	Replace.
Magnetic, inverse time-delay type, slow trip.	Fluid dirty or gummy	Change the fluid and fill to the correct level.
	Mechanical binding, corrosion.	Clean with an approved solvent and adjust.
	Worn or broken parts.	Replace and adjust.
	Fluid too low.	Drain and refill to correct level.
Thermal type, fails to trip.	Wrong size heater.	Install correct size.
	Mechanical binding, dirt, corrosion.	Clean with an approved solvent and adjust.
	Relay damaged by a previous short circuit.	Replace.
Thermal type, trips at too low temperature.	Wrong size heater.	Install correct size.
	Assembled incorrectly.	See the manufacturer's data for correct assembly.
	Wrong calibration.	Replace.

Troubleshooting Chart Overload Relays on Crane Controller (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Thermal type, failure to reset.	Broken mechanism or parts.	Replace.
	Corrosion and dirt.	Clean and adjust.
Thermal type, has burning and welding of control contacts.	Short circuits in the control circuits with fuses that are too large.	Correct the causes of the short circuit; make sure that the fuses are the right size.
Timing relays, flux decay type, too short time.	Dirt in air gap.	Clean.
	Shim too thick.	Replace with a thinner shim.
	Too much spring or tip pressure.	Adjust according to manufacturer's data.
	Misalignment.	Correct the alignment and remedy the cause of misalignment.
Timing relays, flux decay type, too longtime,	Shim worn too thin,	Replace with a thicker shim.
	Weak spring and tip pressure.	Adjust according to manufacturer's data.
	Gummy substance on magnet face or mechanical binding.	Clean with an approved solvent and adjust.

ELECTRIC MOTOR (DC)

The following motor troubleshooting chart is to be used as an aid in determining problems with the DC motors.

Troubleshooting Chart Electric Motor (DC)

SYMPTOM	PROBABLE CAUSE	REMEDY
Motor fails to start.	Control panel doors open.	Close control panel doors.
	Power not connected because of an open supply switch, circuit breaker; or blown fuses.	Close the switch or circuit breaker: check fuses and replace if required.
	Overload relay on the circuit breaker in the supply line trips.	Reset the overload relay or circuit breaker and restart. If it trips again, inspect for a short circuit and check other causes for failure to start.
	Low voltage	See if the voltage shown on the motor nameplate agrees with voltage of the supply line. Measure the voltage at the motor terminals with the motor connected to see if the voltage drop in line is excessive.
	Loose connections or open circuit in the controller or in the wiring to motor.	Check the connections and correct or tighten the connections.

Troubleshooting Chart Electric Motor (DC) (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Motor fails to stop (Continued).	incorrect connections in the controller or to the motor.	Check the connections with the wiring diagrams for controller and motor. Make sure that the motor is connected for correct direction of rotation.
	Open circuit in the motor windings.	Repair the windings.
	Short circuit in the motor windings.	Repair the windings.
	Grounded motor windings.	Repair the windings.
	Overload on driven machine.	Reduce the load, if possible, and start with the driven machine partially or completely unloaded.
	Excessive friction due to— - Gear side thrust. - Misalignment. Stiff grease in the source ball bearings. - Insufficient lubrication of the sleeve bearings. - Bent and sprung shaft. - Rotor rubbing the stator. Driven machine seized.	Check possible causes Disconnect motor from the driven machine, if necessary, to localize the source of trouble.
	Stiff bearings.	Free the bearings.
	Frozen bearings.	Replace the bearings and, for sleeve bearings, resurface and polish shaft.
	Electric brake (If installed) fails to release.	Check operation of the brake.
	Driven machine locked or jammed.	Disconnect the motor from the driven machine. If the motor starts and runs all right, check the driven machine.
Motor stops after it has been running.	Power supply fails because a generator circuit breaker trips out.	Restart the motor when the power is reestablished.
	Circuit breaker or overload relay trips out because of shock or overload.	Reset the circuit breaker or overload relay and restart the motor If it trips again, check for an overload.
	Control panel doors opened.	Close the control panel doors.
Vibration or excessive noise.	inadequate foundation or loose hold-down bolts on the motor or the driven machine.	Tighten the hold-down bolts.
	Rotor loose on shaft.	Tighten the bolts, keys, and mechanical fastenings; or replace the rotor and shaft assembly.
	Loose electrical connections.	Tighten.

Troubleshooting Chart Electric Motor (DC) (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Vibration or excessive noise. (Continued).	Coupling misaligned or loose.	Check the alignment and tighten the coupling bolts.
	Air gaps not uniform.	Center the rotor. Replace the bearings if required.
	Rotor rubbing the stator; an aggravated case of the air gaps not being uniform.	Recenter the rotor and check the bearings for wear.
	Dirt in air gap.	Clean.
	Objects caught between the fan and end shields.	Stop the motor and clean out.
	Motor or driven machine unbalanced.	Disconnect the motor from the driven machine and run alone to determine the source of trouble. Balance the unit that is unbalanced.
	Excessive load.	Reduce the load.
	Short-circuited coils.	Repair the coils.
	Bearinq troubles Insufficient oil or oil rings sticking (sleeve bearings).	Add oil and check the rings
	Overgreased ball bearings.	Remove the drain plug and allow excess grease to run out.
	Excessive end play which allows shaft to bump back and forth.	Check the end play and belt alignment if belts are used.
	Poor fit, bearings too tight or too loose.	Check the fit, and replace the bearings if required.
Bearings overheat.	End shields loose or not replaced properly.	Verify that the end shields fit squarely and are properly tightened,
	Misaligned couplings.	Check and correct the alignment.
	Too much heat conducted to the bearings from an overheated rotor.	Correct cause of the overheated rotor.
	Too much heat conducted to the bearings from overheated windings.	Correct the cause of the overheated windings.

Troubleshooting Chart Electric Motor (DC) (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Ball bearings overheat.	Too much grease.	Remove the drain plug, let the motor run, and allow excess grease to run out.
	Not enough grease.	Add grease.
	Wrong grade of grease.	Replace with proper grade
	Dirt in grease.	Clean the bearings, inspect and replace if damaged, regrease.
	Bearings not aligned.	Check the bearing assembly, and see that the races are perpendicular to the shaft.
Windings overheat.	Bearings damaged or corroded.	Replace the bearings.
	Heat conducted to the windings from overheated bearings.	Correct the cause of the overheating of the bearings.
	Incorrect bearing.	Check the applicable technical manual and bearing stock number.
	Short-circuited coils.	Repair the coils.
	Overload.	Check the electric power input to the motor; reduce the load if excessive.
	Incorrect connection of the motor internally or to external circuit.	Check the connections and correct if required.
	Rotor rubbing the stator.	Check air gaps and the center rotor.
	Restricted ventilation.	See that the fans and baffles are correctly assembled. Clean the air passages and windings.
	Too frequent starting or running at a more severe duty cycle than that for which motor is built; failure of protective devices to function; indiscriminate use of the emergencv fan feature, particularly under conditions of overload.	Check the operation control devices if the motor is on fully automatic control. Check the duty cycle with the nameplate rating on the motor.
	Low voltage on the supply line.	Check the voltage at the motor terminals when the motor is running.
	Overheating due to any of the causes enumerated above.	Check as Instructed above.

Troubleshooting Chart Electric Motor {DC) (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Motor burns out.	Insulation failure due to— - Excessive moisture in the windings. - Grease, oil or dirt on the windings. - Faulty insulation,	Replace with spare motor or rewind.
Motor attempts to start but the over-load relay trips.	Weak field or no field,	Check the field coils for an open circuit. Check the wiring for loose or broken connections.
Motor runs to slowly under load.	Line voltage too low.	Check the line voltage and correct.
	Brushes set ahead of neutral.	Adjust the brushes to neutral.
	Overload.	Check the electric power input to the motor.
Motor runs too fast under load.	Weak field.	Check the field circuit for loose connections. Measure the field current.
	Incorret series field polarity,	Check the series field connections.
	Line voltage too high.	Measure the line voltage at the motor termmals, and correct the line voltage if high.
	Brushes set back of neutral.	Set the brushes on neutral.
Faulty commutation High, white spark under one brush. Grooving of commutator.	Copper embedded in the brush.	Scrape copper of the brush with a knife; sand brush to fit. Recondition the commutator if required.
Periodic sparking, Some highly polished bars with adjacent commutator bars dull or burned.	Loose commutator with high bar.	Stop the motor; tap the high bar into place with a block of wood and mallet Tighten the commutator nuts. Season and resurface the commutator if required.
Blue, snappy sparks.	Defective armature coils, open-circuited or short-circuited.	Locate and replace the defective coils or replace the armature.
Ring of fire.	Defective armature coils or rough and dirty commutator.	Replace the coils or recondition the commutator.
Continuous heavy sparking.	Overload..	Check the line current and reduce the over. load if practical.
	Weak or open main field circuit.	Check for overspeed.

Troubleshooting Chart Electric Motor (DC) (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Faulty commutation (Continued): Continuous heavy sparking (Continued).	Reversed commutating pole or main pole connections.	Check for a loose or broken connection or open circuits. Measure the field current.
	Incorrect adjustment of commutating pole air gap.	Check the connections with the wiring diagram.
	Brushes off neutral.	Set the brushes on neutral.
	Brushes unevenly spaced around the commutator.	Space the brushes evenly.
	Brush studs not parallel to the commutator bars.	Adjust the brushes.
	Brushes wedged in holder: wrong brush pressure.	See the manufacturer's data. Free the brushes in holders. Test the brush pressure.
	Brush holders too near or too far from the commutator.	See the manufacturer's data.
	Loose or high resistance pigtail connections.	Tighten or replace the brushes if required.
	Incorrect grade of brush.	Check motor drawings for the correct brush grade.
	High mica or pitted mica	Undercut the mica.
	Dirty or rough commutator.	Clean or recondition the commutator.
	Vibrating brushes.	Check for excessive machine vibration, rough or eccentric commutator, incorrect brush pressure, wrong grade of brushes, wrong brush angle, incorrect distance from brushholders to commutator or high mica.
	Brushes do not fit the commutator.	Sand the brushes to fit.
	Brushes worn to short or broken.	Replace the brushes.
	Insufficient or excessive brush pressure	See the manufacturer's data.
	Use of emery cloth or paper on the commutator.	Remove all emery from commutator and mica, and replace brushes. Never use emery cloth or emery paper to clean the commutator or fit the brushes.

MAGNETIC BRAKE

Refer to the magnetic brake troubleshooting chart as an aid for isolating problems, determining the probable cause, and finding a suggested remedy.

Troubleshooting Chart Magnetic Brake

SYMPTOM	PROBABLE CAUSE	REMEDY
Worn or broken parts.	High inertial loads, misapplication, excessive temperature.	Replace parts.
Failure to hold load.	Worn parts; out of adjustment; wrong brake lining.	Replace parts with correct materials and adjust.
	Grease or oil on brake drum.	Clean thoroughly with an approved solvent.
Failure to set.	Out of adjustment, worn drum.	Replace worn parts and adjust.
	Mechanical binding.	Clean and adjust.
	Coil not de-energized.	Check the circuit to make sure the current is cut off.
Failure to release.	Out of adjustment.	Adjust according to the technical manual.
	Coil not energized.	Check and repair the circuit.
	Wrong coil.	Relate with the correct coil.
	coil open or short-circuited.	Replace the coil.
	Motor binds.	Align correctly and check the bearings.

SPEED REDUCER

Approximately 98 percent of gear reduction failures can be attributed to improper lubrication, misapplication, and misalignment.

Improper lubrication causes a high percentage of gear reduction unit failures. Too frequently speed reducers are started up without any lubricant at all. Sometimes units are filled to a higher oil level than specified, in the mistaken belief that better lubrication is obtained. This higher oil level usually results in more of the input power going into churning of the oil. This creates excessive temperatures with detrimental results to the bearings and gearing. Insufficient lubrication causes the same results.

Gear failure due to overload is a broad and varied area of misapplication. The nature of load (input torque, output torque, duration of operating cycle, shocks, speed, and acceleration) determines the gear unit sizing and other design criteria. Frequently, a gear drive must be larger than the torque-output capability of the prime mover, An AGMA service factor compensates for the varying severity of application conditions by providing a higher, nominal horsepower. This, in effect, increases the size of the gear unit. If there is any question in the user's mind that the actual service con ditions may be more severe than originally anticipated, this information should be communicated to the gear manufacturer before start-up. Often remedies can be suggested before a gear unit is damaged by overload, but none are effective after severe damage.

Motors and other prime movers should be analyzed while driving the gear unit under fully loaded conditions. This is to determine that the prime mover is not overloaded and thus putting out more than the rated torque. If an overload does exist, the unit should be stopped and the overload removed or the factory contacted to determine suitability of the gear drive under observed conditions.

The troubleshooting chart for the gear reducer describes other causes for problems and suggested remedies.

Troubleshooting Chart Speed Reducer

SYMPTOM	PROBABLE CAUSE	REMEDY
Overheating.	Unit overloaded.	Reduce the loading, or replace with a drive of sufficient capacity.
	Oil level too high or too low.	Check the oil level indicator to see that the housing is accurately filled with lubricant to the specified level.
	Bearings not properly adjusted.	Bearings must not be pinched. Adjustable tapered bearings must be set at the proper bearing lateral clearance. All shafts should spin freely when disconnected from the load.
	Oil seals.	Apply a small quantity of oil externally at the lip until the seal is run in.
	Breather.	Breather should be open and clean. Clean the breather regularly in a solvent.
	Grade of oil.	Oil must be of the grade specified in the lubrication instructions. If it is not, clean the unit and refill with the correct grade.
	Condition of oil.	Check to see if the oil is oxidized or dirty or has a high sludge content, Change the oil if necessary.
	Coupling alignment.	Disconnect the couplings and check the alignment. Realign as required.
	Coupling lateral float.	Adjust the spacing between the drive motor and so forth to eliminate end presssure on the shafts. Replace the flexible coupling with a type allowing the required lateral float.
	Excessive speeds.	Reduce the speed, or replace with a drive suitable for the speed.
Shaft failure.	Wrong type of coupling used.	Rigid couplings can cause shah failure. Replace couplings to provide the required flexibility and lateral float.
	Coupling alignment.	Realign the equipment as required.
	Unit overloaded.	Reduce the loading, or replace with a drive of sufficient capacity.

Troubleshooting Chart Speed Reducer (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Shaft failure (Continued).	Unit subjected to high energy loads or to extreme repetitive shocks.	Apply couplings capable of absorbing shocks and, if necessary, replace with a drive of sufficient capacity to withstand shock loads.
	Torsional or lateral vibration condition.	Vibrations can occur through a particular speed range. Reduce the speed to at least 25 percent below the critical speed System mass-elastic characteristics can be adjusted to control the critical speed location. If necessary, adjust the coupling weight, as well as the shaft stiffness, length, and diameter. For specific recommendations, contact the factory.
	Outboard bearing not properly aligned.	Realign bearing as required.
Bearing failure.	Unit overloaded.	See “Overheating Unit overloaded.” Abnormal loading results in flaking, cracks, and fractures of the bearing.
	Speed of bearing excessive.	See "Overheating Excessive speeds.”
	Coupling alignment.	See “Overheating Coupling alignment."
	Coupling lateral float.	See “Overheating Coupling lateral float.”
	Bearings not properly adjusted.	See “Overheating Bearings not properly adjusted.”
		If bearing is too free or not square with the axis, an erratic wear pattern will appear in the bearing races.
	Bearings not properly lubricated.	See “Overheating Oil level too high or too low, ” “Grade of oil,” and “Condition of oil." Improper lubrication causes excessive wear and discoloration of the bearing.
	Rust formation due to water or humidity.	Make necessary provisions to prevent the entrance of water. Use a lubricant with good rust-inhibiting properties. Make sure the bearings are covered with sufficient lubricant. Turn over gear unit more frequently during prolonged shutdown periods.
	Bearing is exposed to an abrasive substance.	An abrasive substance will cause excessive wear evidenced by dulled rollers and raceways. Make a necessary provision to prevent the entrance of the abrasive substance. Clean and flush the drive thoroughly and add new oil.
	Unit has been stored improperly or damaged by prolonged shutdown.	Prolonged periods of storage, moist, ambient temperatures will cause destructive rusting of bearings and gears. When these conditions have existed the unit must be disassembled, inspected and damaged parts thoroughly cleaned of rust or replaced.

Troubleshooting Chart Speed Reducer (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Oil leakage.	Oil level exceeded.	Check to see that the oil level is correct.
	Breather open.	The breather should be open and clean.
	Oil drains open.	Check to ensure that all oil drain locations are clean and tree flowing. Drains are normally drilled in the housing between the bearings and bearing cap where the shafts extend through the caps.
	Oil seals.	Check the oil seals and replace if worn. Check the condition of the shaft under the seal and polish if necessary. Slight leakage is normally required to minimize friction and heat.
	Plugs at drains, levels, and standard pipe fittings.	Apply Marseal pipe joint sealant or equivalent, and tighten fittings.
	Compression-type pipe fittings.	Tighten the fitting or disassemble; check to see that the collar is gripping the tube properly.
	Housing and caps.	Tighten the cap screws or bolts.
Gear wear.	Gear tooth wear and failure.	Consult the factory.
	Backlash.	Gear set must be adjusted to give the proper backlash. Consult the factory.
	Misalignment of gears.	Check that the contact pattern covers over 75 percent of the face, preferably in the center area. Check the condition of the bearings.
	Housing twisted or distorted.	Check shimming or stiffness of foundation.
	Unequal distribution of wear m units having opposed helical gearing.	Check the flexible coupling for adequate lateral float See "Overheating."
	Unit overloaded	See "Overheating Unit overloaded."
	Oil level too high or too low.	See "Overheating 0il level too high or too low. "
	Bearings not properly adjusted.	See "Overheating Bearings not properly adjusted."
	Grade of oil.	See "Overheating: Grade of oil."
	Condition of oil.	See "Overheating: Condition of oil."
	Coupling alignment.	See "Overheating: Coupling alignment."
	Coupling lateral float.	See "Overheating: Coupling lateral float."

Troubleshooting Chart Speed Reducer (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
Gear wear (Continued).	Excessive speeds.	See "Overheating Excessive speeds."
	Torsional or lateral.	See "Shaft failure: Torsional or lateral vibration condition."
	Rust formation due to entrance of water or humidity.	See same item under "Bearing failure."
	Gears exposed to an abrasive substance.	See same item under "Bearing failure."
Noise.	Unusual or increasing noise.	See all items under "Gear wear" and "Bearing failure."

PILLOW BLOCK BEARING

The following table provides the trouble iagnosis chart for the pillow block bearing.

Troubleshooting Chart Pillow Block Bearing

SYMPTOM	PROBABLE CAUSE	REMEDY
Noise:		
High pitch, steady tone.	Excessive axial load.	Correct outer ring fit in the housing and/or shoulder location to allow thermal expansion.
	Excessive radial load.	Use a correctly fitting inner ring on the shaft. For radial bearings, use the bearing with greater internal clearance.
	Misalignment.	Correct alignment.
Low pitch, continuous or intermittent.	Too much clearance in bearing.	Use the correct shaft fit. For radial bearings, use the bearing with less internal clearance.
	Bearing brinelled.	Replace the bearing: avoid brinelling.
	Raceways pitted due to dirt.	Wash all parts, replace with a new bearing, use clean lubricant, and improve seals.
Intermittent squeal or high-pitch noise,	Shaft rubbing housing.	Correct the seals and machine parts.
Intermittent rumbles, rattles, clicks.	Too much clearance in the bearing.	Correct the shaft fit, or use a bearing with less internal clearance.
	Dirt in bearing.	Wash all parts, replace with a new bearing if necessary, and use clean lubricant.
	Loose machine parts.	Tighten all closures, spacers, and slingers.

Troubleshooting Chart Pillow Blocking Bearing

SYMPTOM	PROBABLE CAUSE	REMEDY
Temperature:		
High after first start.	Grease redistribution.	Allow the machine to cool; restart.
Continuously high during operation.	Churning of the lubricant.	Use a lower oil Ievel, less grease, or grease, or stiffer grease.
	No lubricant.	Add lubricant.
	Excessive axial load.	Check the outer ring fit in the housing and/or shoulder location to allow thermal expansion.
	Excessive radial load.	Use a correctly fitting inner ring on the shaft. May need a bearing with greater internal clearance.
	Bearing misaligned.	Correct the machine parts and alignment procedural.
	Excessive seal drag.	Use Phenolic Seal.
	Outer bearing race is pinched in the housing due to uneven mounting surface.	Loosen the mounting bolts, and check the flatness of the mounting surface. Shim where necessary, and tighten the mounting bolts.
Excessive vibration:		
During acceleration or deceleration periods.	Critical speeds of machine components.	Stiffen the shaft or other machine components to avoid critical speeds.
During operation at fixed speeds.	Unbalanced rotating parts.	Dynamically balance the rotating parts.
	Shaft bent.	Straighten and rebalance.
	Cams, gears, and linkage.	Adjust, Improve, or redesign.
	Mlsalignment.	Correct the machine parts.
	Bearing brinelled.	Replace the bearing; avoid brinelling.
Runout: shaft does not run true, shaft binds when rotated by hand.	Shaft bent.	Straighten the shaft and rebalance.
	Bearing misaligned.	Correct the machine parts and alignment procedures.
	Bearing rings out square.	Check the squareness of the shaft and housing shoulders, spacers and flingers.
	Dirt.	Wash all parts; replace with a new bearing if necessary; use clean lubricant; improve the seals.
	Machine deflection.	Stiffen the machine members.

APPENDIX A

THE 60-TON FLOATING CRANE

The 60-ton floating cranes still in use lift and move loads associated with general marine work and within their rated capacity. This crane (Design 413D) is not self-sustaining and must be towed to its work site. It is classified as a Category C-2 vessel and has an authorized strength of 11 personnel. The operator's cab, engine, hoist, and swing machinery are all part of the machinery house.

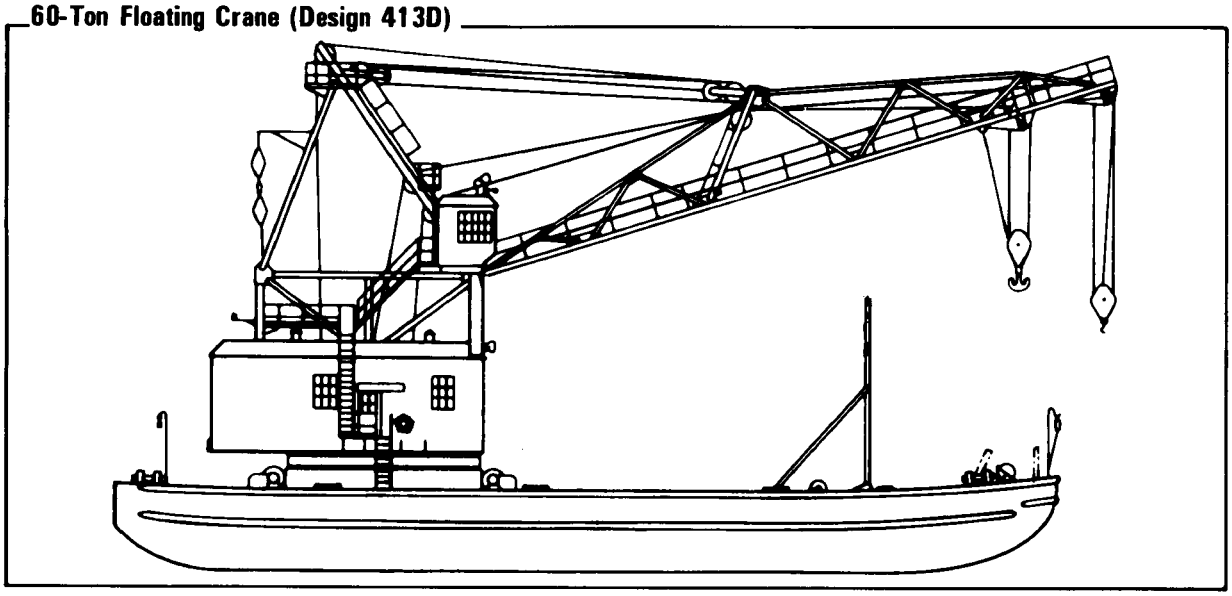
A DC power system provides all power aboard the 60-ton crane. For information on maintenance, troubleshooting, and reeving the hoist and lift blocks, refer to Chapters 9 and 10.

SPECIFICATIONS

The various pieces of barge and crane equipment have been designed, selected, and installed to provide well-coordinated pieces of operating machinery to comply with specified requirements. Safety devices and guards have been built into or about the equipment to protect both the crane and crane operating personnel.

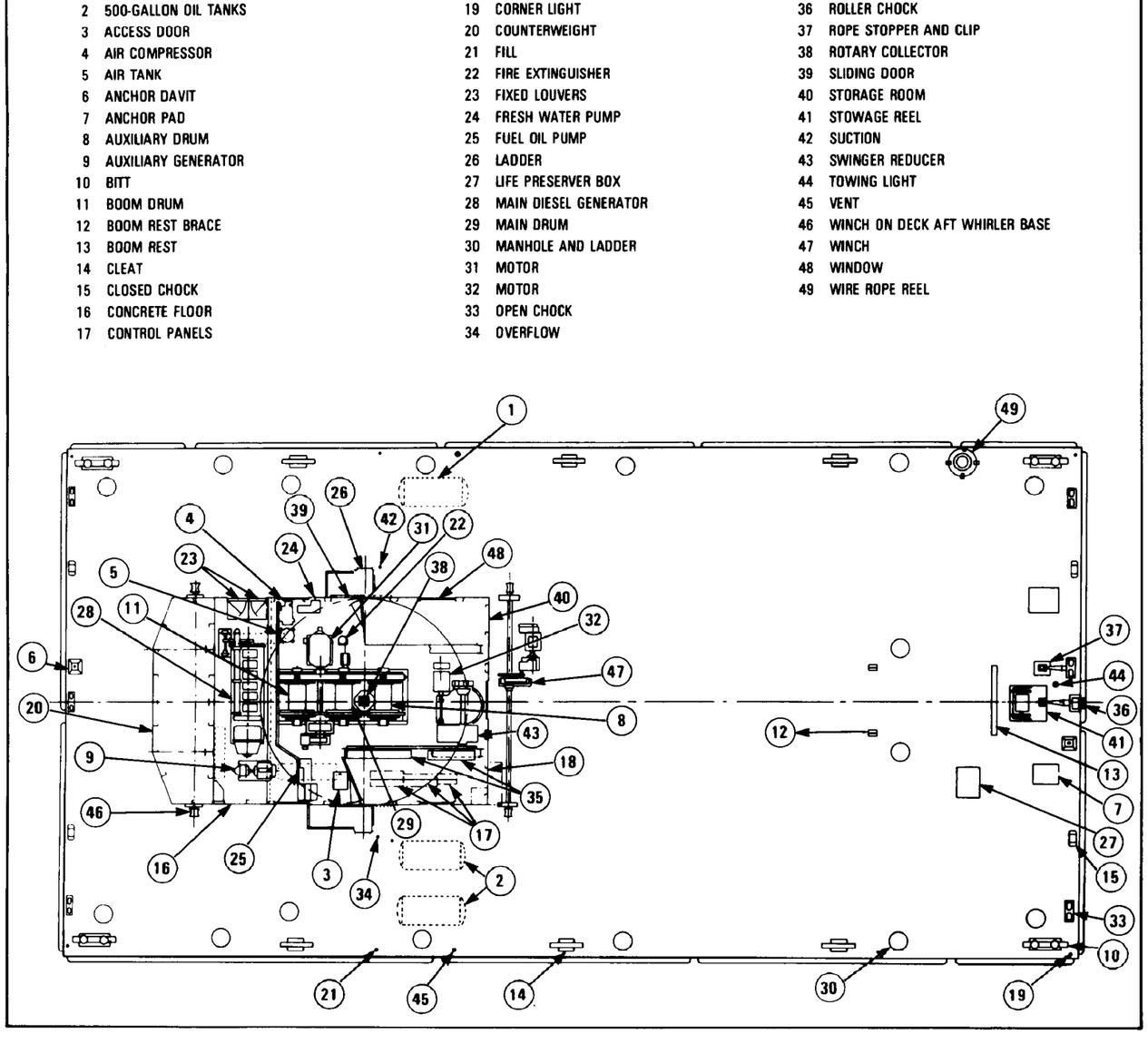
The revolving crane on this unit has a lift capacity of 60 LTONs (2,240 pounds) with a maximum radius of 73 feet. The crane is powered by a diesel-electric generator set. The diesel engine, nominally rated at 250 BHP at 600 RPMs and coupled to a 150-kilowatt, DC generator, supplies electrical energy to the hoist motor, swinger motor, and other equipment. The machinery house and operator's cab are fully enclosed and contain the crane machinery, power units, control panels, auxiliary pumps, and operator's controls. The housing rests cm a steel beam platform that forms the rotating crane base. The entire crane rotates on double-flange steel rollers turning on circular steel tracks around a center steadiment. An auxiliary generator set, consisting of a diesel engine coupled to a DC generator, supplies auxiliary power to operate the air compressor, fuel oil pump, freshwater pump, and other equipment. This unit is also used to provide auxiliary power for lighting, pumps, and other equipment when the main power unit is not in operation. This crane is suitable for loading and unloading heavy lifts of cargo and is mounted on a nonpropelled barge. The following illustrations show the 60-ton floating crane. The table on page A-3 gives its specifications.

60-Ton Floating Crane (Design 413D)



Top View of 60-Ton Floating Crane (Design 413D)

1 500-GALLON FRESH WATER TANKS
2 500-GALLON OIL TANKS
3 ACCESS DOOR
4 AIR COMPRESSOR
5 AIR TANK
6 ANCHOR DAVIT
7 ANCHOR PAD
8 AUXILIARY DRUM
9 AUXILIARY GENERATOR
10 BITT
11 BOOM DRUM
12 BOOM REST BRACE
13 BOOM REST
14 CLEAT
15 CLOSED CHOCK
16 CONCRETE FLOOR
17 CONTROL PANELS
18 CONTROL ROOM
19 CORNER LIGHT
20 COUNTERWEIGHT
21 FILL
22 FIRE EXTINGUISHER
23 FIXED LOUVERS
24 FRESH WATER PUMP
25 FUEL OIL PUMP
26 LADDER
27 LIFE PRESERVER BOX
28 MAIN DIESEL GENERATOR
29 MAIN DRUM
30 MANHOLE AND LADDER
31 MOTOR
32 MOTOR
33 OPEN CHOCK
34 OVERFLOW
35 RESISTORS
36 ROLLER CHOCK
37 ROPE STOPPER AND CLIP
38 ROTARY COLLECTOR
39 SLIDING DOOR
40 STORAGE ROOM
41 STOWAGE REEL
42 SUCTION
43 SWINGER REDUCER
44 TOWING LIGHT
45 VENT
46 WINCH ON DECK AFT WHIRLER BASE
47 WINCH
48 WINDOW
49 WIRE ROPE REEL



60-Ton Floating Crane (Design 413D)

BARGE DATA

Length, overall (molded) .....142 ft
Beam (molded) .....58 ft
Depth, overall (midship) .....12 ft
Draft (mean light) .....3 ft 5 in
Draft (with ballast and load) ....5 ft 1 in

CRANE DATA

Capacity, main hook .....60 LTONs @ 73-ft radius
Capacity, whip hook .....15 LTONs @ 100-ft radius
Hook speed, main hook .....22 1/2 FPM
Hook speed, whip hook .....60 FPM
Operating radius, main hook ....42 ft 6 in to 73 ft
Operating range .....360°
Rotating speed .....0.4 RPM

EQUIPMENT LAYOUT

MACHINERY HOUSE

The machinery house contains the engine equipment and forms an integral part of the rotating structure of the crane. It houses the main power plant, auxiliary power plant, air compressor, freshwater and fuel oil pumps, fire-extinguishing systems, hoist and rotate machinery, associated control panels, and resistor banks for all of this equipment. Refer to the illustration at left.

Main power plant

The crane has one heavy-duty, industrial diesel engine of the solid-injection, cold-starting type. This engine provides power to drive the main DC generators. The engine is a 4-cycle, 6-cylinder, vertical type. The main power plant consists of one 2-wire or 3-wire, 150-kilowatt, 240- or 120/240-VDC generator which is directly driven by a diesel engine. This unit is radiator-cooled and air-started. The fuel pressure is controlled at either the engine or the operator's cab as required. An adjustable, louvered opening in the side of the machinery house provides proper air circulation to the radiator.

Auxiliary power plant

The auxiliary power plant consists of one 2-wire or one 3-wire, 240- or 120/240-VDC generator driven by either a 2-, 3-, or 4-cylinder diesel engine. This unit is battery-started and radiator-cooled. It furnishes power for the operation of the air compressor, fuel oil and freshwater pumps, and all other equipment that must be in operation before initial starting of the main diesel engine.

Main power distribution panel

The main power distribution panel (switchboard), controller panel, and resistor banks for the hoist and rotate machinery are located on the starboard side of the machinery house in separate switchroom enclosures. The main panel board consists of three panel sections. The left panel, when facing the front of the board, is for protector and generator control. The center panel is for hoist control, and the right panel for rotate (slue) control. The power supply to all electrical equipment on the crane is distributed from the right panel, either directly to the equipment or through the lighting panel or rotary collector.

Air compressor

A two-stage, air-cooled air compressor supplies compressed air to the main air receiver for starting the main diesel generator set or sets, for operating the hoist air clutches, and for general service. The compressor is loadless starting and V-belt driven by a 3- or 5-HP, 240-VDC motor. It is usually automatically controlled by an associated pressure switch.

Transfer pumps

The fuel oil transfer pump (cast-iron fitted) is on the starboard side of the machinery house, and the freshwater pump (bronze-fitted) is on the port side. These pumps supply fuel oil and fresh water from the hull fuel oil and freshwater tanks to the respective service tanks mounted in the machinery house, Each pump is driven by a 3/4-HP, 240-HP, 240-VDC motor and controlled by a magnetic starter.

Fire-fighting system

A 50-pound CO_2 cylinder with 50 feet of hose and a discharge nozzle is installed in the machinery house on the portside of the hoisting machinery. This extinguisher protects the crane equipment and the personnel operating in the machinery house area. The system is installed ready for use and will be kept in proper operating condition at all times.

WARNING: Operation of the fire-fighting system while personnel are in the engine room could result in injury or death to personnel. Some type of warning must be established to warn personnel that carbon dioxide (CO^2) is discharging.

Two 15-pound $C0_2$ portable fire extinguishers are mounted in accessible parts of the machinery house. The pm-table bilge and ballast pump, normally stowed on deck, may be used as a fire pump fro-fighting fires, either on board or adjacent to the crane. Fire axes and fire buckets are mounted in accessible places for fighting fires.

Hoist machinery

The hoist machinery consists of a 3-drum, gear-driven, air-clutch-actuated hoist unit, powered by a 135-HP, 240-VDC motor.

Each of the hoisting drums on the crane is equipped with an individual driving gear, manually controlled air clutch, pawl, and mechanical brake. An electric brake is fitted to an extension of the drive motor pinion shaft. Power is transmitted from the motor through the pinion shaft to the hoist reducer gear, which turns the driving gears for both the boom hoist and the main hoist drum. The main hoist drum gear engages directly with the auxiliary hoist drum gear. Each hoist drum is driven by engagement with the driving mechanism through its air clutch and, when not so engaged, is secured by its pawl and mechanical brake. The pawls engage with a ratchet built into each drum. The controls for each drum's clutch, pawl, and mechanical brake are located in the operator's cab.

The hoist motor is controlled through a magnetic controller and resistors in the switch panel room and operated by a master switch in the operator's cab.

The hoist electric brake is a magnetic-type shoe brake that operates with the controller. The brake is arranged for magnetic release when the coil is energized. The brake is automatically set by spring tension when the hoist master switch is in the neutral (OFF) position or power to the motor is interrupted. The brake operating coil is series-wound and is connected in series with the hoist motor.

Two electric air interlock switches, a boom travel limit switch, and two hoist block limit switches are installed as safety devices in the operations of the hoist machinery.

Rotate machinery

The rotate machinery, located at the forward end of the machinery house, provides a rotating movement of the crane upon its base. The crane is rotated when a rotate pinion engages the circular fixed rack on the crane base. The rotate pinion is driven through bevel gearing by a 45-HP, 240-VDC motor.

Power is transmitted from the motor to the driven pinion through a gear reducer and a set of bevel gears. The rotate motor is controlled by a magnetic controller and resistors. It is operated by a master switch in the operator's cab.

One brake is provided with the rotate machinery unit. It is an electrically operated hydraulic brake, equipped with parking and power failure brake controls. The function of the brake is to stop rotate motion and also to hold the rotate platform in a parked position.

WARNING: Do not apply the brake during a power failure if the crane is rotating and a load is on the hook. Sudden brake application would cause the load to swing in an uncontrolled manner, endangering personnel, crane, and cargo.

Center steadiment and rotary collector

The rotary collector is mounted on the center steadiment of the crane and housed in a steel, rectangular enclosure located forward of the main hoist drum. The center steadiment contains the kingpin which helps to maintain the rotating structure in position on the crane base. The rotary collector provides a continuous means of transmitting power from the generator in the machinery house to the various electrical equipment on deck during either a stationary or rotating period of crane operation. The collector consists of a shaft with nine collector rings, one of which is a spare, mounted on a common shaft. This shaft is fixed with the crane base against rotation with the crane, but is flexibly mounted to absorb small deflections. The rings are connected directly to cables leading to the deck equipment. Carbon brushes contact these rings to transmit power supplied from the main switch panel.

Miscellaneous equipment

The *main lighting panel* is located on the starboard side of the machinery house and distributes 120 VDC to the various light receptacles and signal systems in and about the machinery house. The lighting panel also distributes 240 VDC to the fuel oil and freshwater pumps and heater in the operator's cab. The panel is fitted with eight circuit breakers of suitable amperage and voltage capacity for the respective circuits.

A 120-volt DC *engine alarm system* is installed in the machinery house to warn of high water temperatures or low lubricating oil pressures within the main diesel engines. The system is connected to the lighting panel circuit and consists of a warning horn, signal light, and single-pole disconnect switch. In the event of engine trouble, the horn and light operate simultaneously to warn the operator to secure the engine immediately until adjustments or repairs can be made.

An *electric bell* is mounted on the main panel board and sounds when the 120/240-VDC circuit of either the main or auxiliary engine becomes unbalanced beyond safe operation. The engineer is thus immediately warned to correct or adjust the electrical circuits.

A *rotate warning bell* is located under the rotate platform at the forward starboard corner. It is set to operate automatically only when the electric controls for rotation are engaged.

A *trolley* for a 3- to 6-ton hoist is provided for mounting on any one of the several trolley beams installed in the machinery house or the forward engine room.

The location of the various controls is shown in the illustration on page A-9.

OPERATOR'S CAB

The operational controls in the operator's cab of the 60-ton crane are: the hoist master switch, air clutch control valves, hoist pawl levers, boom hoist hand-brake lever, hoist foot-brake pedals, rotate master switch, rotate brake pedal, rotate brake parking push button, emergency stop push button breaker-reset push button, diesel engine fuel pressure control, and electric governor. In addition to the controls, the cab includes a horn for the operator to give warning when moving loads or to otherwise signal for attention during crane operation. A signal bell is included to signal the machinery house, and a floodlight is installed for night operation. List indicators, a portable lantern, cab heaters, cab blowers, and a windshield wiper are installed for the operator's use and comfort.

DECK

Hull deck equipment for the 60-ton crane is discussed as follows.

Deck winches

Two winches are installed—one forward and one aft of the machinery house base. The two winches are utility winches, identical in construction and power. Each is fitted with two winch heads that turn on a common line shaft and may be used for single- or double-load operation within the rated capacities of the units. Manila hawsers and warping lines are supplied with the barge for use with these winches. The drive machinery for each winch

consists of a 10-HP, 240-VDC motor directly driving a speed reducer unit that, in turn, operates the spur gear mounted on the winch shaft. An automatically operated magnetic brake is mounted on an extension of the motor shaft. The control equipment for each winch consists of a drum controller, protective panel, and resistor bank. This equipment is mounted within steel housings, located on the deck just forward or aft of the fore and aft winches respectively. These deck winch units operate only on power supplied from the main generator.

Portable bilge and ballast pump

A skid-mounted portable bilge and ballast pump, complete with lifting frame and operating controller, is normally stowed on deck forward of the machinery house (see the following illustration). This unit serves as either a bilge or ballast pump for emptying or filling the vessel's ballast and void compartments. A portable electric cable and hose for use with the unit are suplied with the vessel. The pump is a centrifugal unit, directly driven by a 7 1/2-HP, 240-VDC motor. The operating controllers are the marine-type starters with an overload protection. This pumping unit also operates on power supplied from the main generator.

Anchor-handling equipment

A hand-operated anchor windlass, located forward, and a cable reel, located midships, are used in handling the forward 750- and 500-pound anchors. The functions of these units are associated with the operation of the forward anchor davit and deck winch. A second 500-pound anchor and anchor davit are installed on the aft deck of the crane and are associated in operation with the aft winch. Canvas covers are provided for both the anchor hoist and the cable reel.

Boom cradle

The cradle, installed on deck just forward of midships, is used for storing the boom when the crane is inactive. This cradle is mounted on pin connections and can be collapsed on deck or completely removed if required. Holes are provided in both the cradle and the boom for securing the boom to the cradle during long periods of shutdown.

Watertight electrical receptacles

Two receptacles are mounted on the crane base, one each on the port and starboard sides of the machinery house. These receptacles are connected to a 120-VDC circuit from the machinery house lighting panel and are intended for general service use about the crane deck. A watertight plug normally will be stowed in the machinery house for use with these receptacles.

MISCELLANEOUS EQUIPMENT

The crew should be acquainted with the nature and existence of the miscellaneous crane equipment. This equipment includes the radio interference suppression equipment, navigation lights, deck equipment, pm-table lights, and floodlights. All other items or portable equipment aboard the crane are listed in the stowage list, a copy of which should be stowed in the machinery house technical data locker. Portable equipment not in use will be stowed in the location described in the stowage list so as to be available at all times.

Several of the motors, generators, and other miscellaneous electrical equipment are fitted with various sizes and styles of electrical capacitors. This is done to prevent static interference with radio reception aboard the crane.

Several oil-burning types of navigation lights with supporting standards or mountings are installed on the cranes: one anchor, four corner, two towing, three dredging, one port, and one starboard. These units will be kept filled with a good grade of kerosene at all times and will be stowed securely to prevent damage when not in use. A navigation yardarm assembly is installed on the aft end of the A-frame, complete with halyard, pulleys, and associated fittings.

Four 120-VDC, 100-watt, hand-portable lights, complete with 100 feet of cable, are furnished for general utility use. These lights are normally stowed in the machinery house storage space. One battery-operated relay hand lantern is bulkhead-mounted in the machinery house near the switchboard, and another near the main engine of the crane. These lights operate in the same manner as the unit installed in the operator's cab, automatically lighting in case the 120-VDC power circuit is interrupted. Each is equipped with a shutoff switch and may be dismounted for portable use.

Four 750-watt, waterproof floodlights are provided for the cranes: one on the machinery house, two on the boom, and one above the operator's cab. The light above the cab can be rotated and elevated from within the cab.

CONTROLS AND INSTRUMENTS

MACHINERY HOUSE

The main controller panel consisting of the controls for the generators, hoist, and rotate motors with protective devises is assembled as a unit. The panel is located on the starboard side of the machinery house in an enclosed control room. The machinery house also contains the lighting panel, engine instrument controls, and miscellaneous switches and push-button signal devices. The crane may be equipped with one or more types Of control panels.

Protective and generator control panel

The controls and instruments located on the control panels are the main and auxiliary circuit breakers, ammeters, voltmeter, main line switch, main generator rheostat, auxiliary generator rheostat, lighting transfer switch, main generator field switch, ground detection lights, and miscellaneous switches and fuses. Although two different types of controllers are used, the same basic functions are performed by each.

The *main circuit breaker* and the *auxiliary circuit breaker* are automatic tripping devices used for overcurrent, undervoltage, and reverse current protection of the main and auxiliary generators. The circuit breakers can be closed by turning the manually operated handle clockwise. Before attempting to start either the main or the auxiliary diesel engine, the respective circuit breakers must be open.

Depending upon the particular model, the panel will be equipped with either one or four *ammeters.* The meters are designed to read output current from either the main or the auxiliary generator. If only one meter is used, a switch allows current to be read from either generator.

One *voltmeter* is used for the control panel. The voltage output of both generators is shown on this meter. The voltage transfer switch is used for switching the meter for voltage output readings from the generators.

The *main line switch* supplies power to the main line contractors. The line switch will be closed only after the main circuit breaker has been closed.

The *main generator rheostat* controls the amount of current supplied to the generator fields, thus controlling the generator voltage output. Before starting the engine, the rheostat will be turned so that maximum resistance is in series with the generator field. After the engine has been started, the rheostat will be rotated according to the arrows and directions on the knob until the desired voltage output is noted on the voltmeter.

The *auxiliary generator rheostat* controls the voltage output from the auxiliary generator in the same manner as described for the main generator rheostat. The *lighting transfer switch* supplies voltage to the lighting panel from either the main or auxiliary generator. The *main generator field switch* completes the circuit to the main generator field and will be left open until the main engine has been started.

Both main and auxiliary generators are provided with red *ground-detection lights.* These lights normally have only one half of the total generator voltage applied to them so that they glow very dimly. When a short circuit occurs on either side of the line, the voltage across one light drops to zero so that full voltage goes across the other, which burns brightly. This indicates aground in the circuit.

The *miscellaneous switches and fuses* for the ballast pump, heater, air compressor, fore and aft winches, hoist, and rotate controls are located on the control panel. Each switch is clearly marked and must be closed before an attempt is made to operate the equipment.

Engine instruments and controls

The crane is equipped with various manufacturer's diesel-driven generator sets that are used for main and auxiliary power. Although the physical location of the controls and instruments varies, the following main diesel engine controls and instruments and the auxiliary generator set and instruments are standard equipment.

The following controls and instruments are found on the main diesel engine. Since the main diesel engine is air-started, the *starting air-inlet valve,* usually located on the operating side of the engine, is a master valve between the air reservoir and the engine. The air-start lever (Atlas Model 6EN668 engine) is used to turn the engine over by applying compressed air to the starting air inlet valve.

The fuel injection pressure is controlled by adjusting the *fuel pressure-regulating valve* handle up or down (Atlas Model 6EN668 engine). Moving the handle in an upward direction increases the pressure, while a downward movement lowers the pressure.

Both the start and stop functions of the engine are performed with a common *control lever* (Chicago Pneumatic Model 9CP engines). A button on the end of the lever is pressed to release the lever so that it may be moved to another position. The lever latches into position when the button is released.

Atlas governors on the main diesel engines are equipped with either a *speed control* handwheel or a lever. The handwheel or lever is used to set the engine speed at idle or to its rated speed. A hand lever, located on top of the governor, is used to stop the engine.

The synchronizer speed control of the Woodward Model UG-8 governor is used to change the speed of the engine the same as the Atlas governor speed control handwheel or lever. The synchronizer indicator, located directly below the synchronizer knob, indicates the number of revolutions of the knob. The speed-droop control is used to divide and balance the load automatically' between engines driving the same shaft or paralleled in an electrical system. The quantity of fuel supplied to the engine is controlled by the load-limit control. The load-limit control is also used to shut off the engine.

The Pickering Type 2600 governor supplied on the Chicago Pneumatic engine is a ball bearing, vertical, centrifugal type, mounted on the engine gear case. The governor is provided with a handwheel attached to its side. The speed is changed by increasing or decreasing the tension upon the governor spring with the handwheel.

The *engine instruments* on the engine instrument board consist of the oil pressure gage, water temperature gage, fuel pressure gage, oil temperature gage, starting air gage, and pyrometer.

The various types of diesel-driven auxiliary generator sets are battery-started. They are equipped with either a 12-volt or 24-volt battery system. An instrument board is supplied with each engine; it usually contains speed controls and various engine instruments.

The *speed controls* for the auxiliary diesels are of the centrifugal, flyball type, designed to provide constant speed under varying load conditions. A throttle knob or adjusting screw is provided for starting and idling the engine.

The *auxiliary engine instruments,* located on the engine instrument board, usually consist of an oil pressure gage, ammeter, and a water temperature gage.

OPERATOR'S CAB

The various electrical and mechanical controls for the boom hoist, main hoist, auxiliary hoist, and rotate motions of the crane are arranged in the crane operator's cab as shown earlier in this chapter.

Hoist controls

The *hoist master switch* is mounted on the control stand at the left of the operator's cab. It regulates the direction of motor rotation and the power applied to the hoist motor. Thus it controls the raising or lowering of the boom and main or auxiliary blocks. There are five notched positions for the handle on each side of the off or center position corresponding to five operating speeds. The hoist master switch also controls the operation of the magnetic electric brake mounted on an extension of the hoist motor pinion shaft.

Three identical *air clutch control valves* are connected to a common air supply header. They are mounted on the front console of the individual air clutch associated with the auxiliary, main, and boom hoist drums respectively. A hand-operated lever on each valve controls the air pressure released to the respective clutch. The clutch air system operates on 110 psi air pressure supplied through a reducing valve from the 250-psi main air pressure system. A small air tank installed in the machinery house is also connected to the system to maintain a slight reservoir or cushion to diminish air pressure fluctuation during operation.

The boom, main, and auxiliary *hoist pawl levers* are located in the cab at the operator's lower right side. Each is connected by a series of link rods and rocker levers from the operator's cab to the respective pawls at the boom, main, and auxiliary hoist drums. Each drum is equipped with a built-in ratchet to which a pawl can be engaged to hold the load on the drum when the respective clutch and mechanical brake are to be released.

The *boom hoist hand-brake lever* is mounted in the floor at the operator's right and is connected to the boom hoist drum mechanical brake by a system of link rods and rocker levers. A vertically mounted ratchet plate is engaged in operation of the lever to hold any set position.

The auxiliary and main *hoist foot-brake pedals* are mounted directly in front of the operator and are connected by a series of link rods and rocker levers to the auxiliary and main hoist drum mechanical brakes respectively. Each pedal is serrated on its forward edge to engage in operation with the dogplate mounted at the floor lever. Springs are fitted to the bottom of each pedal shank so as to engage the serrated edges of the pedals with their dogplates.

Rotate controls

The *rotate master switch* is mounted on the control stand at the right side of the operator's cab. This switch controls the speed and direction of rotation of the rotate drive motor, and thus the speed and direction of motion of the crane on its base.

The *rotate brake pedal* projects from the lower section of the control stand at the left side of the operator's cab. The *rotate brake parking push button* and associated indicating light are mounted on the control stand at the operator's left. This push button de-energizes the magnetic check valve of the brake. This releases the brake fluid trapped in the releasing cylinder and allows the brake to be set by spring action. This parks the crane in the desired position.

Miscellaneous controls

Several miscellaneous controls associated with the general operation of the hoist and rotate machinery are installed in the operator's cab. These controls include the emergency stop push button, breaker-reset

push button, diesel engine fuel-pressure control, electric governor, and radius indicator.

The *emergency stop push button* is located on the floor of the operator's cab at the base of the left control stand. Depressing this push button opens the hoist and rotate contractors on the main panel board. This cuts off power from the hoist and rotate machinery and simultaneously applies the motor brakes.

The *breaker-reset push button* is located on the control stand at the left of the operator's cab. This push button resets the hoist and rotate contractors of the main panel board after interruption of the hoisting or rotate power.

The *diesel engine fuel pressure control is* mounted at the rear to the left of the control stand in the operator's cab. This control increases or decreases fuel pressure to the main diesel fuel injectors.

A dial-type *radius indicator* is mounted on the left side of the operator's cab, just outside the cab window (see the following illustration). This indicator is actuated through linkage by motion of the boom. It serves to indicate the actual radius at which the boom is located during normal service. It also indicates maximum safe loading for the respective positions of the boom, using either the main or auxiliary hoist block.

Miscellaneous cab equipment

In addition to the controls located in the operator's cab, several items of equipment are installed for the convenience of the operator and for the operating safety of the crane. This equipment includes the air horn, signal bell, floodlight control lever, list indicators, cab heater switches, windshield wiper rheostat, and battery lantern.

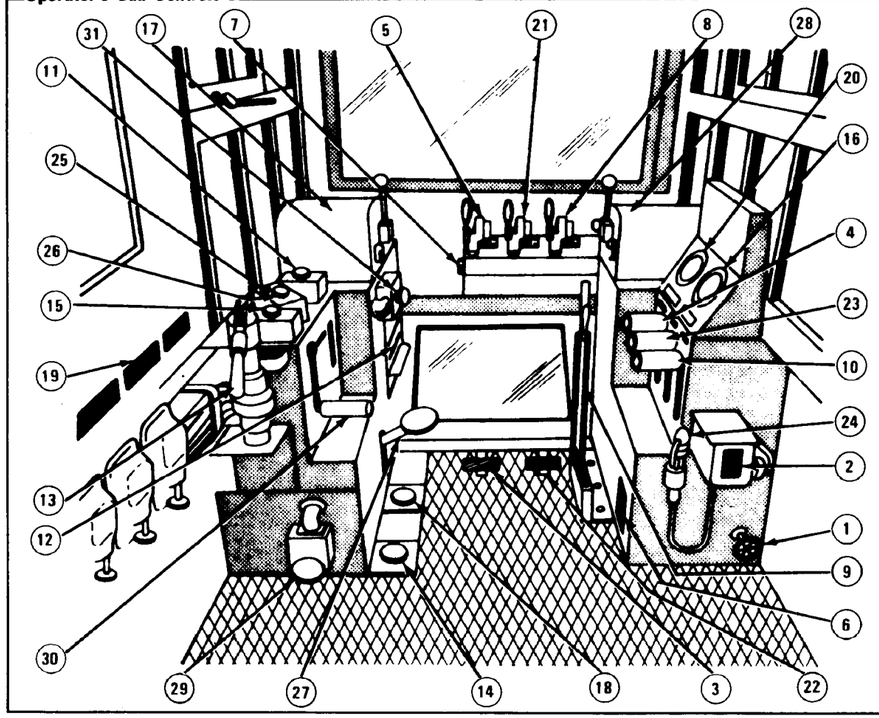
An *electric horn* installed on top of the operator's cab sounds when the floor-mounted horn push button engages the horn. The horn is actuated through an internal solenoid valve connected to a 120-VDC circuit from the machinery house lighting panel.

An 8-inch, 120-VDC *signal bell* and push button are installed in the operator's cab. These are connected in a common circuit to an identical signal bell and push button in the machinery house and forward engine room. They are arranged so that both bells will ring when either push button is operated. The *floodlight control lever* in the operator's cab is used to maneuver the flood light located on top of the operator's cab. Longitudinal transverse list *clinometers* are also installed in the operator's cab, These clinometers (shown in the following illustration) are provided to indicate to the operator the transverse heel and longitudinal trim of the crane hull when the boom is either parallel or at a right angle to the vessel's centerline.

The *cab heater switches* in the operator's cab control the operation of a 240-VDC, blower-type air heater that provides heat to the operator's cab. The windshield wiper on the front of the operator's cab operates on 120-VDC line from the machinery house lighting panel and is started and controlled by the *windshield wiper rheostat* on the left wall of the operator's cab.

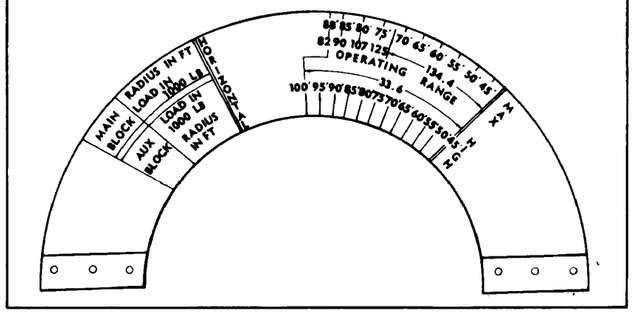
Three *battery-operated hand lanterns* are installed as part of the vessel's equipment. These units are connected to relays and will automatically light when the vessel's 120-VDC electrical circuit is interrupted. Each is equipped with a manual shutoff switch and may be removed for use as a portable lantern.

Operator's Cab Controls

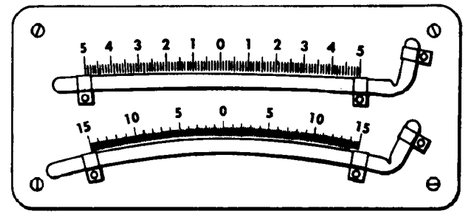


1 AIR CUTOFF VALVE
2 AIR PRESSURE INTERLOCK SWITCH
3 AUXILIARY HOIST FOOT-BRAKE PEDAL
4 AUXILIARY HOIST PAWL LEVER
5 AUXILIARY HOIST AIR CLUTCH CONTROL VALVE
6 BLOWOFF VALVE (AIR FILTER)
7 BLOWOFF VALVE
8 BOOM HOIST AIR CLUTCH CONTROL VALVE
9 BOOM HOIST HAND-BRAKE LEVER
10 BOOM HOIST PAWL LEVER
11 BREAKER RESET PUSH BUTTON
12 CAB HEATER
13 DIESEL ENGINE FUEL PRESSURE CONTROL
14 EMERGENCY STOP PUSH BUTTON
15 ENGINE ROOM-CALL PUSH BUTTON
16 HIGH-PRESSURE AIR GAGE
17 HOIST MASTER SWITCH
18 HORN PUSH BUTTON
19 LIGHTING CONTROL PANEL
20 LOW-PRESSURE AIR GAGE
21 MAIN HOIST AIR CLUTCH CONTROL VALVE
22 MAIN HOIST FOOT-BRAKE PEDAL
23 MAIN HOIST PAWL LEVER
24 RELIEF VALVE
25 ROTATE BRAKE INDICATOR LIGHT
26 ROTATE BRAKE PARKING PUSH BUTTON
27 ROTATE BRAKE PEDAL
28 ROTATE MASTER SWITCH
29 SIGNAL BELL PUSH BUTTON
30 SPUD CONTROL HANDLE
31 SPUD LIMIT SWITCH-BYPASS PUSH BUTTON

Radius Indicator



Clinometers



OIL AND WATER TANKS

FUEL OIL

Storage tank

The fuel oil storage tank is located in the vessel's hold at the starboard side of the whirler base; it holds about 1,620 gallons. The tank is fitted with a 4-inch screened gooseneck vent, a 1 1/4-inch capped return line, and a 1 1/4-inch capped discharge line, all of which extend above the deck. Near the gooseneck vent is a 1 1/2-inch, socket-type deck plug that can be removed for the filling and sounding of the tank. Tee wrenches are usually installed in nearby brackets for removal of these plugs. Any hose required for filling this tank will be obtained from the shore installation and not stored aboard the crane. The tank will never be filled completely; about 2 percent of the volume will remain empty to allow for expansion. A sounding rod, marked in feet and inches, is normally stowed in the engine room. A sounding chart and record of fills is installed near the log desk in the machinery house or engine room.

Day tank

A 150-gallon fuel oil day tank is installed on the crane overhead on the starboard side of the machinery house. This provides for direct fuel oil supply to the main and auxiliary diesel engines in normal operation. This tank is usually filled by the fuel oil pump, except in initial operation when power is not available to operate the pump.

For initial operation, the tank must be filled by hand. A drain tank, located immediately aft of the fuel oil pump, is fitted with a hand pump to pump fuel oil from that tank to the overhead day tank. The drain tank holds about 14.5 gallons. To fill the day tank, pour fuel oil into the drain tank by means of any of the funnel connections installed adjacent to the engine. This fuel oil may then be pumped by hand into the day tank. This will have to be repeated several times to ensure an adequate initial supply of fuel oil in the day tank.

After filling the tank in this manner, the auxiliary diesel generator set will be started to supply power to operate the fuel oil pump. The fuel oil pump may then be operated to complete filling the day tank.

Fill the fuel oil day tank in the following manner:

Step 1. Orient the crane with the boom forward, and temporarily secure it against rotation.

Step 2. Check to see that one end of a 20-foot length of 1 1/4-inch fuel oil hose (installed on stowage brackets on exterior starboard side of machinery house) is connected to the suction line on the fuel oil pump and that the other end is connected to the discharge line on the main tank.

Step 3. Check to see that one end of the other 20-foot length of 1 1/4-inch fuel oil hose is connected to the overflow line from the fuel oil day tank and the other end is connected to the return line on main fuel oil tank.

Step 4. Open the valve at the suction side of the pump and into the overflow line.

Step 5. Start the pump and operate until the sight gage in the overflow line shows that the tank is full; then shut down the pump.

Step 6. Allow a short time for oil in the hoses to drain back to the main fuel oil tank; then close both valves in the pump suction line and overflow line.

Step 7. Disconnect the hoses at the main fuel oil tank connections and stow the free ends in brackets in the machinery house. Recap the fuel oil tank connection.

Step 8. Open the valves in the supply lines to the engine to supply fuel oil to either engine.

Since the supply of fuel oil in the day tank is the immediate running supply for both the main and auxiliary diesel engines, this tank must be kept filled at all times. Loss of day tank fuel oil may create air bubbles in the engine injection system, with consequent difficulty in further operation until the situation is corrected. Since power is required to run the fuel oil pump as supplied by the diesel generators, loss of day tank fuel oil will obviously require refilling that tank by hand.

Drain tank

This drain tank is provided to catch the fuel oil drippings from the engines in normal operation. The fuel oil return from the pressure pumps on the engines is piped directly to the day tank. The drain tank should be emptied occasionally by operating the hand pump. The sounding rod stored in the machinery house provides a means of determining the contents of the tank. Experience will indicate the general frequency of this operation.

LUBRICATING OIL

A 60-gallon lubricating oil storage tank is installed overhead in the machinery house to provide makeup or new oil for engine crankcases and other general lubrication. This tank must be tilled at the 2-inch filling connection that extends above the machinery house roof. The lubricating oil level can be determined by a sight gage glass installed on the end of the tank. A valved supply line from the tank is conveniently located on the starboard side of the house near the auxiliary diesel generator set for general lubricating oil service. Additional oil can be placed in the respective diesel engines by transferring oil from the supply line to the plug or breather opening in the side of the engine. A four-quart measuring can with a funnel spout is provided with the vessel's equipment for this purpose.

FRESH WATER

Two types of freshwater tanks are provided for the crane: the main hull and the service tanks.

Main hull freshwater tank

The main hull freshwater tank is located in the vessel's hold at the port side of the crane whirler base; it holds about 600 gallons. This tank has a screened gooseneck vent and a 1 1/4-inch capped discharge line, both of which extend above the deck. A 1 1/2-inch socket-type deck plug that can be removed with a tee wrench to fill the tank is located just forward of the discharge line. Hose required to fill this tank will be obtained from the shore installation.

Freshwater service tank

The freshwater service tank is installed overhead in the machinery house on the port side. Its purpose is to provide a standby of makeup water for the radiator cm-ding system of the main and auxiliary diesel engines. The freshwater service tank has a 60-gallon capacity. This tank does not have to be filled for initial engine operation, since the radiator systems of the engines may be filled by hand. The auxiliary diesel engine provides power to run the freshwater pump. This pump fills the service tank from the main hull freshwater tank, after which the main engine radiator can be filled.

To fill the service tank by means of the freshwater pump, proceed as follows:

Step 1. Orient the crane with the boom forward, and secure temporarily.

Step 2. Check to ensure that one end of the 20-foot length of 1 1/4-inch freshwater hose is connected to the suction side of the freshwater pump. This hose is stowed on brackets on the port exterior side of the machinery house.

Step 3. Connect the other end of the hose to the discharge connection of the main hull freshwater tank.

Step 4. Ensure that the valves in the supply lines from the service tank to the engines are closed.

Step 5. Open the valve at the suction side of the pump.

Step 6. Start the pump and operate until the sight gage glass on the tank indicates full; then stop the pump.

Step 7. Allow a short period for water in the hose to drain back to the hull tank; then close the valve in the pump suction line.

Step 8. Disconnect the hose when the tank is full and stow the free end in the stowage brackets. Recap the water tank discharge connection. The supply lines from the freshwater service tank terminate in valve connections and flexible hoses just above the filling points for the main and auxiliary engines.

Step 9. After filling the tank, open the valves immediately below the tank to supply water to the terminal valves. Makeup water is then available to fill the radiators.

CRANE OPERATION PROCEDURES

LOAD HOOKS

The crane is equipped with a main and an auxiliary load hook for hoisting and lowering of loads.

Hoisting

Hoisting consists of raising a load vertically on either the auxiliary or main load hook. This is done by applying power to the respective drum that, through the cable and sheave block arrangement, lifts the hook. After consulting the operational load chart, proceed with the hoisting as follows.

Place the master switch in the neutral position. Operate the clutch control to engage the clutch on the drum to be used for hoisting, and, at the same time, release the foot-brake pedal and increase the engine speed to prevent stalling. To raise the hook, pull the master switch back to the desired position. To stop movement when the load or tackle has reached the desired height, place the master switch in the neutral position, and, at the same time, release the drum clutch, depress and lock the foot-brake pedal, and throttle the engine to about half speed. If the load is to be held in the raised position for an extended time, engage the dog pawl into its drum ratchet.

Procedures for operating the whip or main load hook are identical. Each hook has its own hoisting drum with separate controls. On heavy lifts, inch the load slightly, stop and test the brakes to see if they are functioning properly, and then complete the hoisting operation. Do not lift loads heavier than those specified at the selected operating radius.

During hoisting operations, the operator will strive to improve coordination in movement of controls for smoothest operation possible. This practice will minimize strain on the equipment and prevent rough and jerky operation.

Lowering

This operation consists of lowering the auxiliary or main load hook to the desired position. Lowering is performed by the weight of the empty hook blocks or the load unwinding the cable from its respective drum. It is controlled by the braking action on the drums. To lower the loads, proceed as follows.

With the engine throttle at approximately half speed and the selected clutch control in its neutral position, release the foot-brake pedal or motor dynamic brake controller, and control lowering by brake resistance. When the load is partially lowered and left hanging for an extended time, engage the dog pawl into its drum ratchet.

LOAD SWINGS

One of the main difficulties for an inexperienced crane operator is controlling the tendency of a load to swing while transporting. Unusual load swings are caused by sudden stops and starts of the swinger gear, but sometimes are the result of high winds and heavy seas. A slow, deliberate operation of the swinger control and smooth brake operation will help reduce load swings to a minimum. If a load should develop an undesirable swing, it can be neutralized by quickly moving the boom tip directly over the center of the load and stopping the swinger gear at that point. With diligent practice, the operator will soon become adept at controlling load swings.

HEAVY LIFTS

Rotate control

At times the crane will be lifting at almost capacity tonnage, and during such operations there may be a great deal of rotating.

The operator must be very careful when swinging the load, and, unless he is experienced and accustomed to the crane, he must make the swing very slowly. The load must have tag lines attached to prevent it from swinging. Remember that the barge will list in the direction of the lift. When transporting the load, the barge will be pulled slowly up this incline until the crane is level. As the crane begins to list in the opposite direction, the load will travel faster because of gravity. An experienced operator will compensate for this condition by the proper use of the controls. Stress on the legs of slings varies according to the angle of the sling and load. When making heavy lifts with a sling, it is advisable during normal operations to have an angle of 60° or more at the point where the sling joins the load.

Stress gage

The use of a stress gage enables the crane operator to lift loads within the safe limits for which the crane is designed. Without the use of this gage, the load may exceed the maximum capacity, serious damage may result, and the lives of personnel may be endangered. The stress gage comes as a self-contained unit with hose, reservoir diaphragm, gage, clamps, and instructions for installation. It is loaded and sealed with the proper amount of fluid when manufactured and, after installation, can be used with only minor adjustments.

> *NOTE:* For information on trouble-shooting, maintenance, and reeving the hoist and lift blocks, refer to Chapters 9 and 10.

APPENDIX B

RADIO CHANNELS FOR THE FLOATING CRANE

Select only the channels you are authorized to use.

Operating Channels for AN/URC-80{V)1/3 Radio Set

CHANNEL	FREQUENCY (MHz) TRANSMIT	RECEIVE	ASSIGNED FUNCTION
00	Inhibited	160.600	Not assigned
01	156.050	160.650	Land mobile public safety
02	156.100	160.700	Land mobile public safety
03	156.150	160.750	Land mobile public safety
04	156.200	160.800	Land mobile public safety
05	156.250	160.850	Land mobile public safety
06	156.300	156.300	Internship safety, ship to ship
07	156.350	156.350	Commercial, ship to shore
08	156.400	156.400	Commercial, to ships only
09	156.450	156.450	Commercial, ship to shore and noncommercial, to shore only
10	156.500	156.500	Commercial, ship to shore
11	156.550	156.550	Commercial, ship to shore
12	156.600	156.600	Port operations, ship to shore
13	156.650	156.650	Navigational, ship to ship and ship to shore
14	156.700	156.700	Port operations, ship to shore
15	156.750	156.750	Environmental conditions, coast stations broadcast
16	156.800	156.800	INTERNATIONAL DISTRESS, SAFETY AND CALLING
17	156.850	156.850	State control, ship to shore
18	156.900	156.900	Commercial, ship to shore
19	156.950	156.950	Commercial, ship to shore
20	157.000	161.600	Port operations, ship to shore
21	157.050	157.050	US government stations only
22	157.100	157.100	US government stations only
23	157.150	157.150	US government stations only
24	157.200	161.800	Public correspondence, ship to public coast station
25	157.250	161.850	Public correspondence, ship to public coast station

Operating Channels for AN/URC-80(V)1/3 Radio Set (Continued)

CHANNEL	FREQUENCY (MHz) TRANSMIT	RECEIVE	ASSIGNED FUNCTION
26	157.300	161.900	Public correspondence, ship to public coast station
27	157.350	161.950	Public correspondence, ship to public coast station
28	157.400	162.000	Public correspondence, ship to public coast station
29	Inhibited	157.450	Not assigned
60	156.025	160.625	Land mobile public safety
61	156.075	160.675	Land mobile public safety
62	156.125	160.725	Land mobile public safety
63	156.175	160.775	Land mobile public safety
64	156.225	160.825	Land mobile public safety
65	156.275	156.275	Port operations, ship to shore
66	156.325	156.325	Port operations, ship to shore
67	156.375	156.375	Commercial, to ships only
68	156.425	156.425	Noncommercial, ship to shore
69	156.475	156.475	Noncommercial, to shore only
70	156.525	156.525	Noncommercial, to ships only
71	156.575	156.575	Noncommercial, to shore only
72	156.625	156.625	Noncommercial, to ships only
73	156.675	156.675	Port operations, ship to shore
74	156.725	156.725	Port operations, ship to ship
75	Inhibited	156.775	Not assigned
76	Inhibited	156.825	Not assigned
77	156.875	156.875	Commercial, to ships only
78	156.925	156.925	Noncommercial, to shore only
79	156.975	156.975	Commercial, ship to shore
80	157.025	157.025	Commercial, ship to shore
81	157.075	157.075	US government stations only
82	157.125	157.125	US government stations only
83	157.175	157.175	US government stations only

Operating Channels for AN/URC-80(V)1/3 Radio Set (Continued)

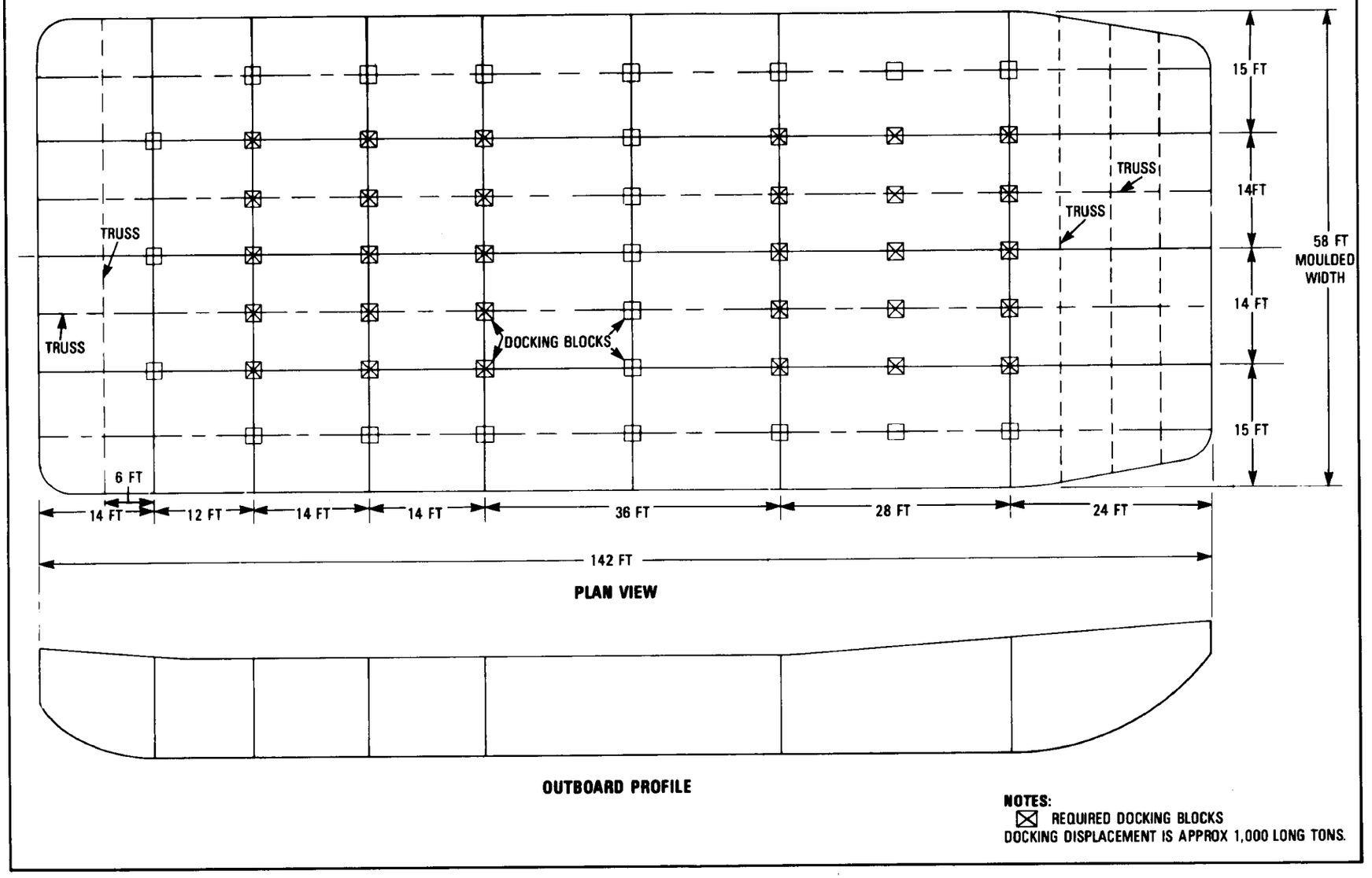
CHANNEL	FREQUENCY (MHz) TRANSMIT	RECEIVE	ASSIGNED FUNCTION
84	157.225	161.825	Public correspondence, ship to public coast station
85	157.275	161.025	Public correspondence, ship to public coast station
86	157.325	161.925	Public correspondence, ship to public coast station
87	157.375	161.975	Public correspondence, ship to public coast station
88	157.425	157.425	Commercial, ship to shore
89	Inhibited	157.475	Not assigned
W	Inhibited	162.550	Weather monitor channel

APPENDIX C

DOCKING PLANS

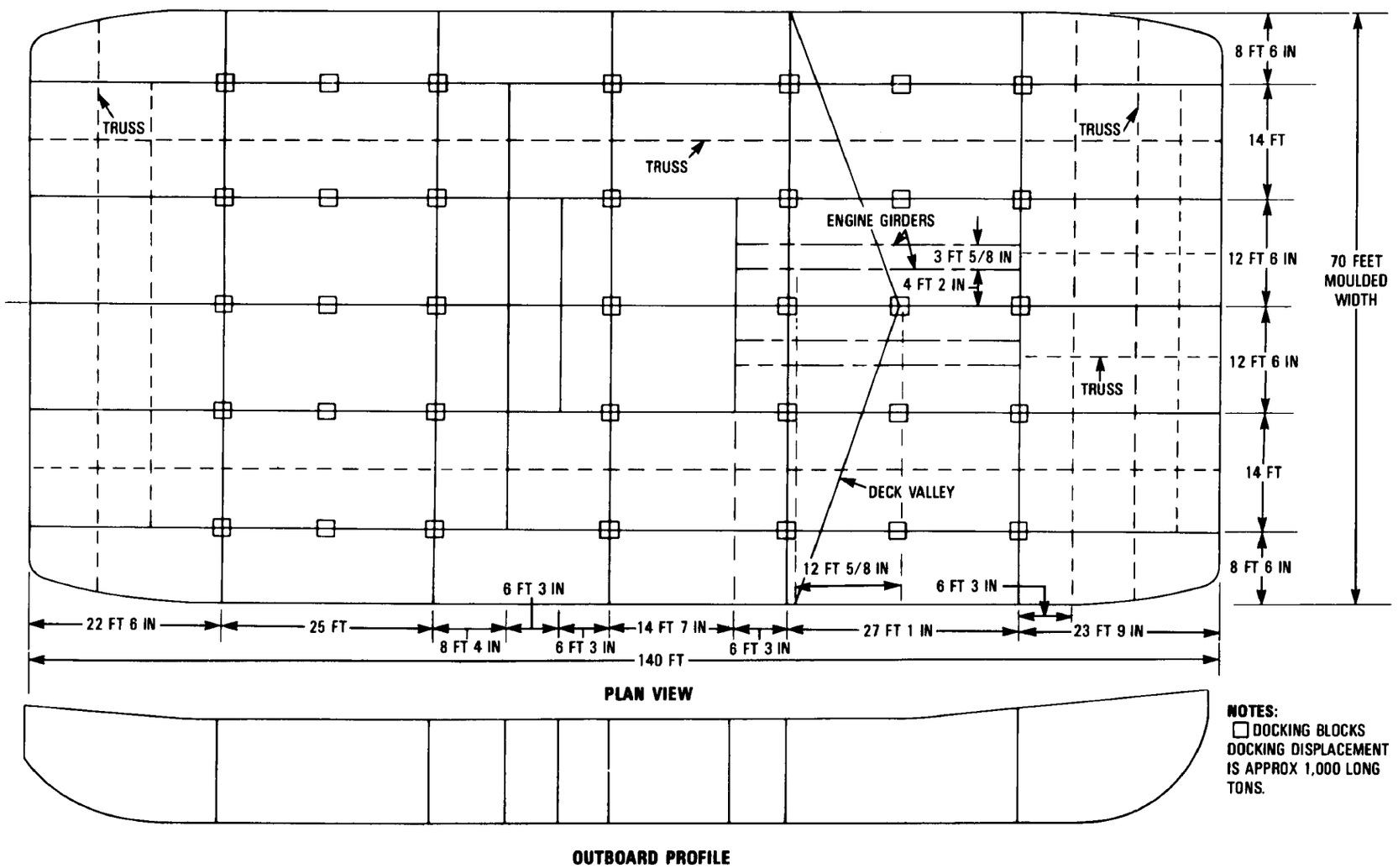
Proper dry-docking of the 60- and 100-ton cranes is carried out by using a drawing or docking plan of the particular crane being docked. The following docking plans for the 60- and 100-ton crane may be used in the absence of the crane's standard docking plans.

Docking Plan for 60-Ton Floating Crane

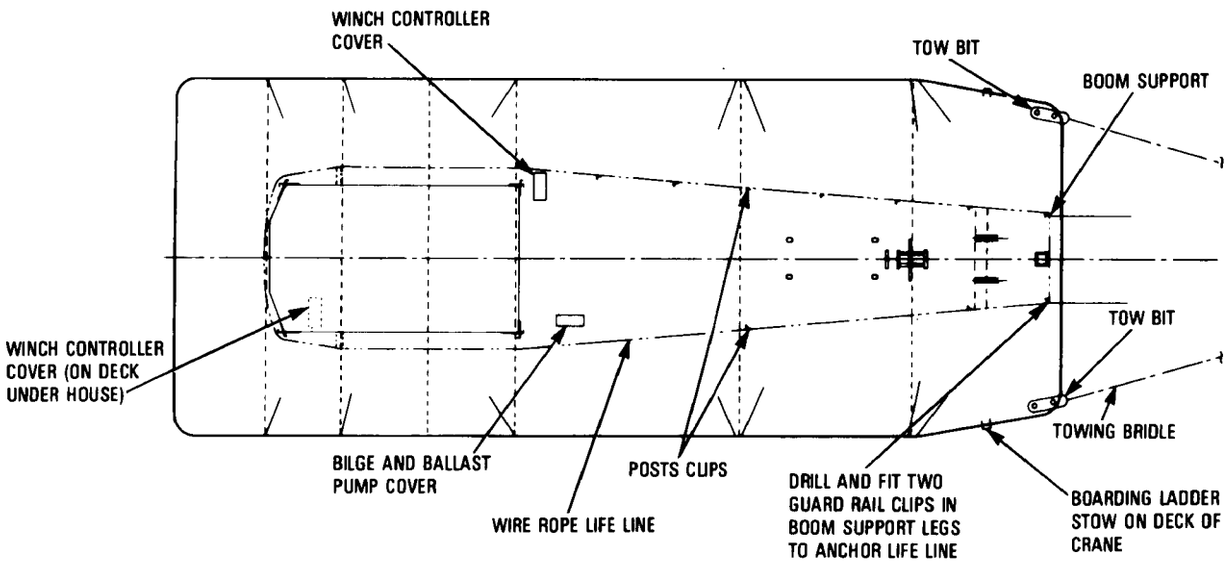


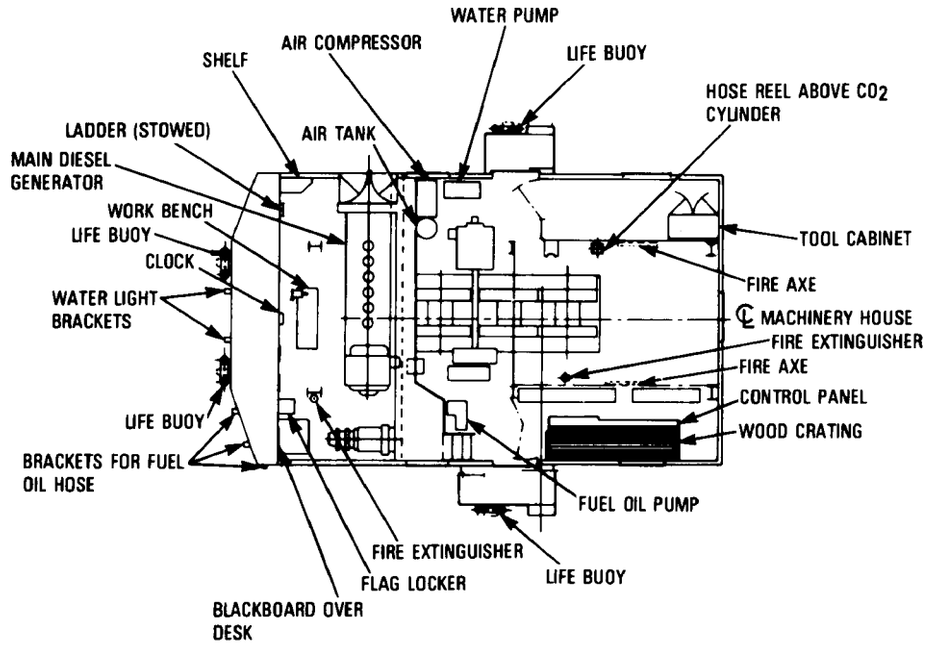
NOTES:
☒ REQUIRED DOCKING BLOCKS
DOCKING DISPLACEMENT IS APPROX 1,000 LONG TONS.

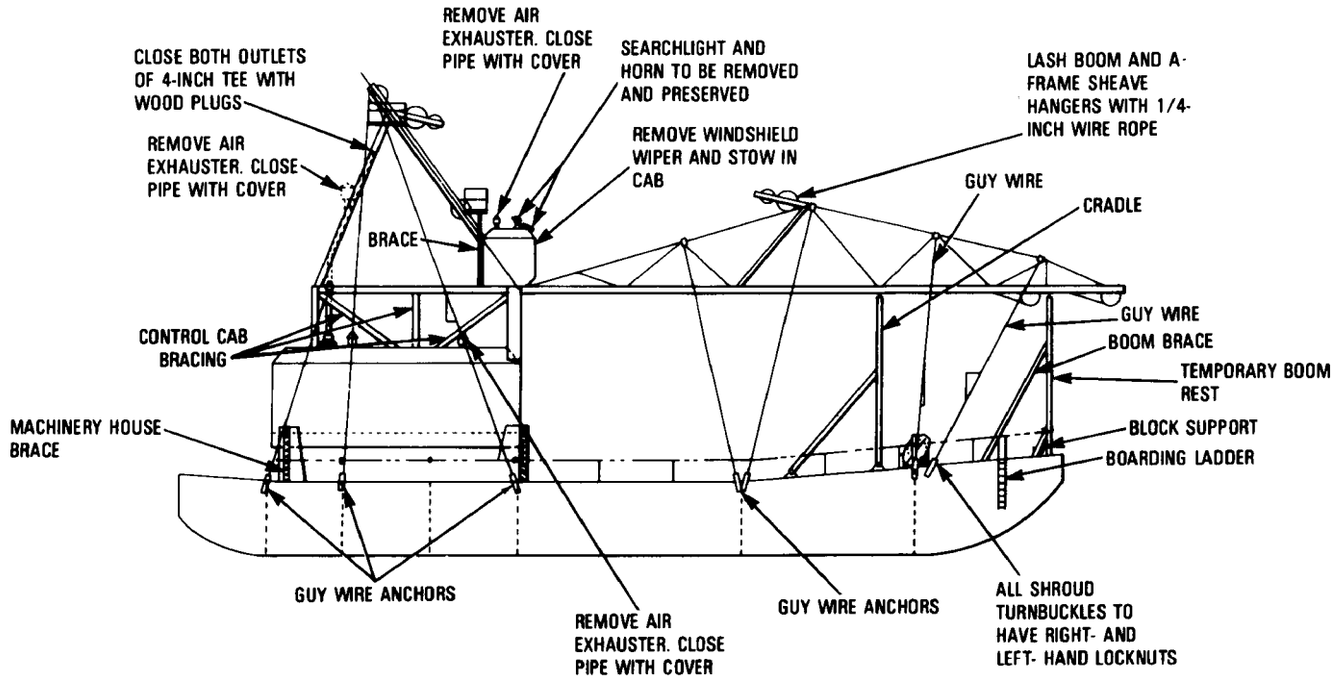
Docking Plan for 100-Ton Floating Crane

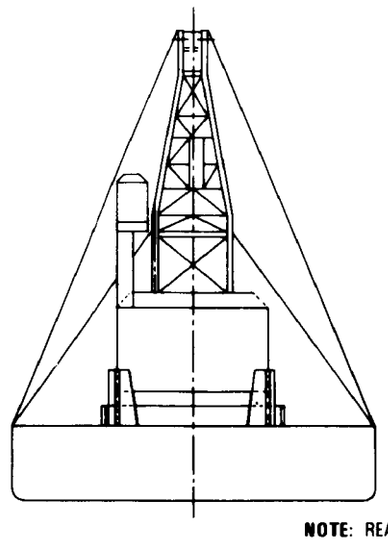


60-Ton Crane Prepared for Storage or Oversea Shipment



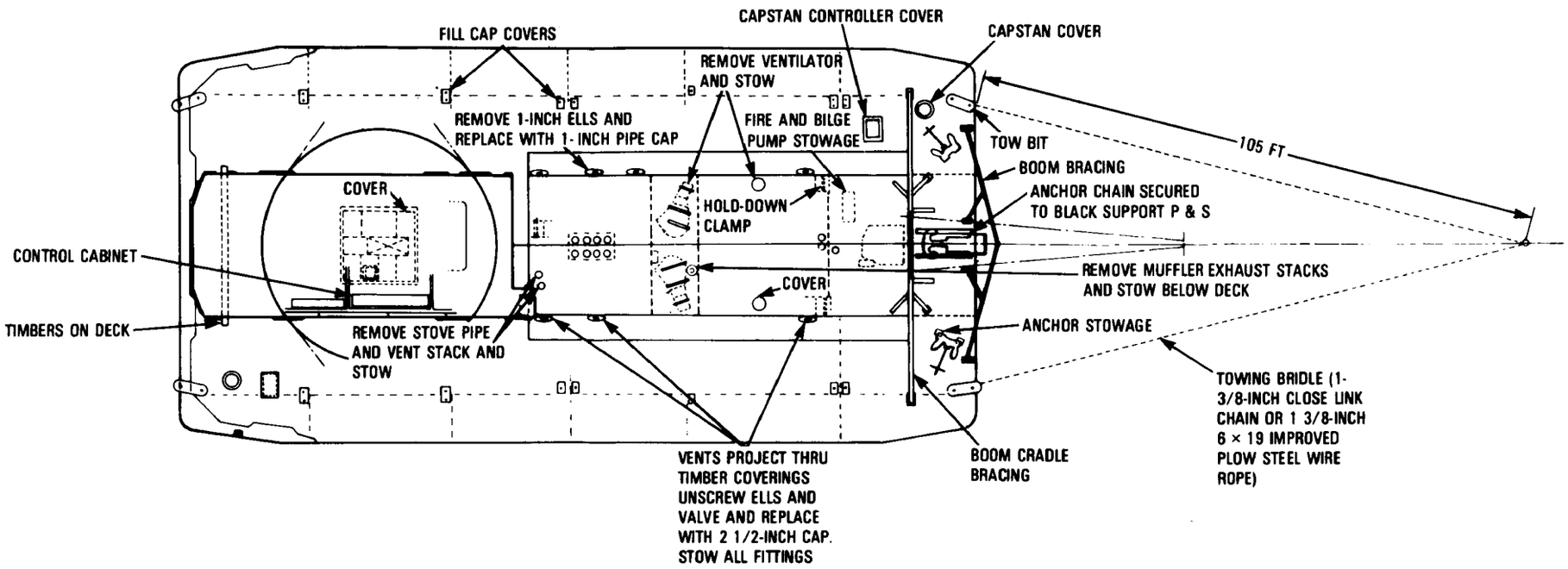


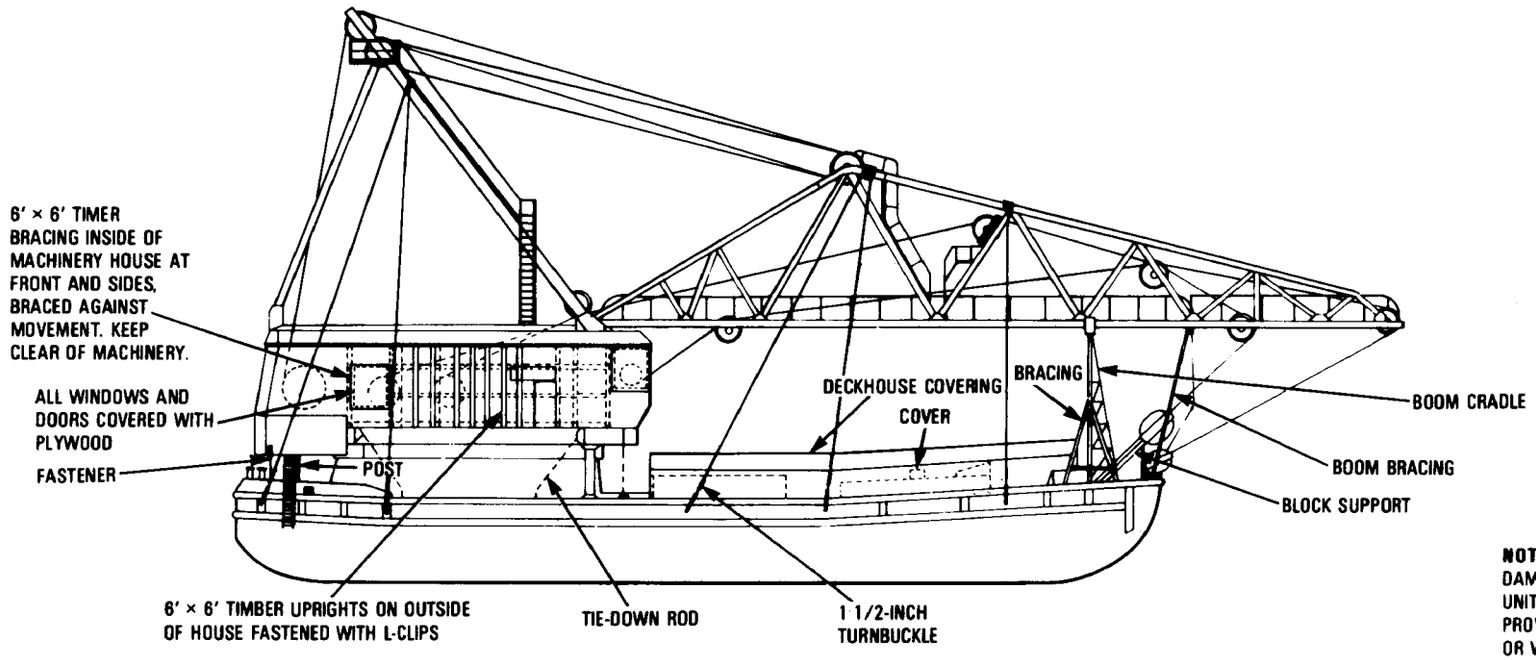




NOTE: READILY REMOVABLE ITEMS, SUBJECT TO LOSS OR DAMAGE DURING SHIPMENT, SHALL BE REMOVED FROM BASIC UNITS, PRESERVED, AND STOWED. MATCH-MARKING SHALL BE PROVIDED IN THE FORM OF MINIMUM 1-INCH STENCIL LETTERS OR WATERPROOF TAGS.

100-Ton Crane Prepared for Storage or Oversea Shipment





NOTE: READILY REMOVABLE ITEMS, SUBJECT TO LOSS OR DAMAGE DURING SHIPMENT, SHALL BE REMOVED FROM BASIC UNITS, PRESERVED, AND STOWED. MATCH-MARKING SHALL BE PROVIDED IN THE FORM OF MINIMUM 1-INCH STENCIL LETTERS OR WATERPROOF TAGS.

APPENDIX D

AUTHORIZED DAMAGE CONTROL KIT

Equipment Kits

NOMENCLATURE	NSN	QUANTITY
Damage Control Operating Equipment Kit P/N T1-E1-80278	2090-01-064-8020	1 ea
Repair Kit, Pipe, Emergency P/N Assembly 2 FSCM 20420 Consists of the following three nonsupply items: -Can paste, resin; 4 ea -Can paste, hardener; 4 ea -Paddle, wooden; 4 ea	4730-00-542-3362	1 ea
Repair Kit, Pipe, Emergency P/N MIL-R-17882B (81349) Consists of the following 11 nonsupply items: -Can, epoxy, resin; 4 ea -Bottle, liquid hardener; 4 ea -Roll, PVC film; 1 ea -Roll, impregnated fiberglass cloth; 1 ea -Roll, woven, fiberglass cloth; 1 ea -Roll, string; 1 ea -Paddle, wooden; 4 ea -Roll, paper, thin; 1 ea -Goggles; 2 ea -Cloth, abrasive; 1 ea -Sheet, instruction; 1 ea	4730-00-542-3359	1 ea
Tool Kit, Electrician's Repair, Magnetic 9000S 6202-73125 (80064); Rev F, Type 234 AMACN Consists of the following: -Bag; 1 ea -Belt; 1 ea -Hacksaw frame; 1 ea -Blade, hacksaw, 14-inch; 1 ea -Chisel, cold, 1/2-in; 1 ea -Gloves; 1 pr -Hammer; 1 ea -Indicator; 1 ea -Tape; 1 ea -Lantern, electric; 1 ea -Matting; 1 ea -Pliers, slip-joint; 1 ea -Puller, fuse no 2; 1 ea -Screwdriver, flat-tip; 2 ea -Stripper, electrical wire; 1 ea -Twine; 1 ea -Wrench, adjustable, 8-inch; 1 ea	5180-00-391-1087	1 ea

Additional Tools Required

NOMENCLATURE	NSN	QUANTITY
Toolbox	514-00-587-5558	1 ea
Tester, voltage	6625-00-132-1196	1 ea
Tape, insulation, electrical	5970-00-184-2002(new)	1 ea
Cutter, bolt	5110-00-188-2524	1 ea
Chisel, cape, hand	5110-00-197-9497(new)	1 ea
Punches, drive pin	5120-00-223-1014	1 ea
	5120-00-223-1016	1 ea
	5120-00-223-1018	1 ea
Blades. hacksaw	5110-OO-277-4590(new)	1 ea
	5110-00-277-4591(new)	1 ea
	5110-00-277-4592(new)	1 ea
Frame, hacksaw	5110-00-289-9657	1 ea
Pliers, slip-joint	5120-00-223-7396	1 ea
Puller, fuse	5120-99-224-9456	1 ea
Hatchet, half	5110-00-228-3161	1 ea
Chisel. cold, hand	5110-00-236-3273	1 ea
Screwdrivers, flat-tip	5120-00-237-69B5	1 ea
	5120-00-222-8852(new)	1 ea
Pliers	5120-00-239-8251	1 ea
Pliers, diagonal cut	5120-00-239-8253	1 ea
Wrench, adjustable, 10-inch	5120-00-277-4244	1 ea
Wrench, adjustable, 7-inch	5120-00-440-B083	1 ea
Wrench, open end, adjustable	5120-00-264-3795	1 ea
Wrench, adjustable	5120-00-264-3796	1 ea
Wrench, pipe, 14-inch	5120-00-277-1486	1 ea
Wrench, pipe, 36-inch	5120-00-270-4309	1 ea
Shears, metal-cuttmg	5110-00-293-0089	1 ea
Bar, wrecking	5120-00-293-0665	1 ea
Bar, wrecking, pinchpoint, 1 1/4-inch x 5-foot	5120-00-224-1390	1 ea
Sew, hand (cross cut, 26-inch)	5120-00-240-5328(new)	1 ea

Additional Tools Required (Continued)

NOMENCLATURE	NSN	QUANTITY
Axe, fire, pickhead	4210-00-142-4949	1 ea
Maul, ships, 5-pound	5120-00-255-1476	1 ea
Hammer, machinist's, 2-pound	5120-00-061-8546	1 ea

Clothing

NOMENCLATURE	NSN	QUANTITY
Hood, fireman's, aluminum	8415-00-401-3913	2 ea
Gloves, asbestos	8415-01-003-3435	2 pr
Coveralls, safety, heat protection	8415-00-491-5362	2 ea
Shells, gloves	8415-01-003-3437	2 pr
Boots	8430-00-147-1036 8430-00-299-0342	2 pr 2 pr

Lumber—Plugs, Softwood

LARGE	SMALL	LENGTH	NSN	QUANTITY
1"	0"	3“	5510-00-260-8953	20 ea
2"	0"	4"	5510-00-260-8958	20 ea
3“	0"	8"	5510-00260-8962	20 ea
5“	1"	10"	5510-00-260-8966	20 ea
7"	3“	10"	5510-00-260-8969(new)	20 ea
10"	7“	12“	5510-00-260-8949	5 ea
8“	4"	10"	5510-00-260-8973(new)	10 ea

Lumber—Wedges, Plug, Tapered, Hardwood

THICKNESS	WIDTH	LENGTH	NSN	QUANTITY
2“	2"	8"	5510-00-268-3479	10 ea
4"	2"	8"	5510-00-2683485	10 ea
3"	3"	12"	5510-00-268-3481	10 ea

Lumber–Shoring, Tapered, Hardwood

THICKNESS	WIDTH	LENGTH	NSN	QUANTITY
1 1/2"	2"	12"	5510-00-268-3475	10 ea
1 1/2"	3"	12"	5510-00-268-3476	10 ea

Lumber—Shoring, Softwood

THICKNESS	WIDTH	LENGTH	NSN	QUANTITY
4"	4"	8'	5510-00-220-6178	53 BF
2“	10“	12'	5510-00-501-7146	114 BF

Lumber—Wedges, Plug, Tapered, Hardwood

THICKNESS	WIDTH	LENGTH	NSN	QUANTITY
3/4"	1 1/2”	6'	5120-00-224-9486	2 ea
2"	2"	10'	5120-00-224-9487	2 ea

GLOSSARY

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

A

A	ampere
@	at
AC	alternating current
A/C	air conditioning
ACB	air current breaker
AF	alternating frequency
am	ammeter
amp	ampere
approx	approximately
assy	assembly
auto	automatic
aux	auxiliary
avg	average

B

bd	blade
BF	board foot (feet)
BHP	brake horsepower
BTU	British thermal unit
bus	bus bar

C

CFM	cubic feet per minute
CHT	collect, hold, and transfer
circ	circulating
CL	centerline
CO_2	carbon dioxide
compr	compressor
cont	control
contam	contaminated
ct	circuit

D

DC	direct current
dia	diameter
disch	discharge
dr	drain

E

ea	each
emerg	emergency
eng	engine
exst	exhaust

F

F	Fahrenheit
FAC	free available chlorine
fdn	foundation
FM	frequency modulated
FO	fuel oil
FPM	feet per minute
ft	foot, feet
ft lb	foot-pound(s)
FW	freshwater
fwd	forward

G

gal	gallon(s)
gov	governor
GPH	gallon(s) per hour
GPM	gallon(s) per minute

H

HP	horsepower
hr	hour(s)
HQ	headquarters
hse	house
HW	hot water
Hz	hertz

I

in	inch(es)

K

kva	kilovolt-ampere(s)
kw	kilowatt(s)

L

lb	pound(s)
LO	lubricating oil
LOA	length overall
ltg	lighting
LTON	long ton
LVP	low voltage protection
LVR	low voltage release

M

mach	machinery
man	manual
max	maximum
MHz	megahertz
min	minute(s)
mn	main
MPH	miles per hour

N

neg	negative
NSN	national stock number

O

OL	overload

P

P&S	port and starboard
pH	designation of acidity and alkalinity
PIP	Product Improvement Program
pnl	panel
ppm	parts per million
pr	pair
psi	pounds per square inch
psig	pounds per square inch gage
pwr	power

Q

qtr	quarters

R

rad	radius
rcvr	receiver
rm	room
RMS	rheostat multiterminal switch
RPM	revolutions per minute

S

sep	separator
Sply	supply
sta	station
stbd	starboard
STON	short ton
SVC	service
SW	switch
swbd	switchboard
SWL	safe work load
sync	synchroscope

T

TB	technical bulletin
TDH	total displacement height
tk	tank
TRADOC	US Army Training and Doctrine Command
TSR	transformer saturable reactor

V

V	volt
VAC	volts alternating current
VDC	volts direct current
VHF-FM	very high frequency-frequency modulated
vm	voltmeter

W	
w	watt
W/	with
WM	wattmeter
WT	watertight
wtr	water

X	
XMIT	transmit

DEFINITIONS

bell crank lever	Lever consisting of two arms, generally at right angles, with a common fulcrum at their junction.
bight	Loop of rope or cable; any part of a rope within the ends
boom point bale	Triangular plates of steel used as a connection between the bull chain, bull line, and single-topping lift.
boom topping drum	Drum on which cable for raising and lowering a boom is wound.
breather port or vent	Small opening in the machinery housing or casing which will allow air to enter or escape.
camels or breasting floats	Floating fenders used to keep vessel, while secured, away from a pier.
carry away	To break or tear loose.
chain falls	(1) A hoist made up of chains and blocks of one or more sheaves. (2) End of tackle chain to which power is attached.
dynamic brake or rheostatic brake	System using the electric motor for braking. (Motors are allowed to run as generators, supplying power to resistances.)
fleeting sheaves	Sheaves used to guide cable evenly onto a cable drum.
friction brake	Brake using the principle of friction (the resistance to motion called into play when a moving surface is brought into sliding contact with an immobile surface).
gooseneck boom	Boom with an end bent downward at an angle to give increased clearance between a suspended load and the boom when the boom is raised.
idler gear, idle wheel	Gear in a gear train used to reverse rotation without affecting the ratio of the drive.
luffing	The act of raising or lowering the boom vertically.
magnetic brake	Method of braking in which force is applied and released by an electromagnet.
pay out	To let out chain or ease off a line.
purchase	Turn or loop of rope or cable around an object.
reduction gears	A set of gears used to step down the RPM between a driving wheel and a wheel being driven.
rotor seals	Flexible joints or swivel joints in a pipe system.

sluing	Act of rotating a crane about its vertical axis (sometimes called swinging).
splined shaft	Shaft cut to have a number of equally spaced grooves so as to form a series of projecting keys and fittings into an internally grooved cylindrical part.
topping lift	Tackle used for raising and lowering a boom.
whip drum	Drum to which a cable is attached and then run through a fixed pulley.
wildcat	Small, drum-like extension on the side of a winch used for taking in and paying out lines (sometimes called a gypsy head).

REFERENCES

REQUIRED PUBLICATIONS

Required publications are sources that users must read in order to understand or to comply with this publication.

Field Manuals (FMs):

55-501	Marine Crewman's Handbook
55-501-2	Harbor Craft Crewman's Handbook

Technical Manuals (TMs):

5-725	Rigging
11-5820-820-12	Operator's and Organizational Maintenance Manual (Including Repair Parts and Special Tools List): Radio Sets AN/URC-80(V)1 and AN/URC-80(V)3 (NSN 5820-00-097-0082)
55-1935-201-12	Operator's and Organizational Maintenance Manual for Crane, Barge, Diesel-Electric, 60-Ton Capacity, Design 413 (FSN 1935-178-9947) and Design 413D (FSN 1935-264-6220)
55-1935-201-12P	Operator's and Organizational Maintenance Repair Parts and Special Tools List for Crane, Barge, Diesel-Electric, 60-Ton Capacity, Design 413 (FSN 1935-178-9947) and Design 413D (FSN 1935-264-6220)
55-1935-204- 12P	Operator's and Organizational Maintenance Repair Parts and Special Tools List for Crane, Barge, Diesel-Electric, 100-Ton Capacity, Design 264 (FSN 1935-178-8205) and Design 264B (FSN 1935-264-6219)

Technical Bulletins (TBs):

43-0144	Painting of Vessels
55-1900-202-12/1	US Army Mobility Equipment Center Floating Craft; Preventive Maintenance
740-97-4	Preservation of Vessels for Storage

Commercial Publication:

Operations and Maintenance Manual for Modernization Kit-Crane Barge, Diesel-Electric, 100-Ton Capacity, Design 264B, FSN 1935-00-264-6219. Volumes I, II, and III, PRC/Technical Applications, 5252 Bilboa Avenue, San Diego, CA 92117, 1981.

DA Forms:

2028	Recommended Changes to Publications and Blank Forms
4640	Harbor Boat Deck Department Log for Class A and B Vessels
4993	Harbor Boat Engine Department Log for Class A and B Vessels

RELATED PUBLICATIONS

Related publications are sources of additional information. They are not required in order to understand this publication.

Army Regulation (AR):

750-1	Army Materiel Maintenance Concepts and Policies

Supply Bulletin (SB):

700-20	Army Adopted/Other Items Selected for Authorization/List of Reportable Items

INDEX

FM 55-511

12 DECEMBER 1985

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

MILDRED E. HEDBERG
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:

Active Army, USAR, and ARNG: To be distributed in accordance with DA Form 12-1 1A, Requirements for Army Water Transport Operations (Qty rqr block no. 394), plus DA Form 12-346, Operation of Floating Cranes (Qty rqr block no. 877).

Additional copies may be requisitioned from the US Army Adjutant General Publicatlons Center, 2800 Eastern Boulevard. Baltimore, MD 21220-2896.

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