TECHNICAL MANUAL

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

FOR

WATER PURIFICATION BARGES (NSN 1930-01-234-2165) VOLUME 9-1 ELECTRICAL POWER SYSTEM

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

Approved for public release; distribution Is unlimited

***This manual supersedes TM 55-1 930-2091 4&P-9-1, 30 January 1989.**

HEADQUARTERS, DEPARTMENT OF THE ARMY
15 OCTOBER 1992

TECHNICAL MANUAL
NO. 55-1930-209-14&P-9-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
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WATER PURIFICATION BARGES (NSN 1930 01-234-2165) VOLUME 9-1 ELECTRICAL POWER SYSTEM

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Bland Forms), or DA Form 2028-2 located in the back of this manual direct to : Commander, US Army Troop Support Command, ATTN: AMSTR-MMTS, 4300 Goodfellow Blvd, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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*Supersedes TM 55-1930-209-14&P-9-1, 30 January 1989

WARNINGS AND SAFETY NOTICES

WARNING
DANGEROUS VOLTAGES AND HAZARDOUS MATERIALS
ARE USED IN THIS EQUIPMENT.
DO NOT TAKE CHANCES
GENERAL WARNINGS

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

SPECIFIC WARNINGS

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

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

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

ELECTRICAL SHOCK SAFETY STEPS

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

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

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INTRODUCTION TO

TM 55-1930-209-14&P-9-1

You can help improve this manual. If you find any mistakes or if you know of away to improve-the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Troop Support Command, ATTN: AMSTR-MMTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

1. SCOPE

TM 55-1930-209-14&P covers the Reverse Osmosis Water Purification Barges, Models 300-WPB-1, 300-WPB-2 and 30OWPB-3, NSN 1930-01-234-2165. This manual consists of twenty-one volumes.

2. REVERSE OSMOSIS WATER PURIFICATION BARGES

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

3. VOLUME 1 -- NORMAL OPERATIONS

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

4. VOLUME 2 -- SEAWATER SYSTEM

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

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

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

6. VOLUME 4 -- CHLORINATION SYSTEM

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

7. VOLUME 5 -- DRINKING WATER SYSTEM

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

8. VOLUME 6 -- SHORE DISCHARGE SYSTEM

This volume provides operation and maintenance procedures for the shore discharge system which transfers drinking water from barge storage tanks to holding/storage facilities ashore.

9. VOLUME 7 -- COMPRESSED AIR SYSTEM

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

10. VOLUME 8 -- FUEL OIL SYSTEM

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

11. VOLUME 9 -- ELECTRICAL POWER SYSTEMS

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

12. VOLUME 10 -- LIGHTING SYSTEM

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

13. VOLUME 11 -- EQUIPMENT MONITORING SYSTEM

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

14. VOLUME 12 -- COMMUNICATIONS SYSTEM

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

15. VOLUME 13-- HANDLING EQUIPMENT

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

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

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

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

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

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

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

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

Volume 17 includes procedures for the operation and maintenance of:

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

b. Lifesaving Equipment -- installed on the barges and consisting of 2 liferafts, 15 Type 11 and 24 Type V lifevests and 4 lifesaving rings.

c. Firefighting Equipment -- installed on the barges and consisting of Halon 1301 system, 2 C02 hose reel units, a smoke detector system, 17 portable C02 fire extinguishers, 5 dry chemical fire extinguishers, 5 self-contained breathing apparatuses, and a portable, engine driven firefighting pump. The workboat also has a 1 0-pound, portable, dry chemical fire extinguisher.

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

Volume 18 contains the Maintenance Allocation Chart, Components of End Item List, Tools and Test Equipment List, Expendable/Durable Supplies and Materials List and the Repair Parts and Special

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

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

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

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

22. VOLUME 20 -- SUPPLEMENTAL DATA

Volume 20 contains the Basic Issue Items List, and additional Authorization List for all onboard systems for the Reverse Osmosis Water Purification Barges.

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

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

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LIST OF APPENDICES

NOTE

The following appendices, common to all TM's in this series, are in TM-55-1930-209-14&P-18.

MAINTENANCE ALLOCATION CHART (MAC)
TOOLS AND TEST EQUIPMENT LIST CTTEL)
EXPENDABLE /DURABLE SUPPLIES AND MATERIALS LIST (ESML)
REPAIR PARTS AND SPECIAL TOOLS LIST (RPSTL)
REPAIR PARTS LIST TO FIGURE NUMBER CROSS-REFERENCE LIST

NOTE

The following appendices, common to all TM's in this series, are in TM 55-1930-209-14&P-20.

COMPONENTS OF END ITEM LIST (COEIL) AND BASIC ISSUE ITEMS LIST (BIILL)
ADDITIONAL AUTHORIZED ITEMS LIST (AAL)

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VOLUME 9-1

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

CHAPTER 1 INTRODUCTION

SECTION I. General Information

1-1. Purpose. This Technical Manual (TM) describes the operation and maintenance of electrical power systems on the Water Purification Barges. Information about other systems installed onboard is in TM's 55-1930-209-14&P-1 thru P-8 and P-10 thru P-1 7. TM 55-1930-209-14&P-18 and TM 55-1930-209-14&P-20 contain appendices common to all TM's. Equipment location on the barge is shown in Figure 1-1.

1-2. Scope. Two electrical systems, normal and emergency, are installed onboard. The normal electrical system generates, controls, and distributes all electrical power onboard for operating the water purification system and its auxiliary systems. The emergency electrical system supplies 24 Vdc from a battery bank to 24 Vdc equipment and converts 24 Vdc through an inverter to 120 Vac to power emergency lighting and equipment.

1-2.1 Normal electrical system

1-2.1.1 Electrical power is generated by three diesel-powered generator sets, located in voids 4 port and starboard, or is acquired from an onshore power source or another vessel through an external power receptacle. In addition, power can be transmitted off the barge through another external power receptacle.

1-2.1.2 Power from these various sources is controlled and initially distributed by a master switchboard in the Reverse Osmosis Water Purification Unit (ROWPU) space.

1-2.1.3 Distribution from the switchboard goes directly to either the equipment, such as seawater pumps, or to three intermediate distribution power panels.

1-2.2 Emergency electrical system. This system obtains 24 Vdc power from a battery bank on the deckhouse top. It distributes it through a 24 Vdc power panel for operation of navigation lights and other equipment. It also supplies power to an inverter that converts 24 Vdc to 115 Vac for the emergency lighting system.

1-3. Warranties and guarantees. Warranty/guarantee information is contained in Section VII of Chapters 2, 3, 4, and 5.

1-4. Maintenance forms and records. Required maintenance forms and records are explained in DA PAM 738-750, The Army Maintenance Management System (TAMMS).

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

1-6. Storage. For storage of this equipment, refer to Section V of Chapters 2, 3, 4, and 5.

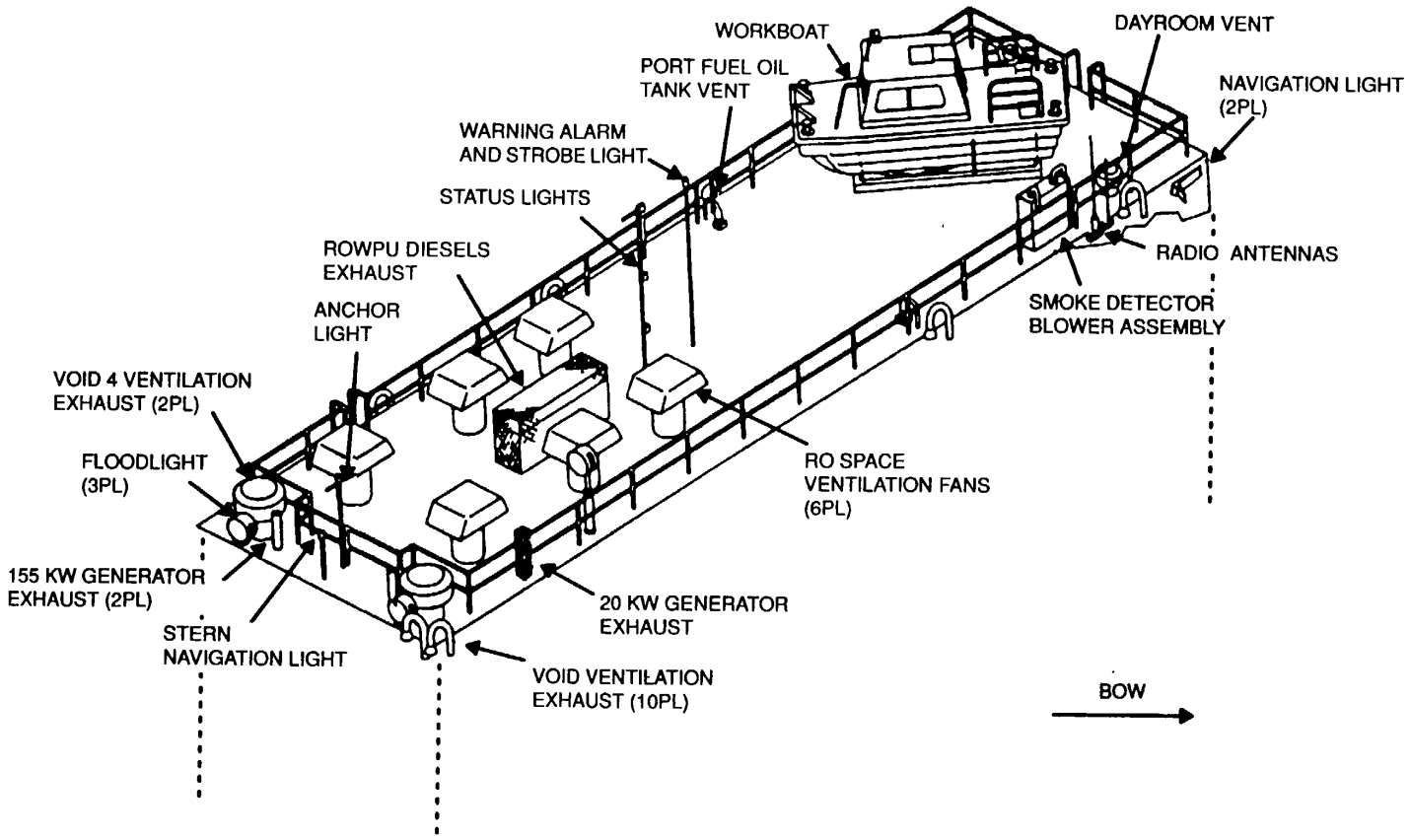


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment - Deckhouse Rood (Sheet 1 of 3)

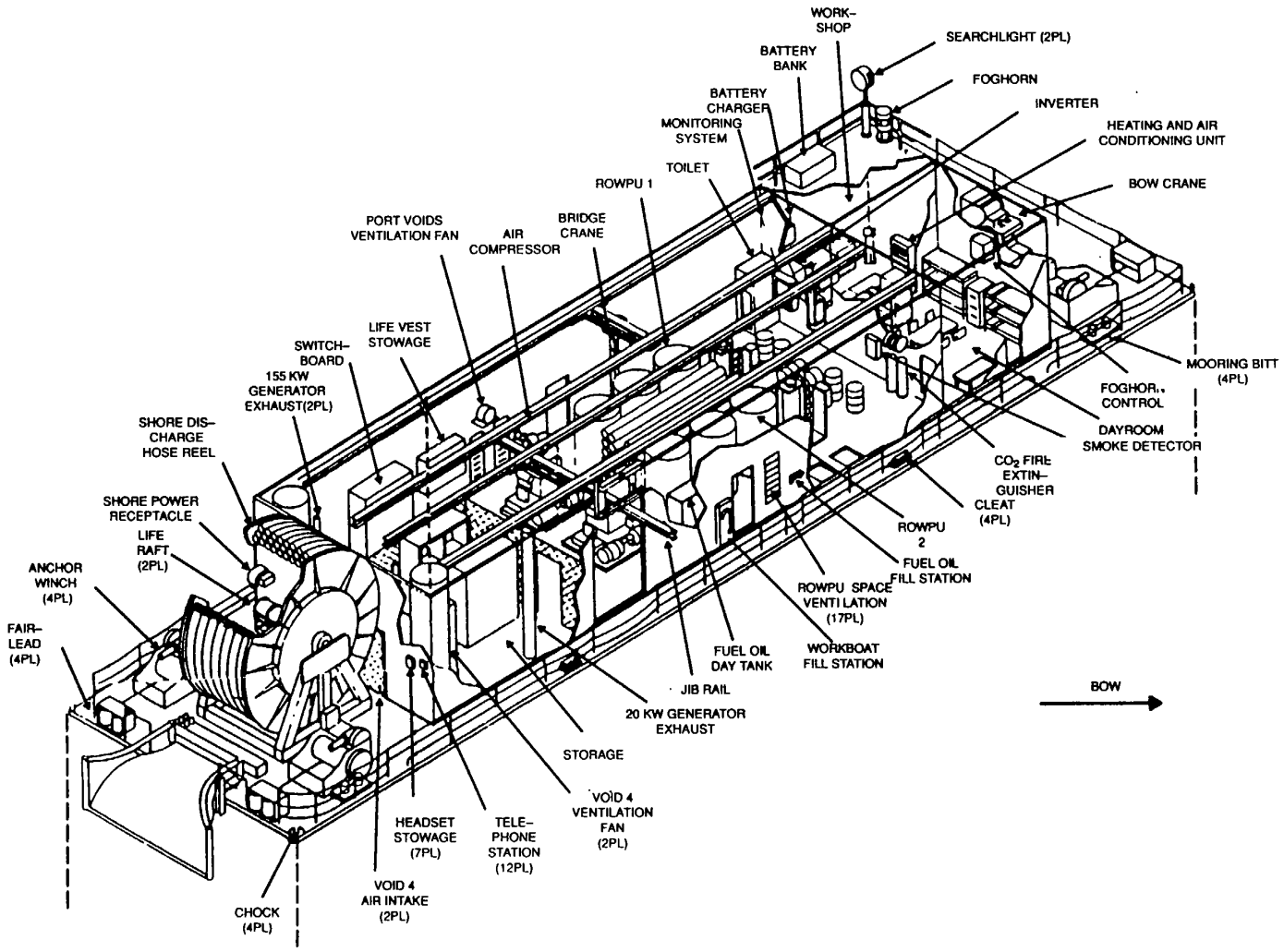


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment - Deckhouse (Sheet 2 of 3)

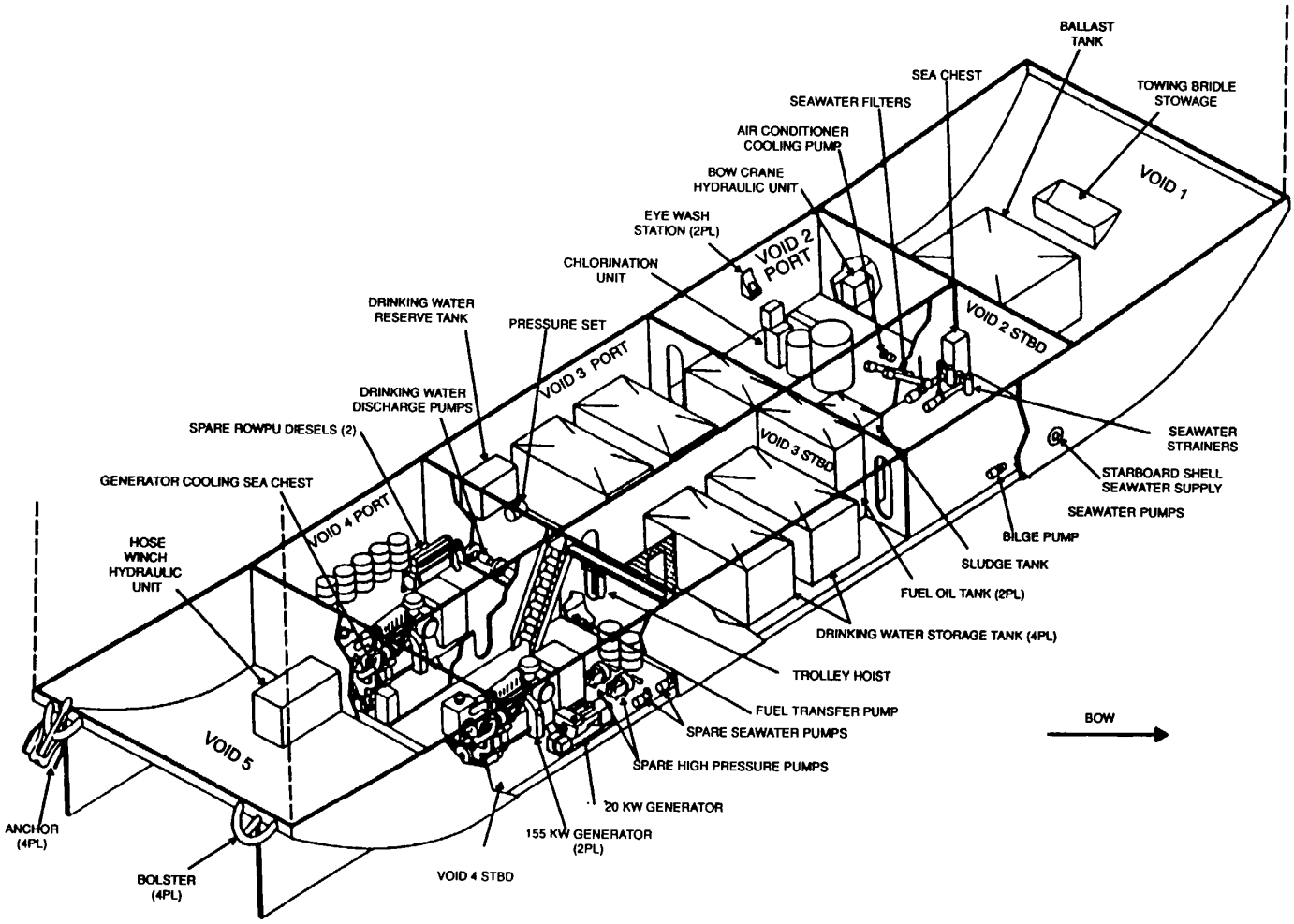


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment - Voids (Sheet 3 of 3)

CHAPTER 2 NORMAL ELECTRICAL SYSTEM

SECTION I. Description and data

2-1. Description

2-1.1 The normal electrical system provides electrical power for the operation of major and auxiliary systems on the barge including the emergency system battery charger discussed in Chapter 3. The normal system has six major elements, which are discussed below:

a. Normal electrical power is generated onboard by one of three diesel-powered generator sets. These generators, located in voids 4, are normally operated and controlled from a master switchboard in the ROWPU space. Chapter 4 provides detailed information on the two ship service generator (SSG) sets, and Chapter 5 provides similar information on the ship auxiliary generator (SAG) set. When all generator sets are shut down, a shore-based powerplant or another vessel can be used to provide electrical power to operate onboard equipment. This outside source is connected to the barge through electrical cabling to a watertight shore power receptacle on aft weatherdeck portside. These sources provide 440 Vac, 60 Hz 3 ph electrical power.

b. Power control and distribution is provided by a main switchboard on the port bulkhead aft of diesel high pressure (HP) pumps in the ROWPU space. This unit has six panels, three above the grab rail and three below. The three panels above the grab rail are controls and indicators for the three diesel generators in voids 4. The lower left (as operator faces the switchboard) distribution panel has two rows of circuit breakers that provide initial normal power distribution. Two lower right panels contain controls and indicators for the electrical systems. This panel also has indicators for ground detection system. Normal electrical system controls and indicators are discussed in paragraph 2-10.

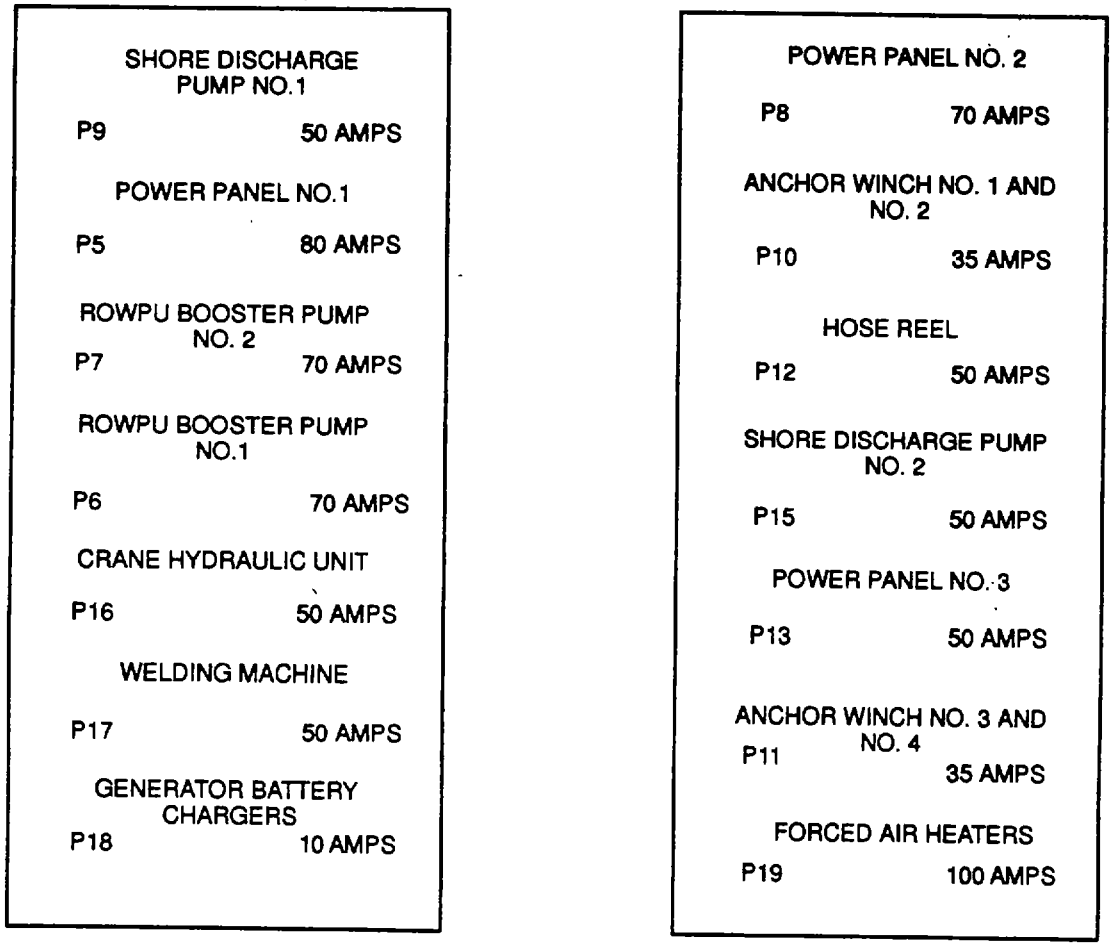
c. Electrical power is distributed through the switchboard distribution panel (Figure 2-1 for Barge 1 and Figure 2-2 for Barges 2 and 3) and these additional distribution panels:

Power panel 1 (440 Vac) (Figure 2-3)
Power panel 2 (440 Vac) (Figure 2-4)
Power panel 3 (120 Vac) (Figure 2-5)
Power panel 4 (440 Vac) (Figure 2-6) (Barge 1)
Deck lighting panel (120 Vac) (Figure 2-7)
Void lighting panel (120 Vac) (Figure 2-8)
Receptacle panel (120 Vac) (Figure 2-9)
Emergency lighting panel (120 Vac) **
Direct current panel (24 Vdc) **
** Discussed in Chapter 3, Emergency electrical system.

d. Transformers change electrical power from 440 Vac to either 220 Vac or 120 Vac. Three 15 kVA transformers (in parallel) on switchboard circuit breaker P13 provide 120 Vac power for power panel 3 which provides 120 Vac power distribution for the barge. One 2 kVA transformer on power panel 1 circuit breaker 11 P5 provides 220 Vac for the electric motor that powers the drinking water pressure seL

e. Mechanisms such as starters, controllers, and switches provide another level for controlling electrical power. These are discussed in the TM for each individual system.

f. The final elements are the electrical power consuming devices such as motors, lights, and heaters. These are discussed in the TM for the system of which they are a part.



THE FOLLOWING PRIMARY CIRCUIT BREAKERS ARE NOT ON DISTRIBUTION PANEL BUT ARE LOCATED ON SWITCHBOARD:

P1 SSG1 TO SWITCHBOARD BUS (300 AMPS)

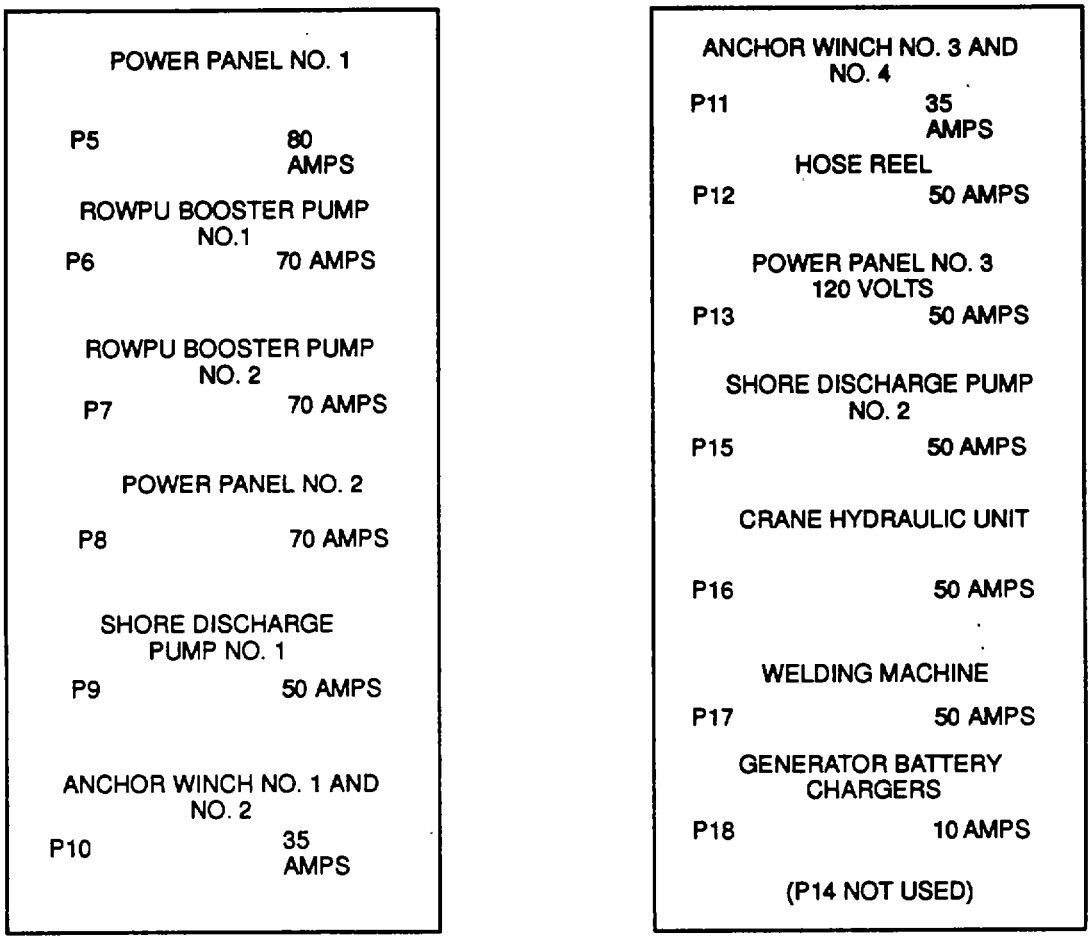
P2 SSG2 TO SWITCHBOARD BUS (300 AMPS)

P3 SAG3 TO SWITCHBOARD BUS (50 AMPS)

P4 SHORE POWER TO SWITCHBOARD BUS (200 AMPS)

P14 NOT ON SWITCHBOARD. DESIGNATION USED FOR 24 VDC POWER PANEL

Figure 2-1 . Switchboard Distribution Circuit Breakers (Barge 1)



THE FOLLOWING PRIMARY CIRCUIT BREAKERS ARE NOT ON DISTRIBUTION PANEL BUT ARE LOCATED ON SWITCHBOARD:

P1SSG1 TO SWITCHBOARD BUS (300 AMPS)

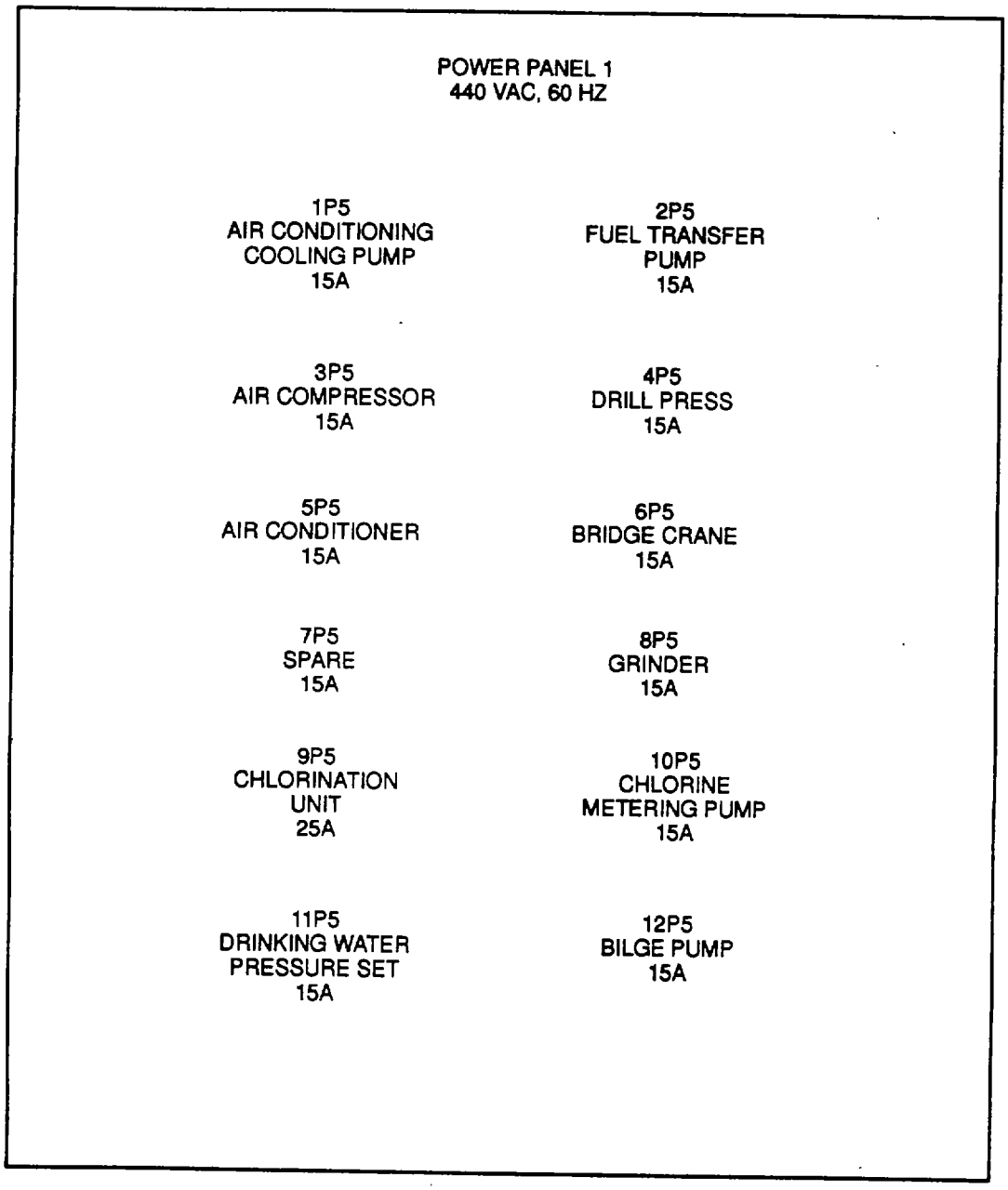
P2SSG2 TO SWITCHBOARD BUS (300 AMPS)

P3SAG3 TO SWITCHBOARD BUS (50 AMPS)

P4SHORE POWER TO SWITCHBOARD BUS (200 AMPS)

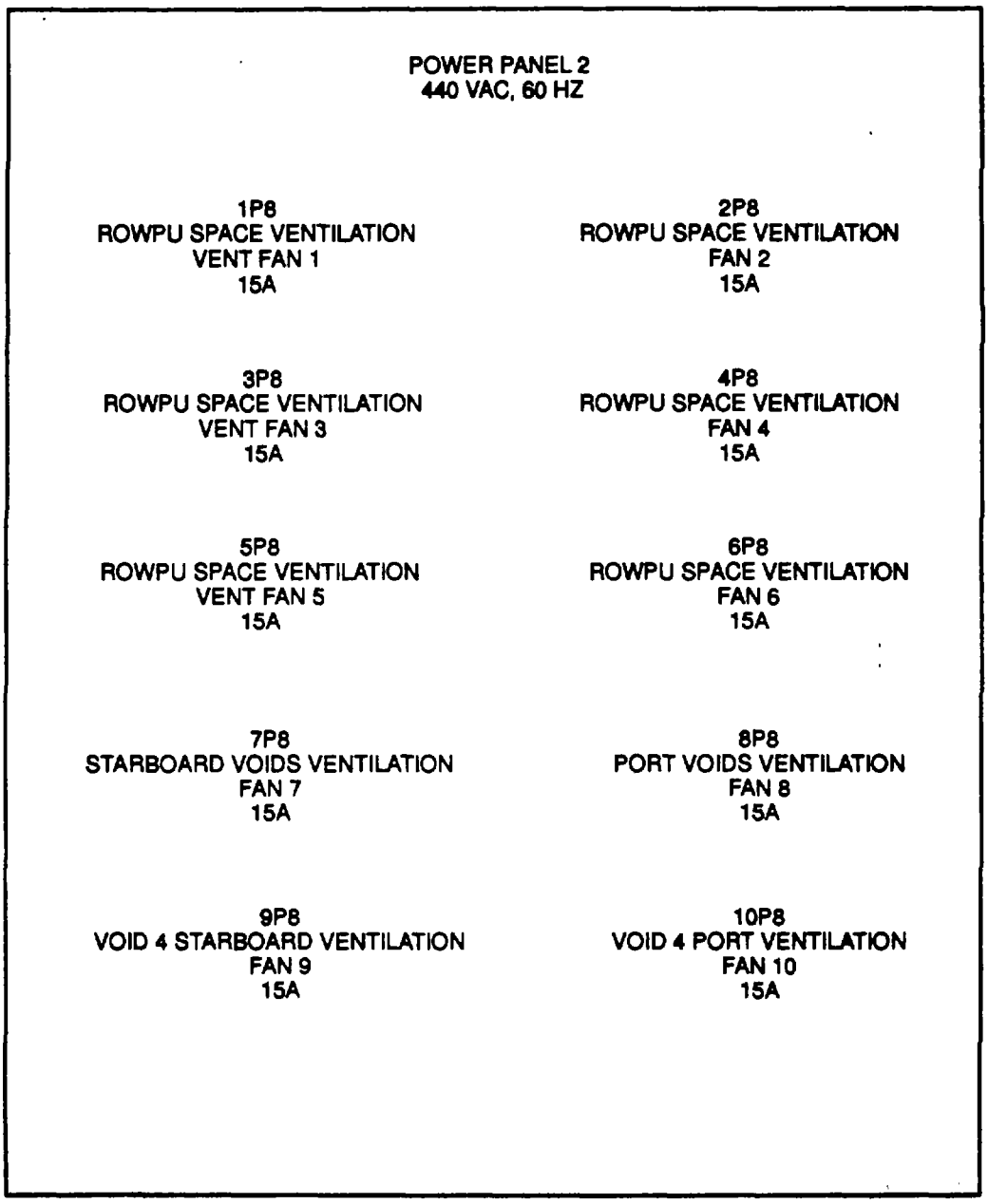
P14 NOT ON SWITCHBOARD. DESIGNATION USED FOR 24 VDC POWER PANEL

Figure 2-2. SwItchboard Distribution Circuit Breakers (Barges 2 and 3)



LOCATED IN ROWPU SPACE ON FORWARD PORT BULKHEAD FORWARD OF DOOR TO WEATHERDECK. POWER INPUT FROM SWITCHBOARD CIRCUIT BREAKER P5.

Figure 2-3. Power Panel I Circuit Breakers, 440 Vac



LOCATED IN ROWPU SPACE ON STARBOARD BULKHEAD FORWARD OF SLIDING DOOR. POWER INPUT FROM SWITCHBOARD CIRCUIT BREAKER P8.

Figure 2-4. Power Distribution Panel 2,440 Vb.

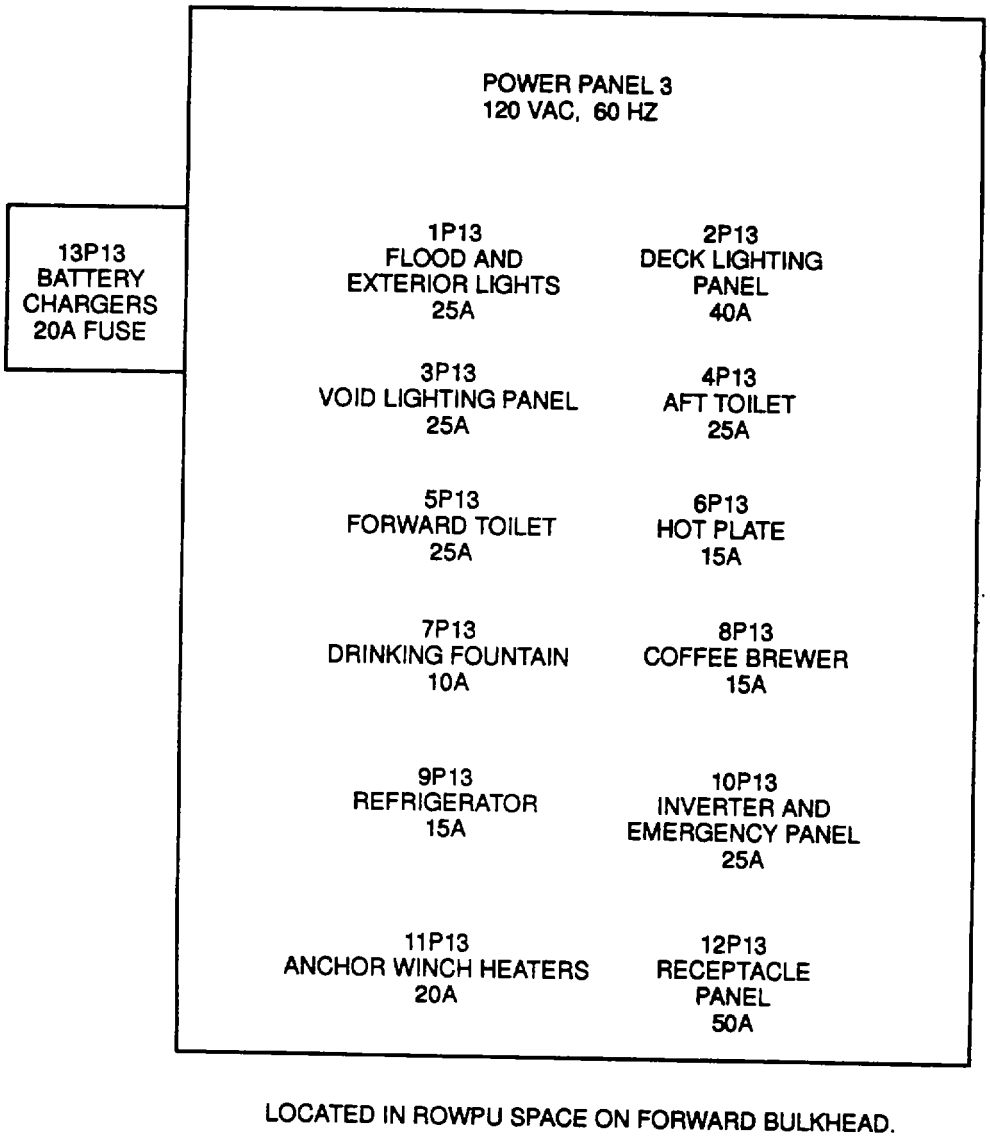


Figure 2-5. Power Distribution Panel 3,120 Vac

2-1.2 Components of this system are listed in Table 2-1 and shown in engineering drawings listed in Appendix A.

2-2. Capabilities. This system provides electrical power for operating barge equipment. Either of two 155 kW SSG's provides sufficient electrical power to operate all systems onboard. The SAG provides sufficient power for barge occupancy but not for major ROWPU systems operation. When onboard generator sets are not operating, power can be supplied through the shore power receptacle from onshore or from another vessel. An emergency shutdown system is also provided to stop individual systems or to stop all electrically powered equipment onboard. Paragraph 2-18 provides additional information.

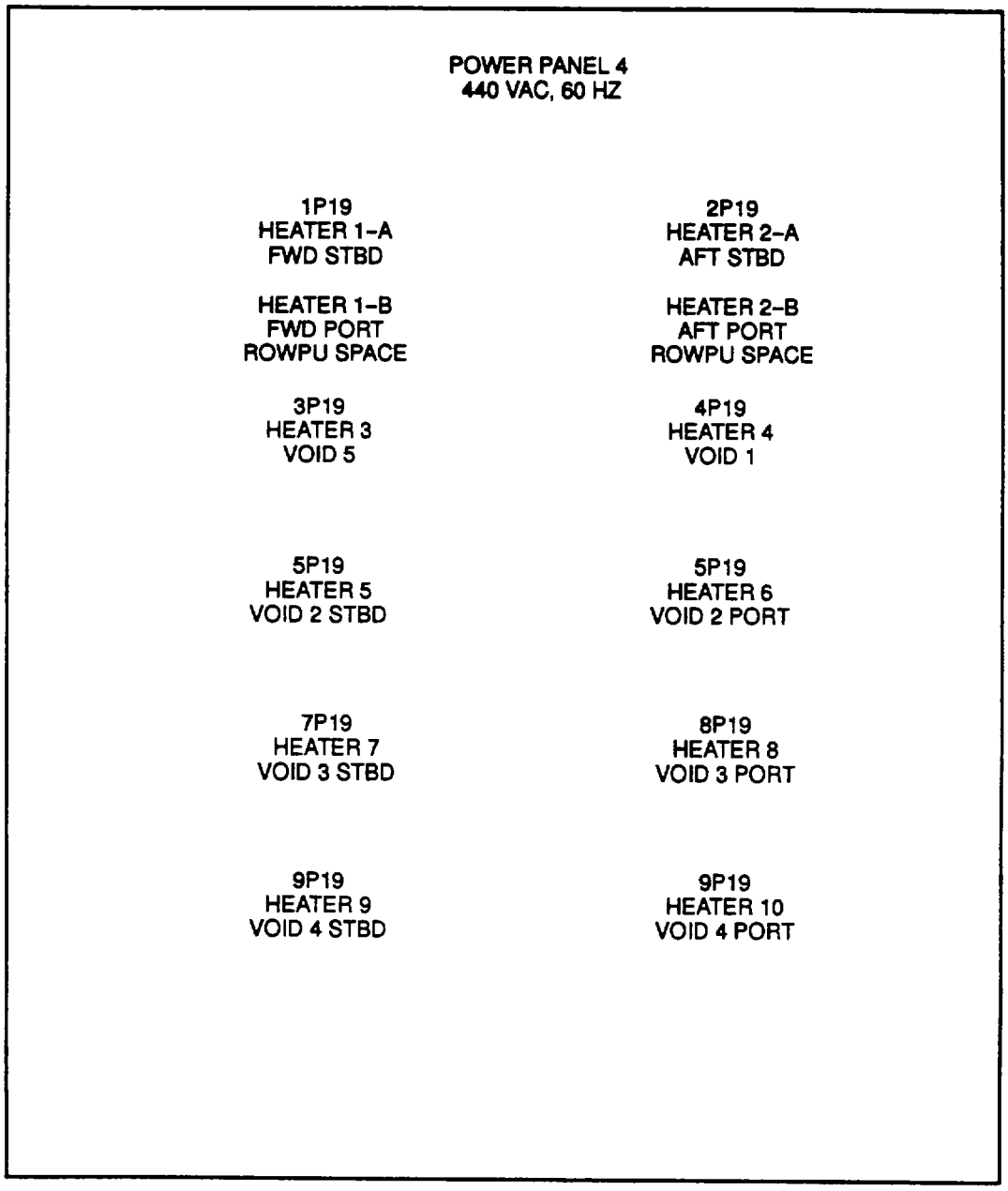
2-3. Special limitations. This system must have sufficient fuel for diesel-powered generators and the generators must be operational.

2-4. Performance characteristics

a. Shore power to switchboard 440 Vac, 60 Hz, 3 ph
b. Generators to switchboard 440 Vac, 60 Hz, 3 ph
c. Switchboard 440 Vac, 60 Hz, 3 ph

Table 2-1. Electrical Power System Major Components

Component	Quantity/Function	Location
Switchboard	1 - Controls and distributes electrical power	ROWPU space port bulkhead aft
Shore power receptacle	1 - Receives power from outside source	Stem weatherdeck portside
SSG	2 - Provides electrical power	Voids 4 port & starboard
SAG	1 - Provides electrical power	Void 4 starboard
Power panel 1	1 - Distributes 440 Vac power near door to weatherdeck	ROWPU space port bulkhead forward
Power panel 2	1 - Distributes 440 Vac power	ROWPU space starboard bulkhead forward of sliding door
Power panel 3	1 - Distributes 220 Vac power	ROWPU space forward bulkhead
Power panel 4 (Barge 1)	1 - Distributes 440 Vac power to heaters	ROWPU space starboard bulkhead
Deck lighting panel	1 - Controls electrical power for deck lights	ROWPU space starboard bulkhead
Void lighting panel	1 - Controls electrical power for void lights	ROWPU space starboard bulkhead near dayroom door
Receptacle panel	1 - Controls electrical power to receptacle	Workshop aft bulkhead
Ground detector panel	1 - Indicates ground in 115 Vac power system	ROWPU space forward bulkhead
Emergency shutdown	7 - Shut down electric-powered equipment or total electric power 6- Shut down total electric power	See paragraph 2-18



LOCATED IN ROWPU SPACE ON STARBOARD BULKHEAD FORWARD OF DOOR TO WEATHER-DECK. POWER INPUT FROM SWITCHBOARD CIRCUIT BREAKER P19.

Figure 2-6. Power Distribution Panel 4 (Barge 1)

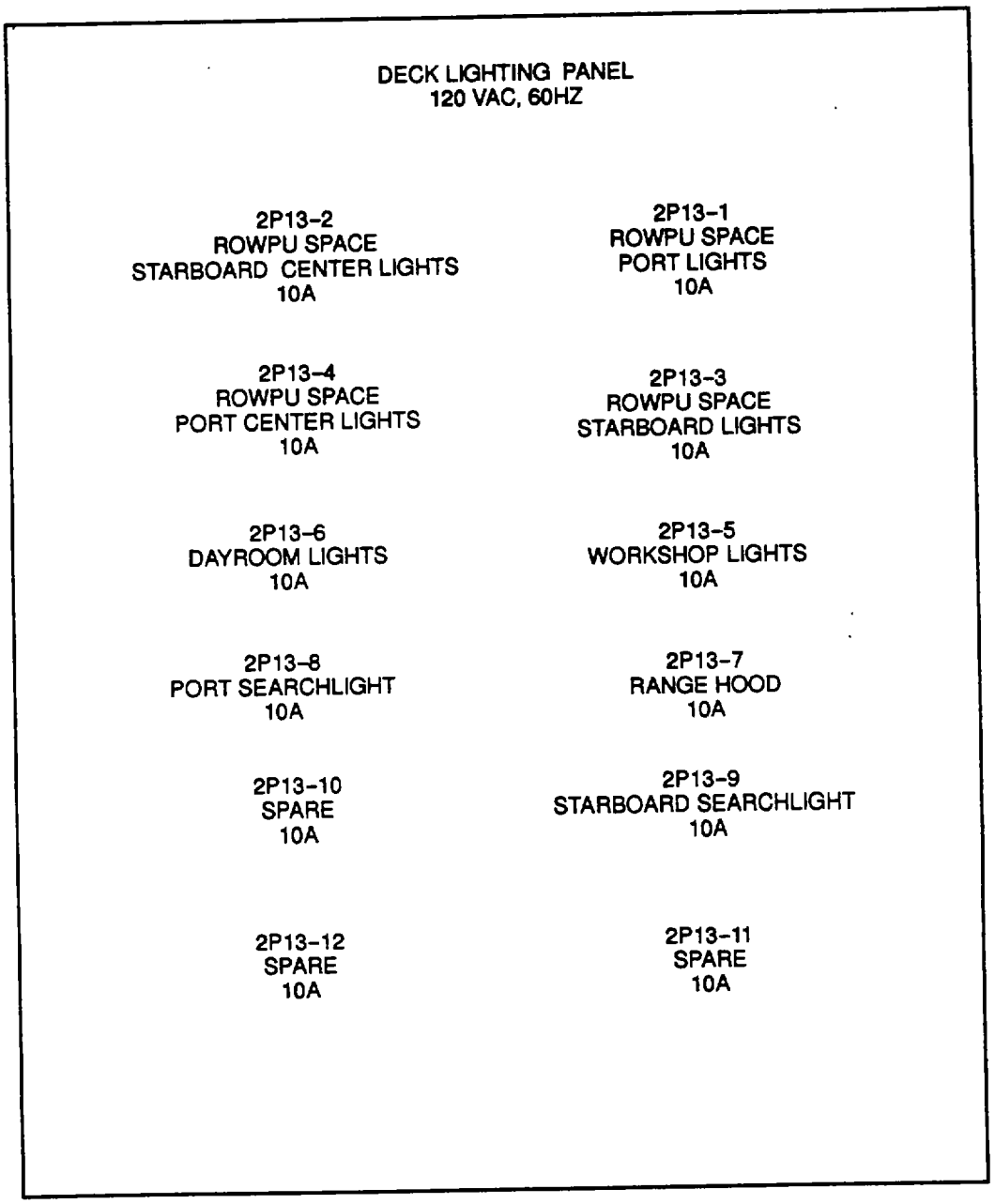


Figure 2-7. Deck Lighting Panel

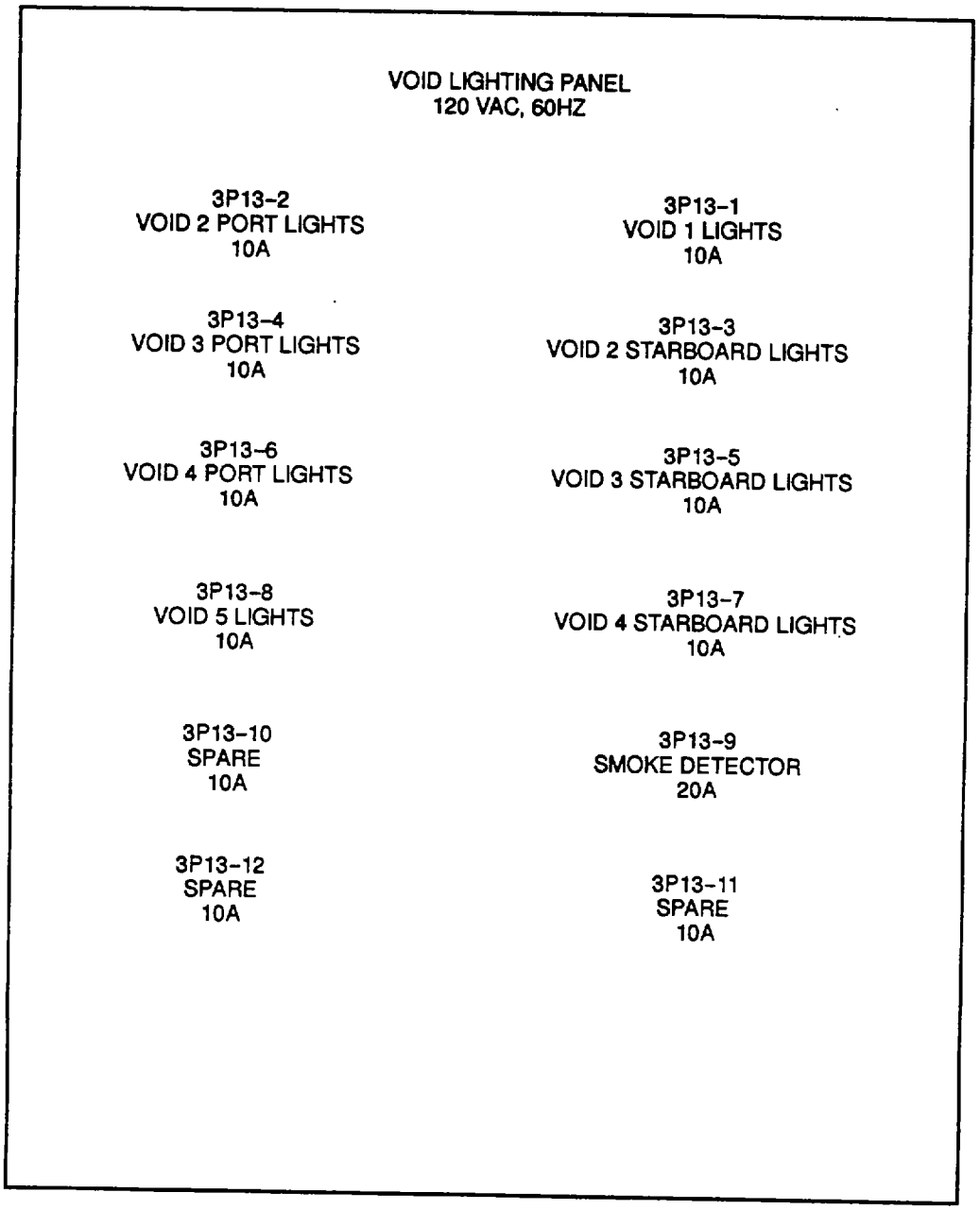
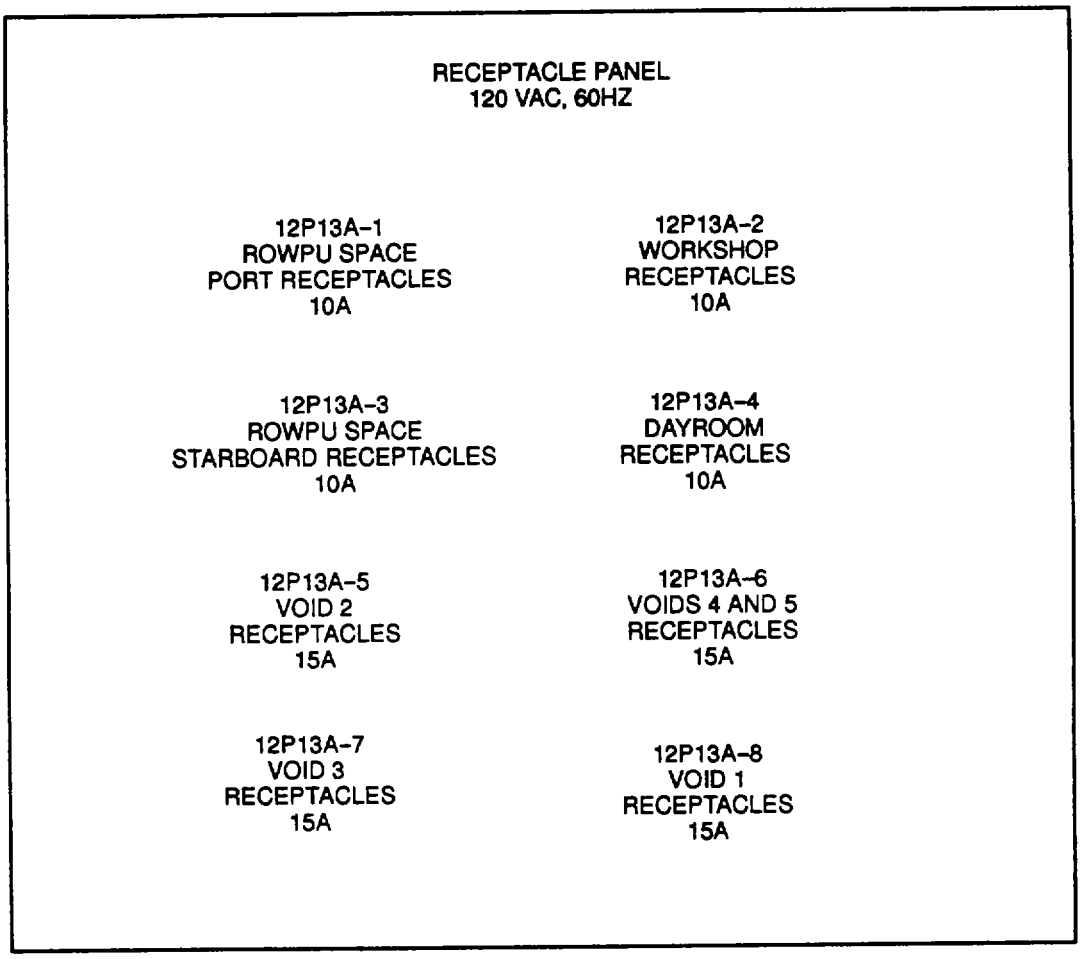


Figure 2-8. Void Lighting Panel



LOCATED IN WORKSHOP ON AFT BULKHEAD. POWER INPUT FROM POWER PANEL 3 CIRCUIT BREAKER 12P13.

Figure 2-9. Receptacle Panel

2-5. Equipment specifications

a. Switchboard

Manufacturer	Electric Power Controls RO. Box 5146 Springfield, IL 62705
CAGEC	Not Assigned
Part no.	55-1930
Dimensions	76 in x 72 in x 30 in
Rated	440 Vac, 3 ph, 3W, 1000 A buss
Type	Marine
Quantity	1

b. Shore power receptacle (440 Vac)

Manufacturer	Midland-Ross Corp. Russel Stoll Div.
CAGEC	78011
Part no.	JRFA2033F
Rating	440 Vac, 3 ph, 3 W. 220 A
Type	Weathertight
Quantity	1

c. Power panel 1

Manufacturer	Square D Co. Milwaukee Manufacturing Plant
CAGEC	55947
Part no.	2533
Military specification	MIL-P-2392814
Rating	500 Vac, 3 ph, 3 W
Circuits	12
Quantity	1

d. Power panel 2

Manufacturer	Square D Co.
Milwaukee	Manufacturing Plant
CAGEC	55947
Part no.	2532
Military specification	MIL-P-23928/4
Rating	440 Vac, 3 ph, 3
Circuits	10
Quantity	1

e. Power panel 3

Part no.	H-61 3-A ALB-5 1 2CKT
CAGEC	92722
Military specification	MIL-P-23928/2
Rating	120 Vac, 3 ph, 3 W
Circuits	1 0
Quantity	1

f. Power panel 4

Manufacturer	Westinghouse Electrical Supply Co. Norfolk VA 11037
CAGEC	11037
Part no.	
Rating	440 Vac, 3 ph, 3 W
Circuits	10
Quantity	1

g. Deck and void lighting panel

Part no.	M23928/2)DP
CAGEC	81349
Military specification	MIL-P-23928/2
Class	2
Rating	50 amps, 120 Vac
Branches	12
Quantity	2

h. 2kVA transformer

Manufacturer	Square D Co. Milwaukee Manufacturing Plant
CAGEC	55947
Part no.	2SIF
Rating	2kVA, 1 ph, 480/240 Vac, 60 h
Quantity	1

i. 1 5kVA transformer

Manufacturer	General Electric Co. Specialty Transfer Department
CAGEC	03512
Part no.	Type 9T21 B9109
Rating	15kVA, 1 ph, 440/120 Vac
Quantity	3

j. Receptacle

Manufacturer	Oceanic Electrical Manufacturing Co. Inc.
CAGEC	76857
Part no.	1231
Rating	125 Vac, 20 A
Type	Polarized, angle type, single gang, 2 wire, 3 pole
Quantity	4

k Ground detector panel

Part no.	M2439511 -M1
CAGEC	81349
Military specification	MIL-P-24395/1
Rating	120 Vac, 3 ph, 60 Hz
Type	Dripproof
Quantity	1

I. Plug (hot plate, coffee brewer, drinking fountain, refrigerator)

Manufacturer	Midland-Ross Corp. Russel Stoll Division
CAGEC	78011
Part no.	JP2033F
Rating	3 ph, 3 W, 200 A w/l 5 foot pigtail and lugs
Quantity	4

m. Receptade panel

Part No.	W3928/2-04 DP
CAGEC	81349
Military specification	MIL-P-23928/2
Class	1
Rating	120 Vac, 50 A
Branches	8
Quantity I	

n. Emergency shutdown security control station

Manufacturer	Square D Co.
CAGEC	08556
Part no.	KY-1
Type	Pushbutton
Quantity	13

o. Emergency shutdown enclosure

Manufacturer	Hoffman Engineering Co.
Division of Federal Cartridge Corp.	
CAGEC	00843
Part no.	A-16128JFG
Type	NEMA, type 4
Material	Fiberglass
Quantity	1

p. Emergency shutdown control relay

Manufacturer	Square D Co.
CAGEC	08556
Part no.	XDO80
Coil	24 Vdc
Quantity	1

q. Emergency shutdown switch

Manufacturer	Square D Co.
CAGEC	0855
Part no.	TRM-4
Type	Pushbutton w/KA-1 contact black
Quantity	13

r. Emergency shutdown solenoid valve

Manufacturer	Automatic Switch Co.
CAGEC	04845
Part no.	8210C33
Type	Normally dosed, 2 way
Material	Brass
Quantity	2

s. Emergency shutdown solenoid valve

Manufacturer	UTT Controls Division
International Telephone and Telegraph Corp.	
CAGEC	60219
Part no.	KI OAM 73
Type	Normally open
Pressure range	0 to 30O psi
Material	Brass
Quantity	2

2-6. Items furnished

2-6.1 Components installed as part of the normal electrical power system are listed on the parts list in drawings listed in Appendix A and in the Components of End Item List in TM 55-1930-209-14&P-20.

2-6.2 Common and bulk items onboard are listed in the Expendable Supplies and Materials List in TM 55- 1930-209-1 4&P-20.

2-6.3 Repair parts and special tools onboard are listed in the Repair Parts and Special Tools List in TM 55- 1930-209-14&P-18.

2-7. Items required but not furnished. All required items are furnished.

2-8. Tools and test equipment. Use existing tools and equipment. A complete list of tools and test equipment onboard is in the Tools and Test Equipment List in TM 55-1930-209-14&P-8.

SECTION II. Description of operation

2-9. Description of operation. Normal electrical power is generated onboard by one of three diesel-powered generator sets. Two of these are rated at 155 kW, designated as the SSG1 and SSG2 sets, and one is rated at 20 kW and designated as the SAG set. Except for a few minutes when transferring power loads from one generator to another, only one of these three generators is providing power (termed 'online") at any moment. These generator sets are normally operated and controlled from the master switchboard in the ROWPU space. For maintenance and servicing, they can be locally operated and controlled at the generator set location.

Either 155 kW SSG set supplies electrical power to the switchboard power distribution center. Power flow is then distributed from the switchboard directly to ROWPU operating equipment and to subordinate distribution panels for the auxiliary systems used in barge support. Electrical power generated by the 20 kW SAG set also flows through the switchboard power distribution center, but power from the SAG is distributed only to crew support auxiliary systems such as communications, day room equipment, workshop equipment, and interior lighting. When electrical power is supplied from either a shore-based facility or from another vessel, the power is received through the shore power receptacle located on the aft weather deck port side. From there it flows to the switchboard distribution center. Table 2-2 lists power distribution from normal electrical power supply sources.

Table 2-2. Barge Normal Electrical Power Distribution

SSG's	SAG
Power generated by the 155 kW SSG's, shore-based power, or power from another vessel supports the following:	Power generated by the 20 kW SAG or equivalent wattage transmitted to the barge supports the following only:
All ROWPU operating systems and both barge and crew support systems such as: anchor winches, bridge and bow cranes, trolley hoist, ventilating systems, exterior and interior lighting, communications, navigation lights, day room and workshop equipment, bilges, and sanitation systems.	Crew support systems including dayroon and workshop equipment, communications, interior lighting, navigation lights, emergency battery charger, heating and air conditioning, chlorination system initial startup, ventilation, bilge pumps, and toilets.

SECTION III. Operating Instructions

2-10. Operating controls and Indicators

2-10.1 General. Figure 2-10 shows an overall view of the switchboard. It is divided into four different types of panels: generator control panels, switchboard distribution panel, paralleling and control panel, and miscellaneous controls and indicators.

2-10.2 Generator control panels Three panels (Figure 2-11) across the top of the switchboard (SSG 1 on left, SSG 2 in center, and SAG on right) control the generator sets.

a. VOLTMETER. Reads voltage output from generator. Left gauge in top row of gauges.

b. AMMETER. Reads amperage output from generator. Center gauge in top row of gauges.

c. FREQUENCY METER. Reads generator output frequency. Right gauge in top row of gauges.

d. VOLTMETER SWITCH. Selects bus Vi -2 on left, OFF in center, and GEN VI -2, V2-3, or V3-1 on right. Left switch in top row of switches.

e. AMMETER SWITCH. Selects A-3 on left, OFF in center top, A-2 in center bottom, and A-1 on right. Left center switch in top row of switches.

f. GOVERNOR SPEED CONTROL. Toggle switch increases governor speed by moving left for INCREASE and right for DECREASE. Right center switch on top row of switches. Not connected on the SAG panel since the SAG does not have a governor.

g. VOLTAGE REGULATOR. Two-position switch sets engine to either RUN or IDLE. Right switch in top row of switches.

h. AUTOMATIC VOLTAGE CONTROL RHEOSTAT. Rotating switch controls generator output voltage. Left switch on bottom row of switches and warning lights. Not installed on the SAG panel.

i. ENGINE FAILURE LIGHTS. This grouping shows four warning lights, from left to right: REVERSE POWER, OVER SPEED, LOW OIL PRESSURE, and HIGH WATER TEMPERATURE. Press to test to check lights.

j. ENGINE CONTROL SWITCH. Toggle switch has three positions: START, STOP, and REMOTE. Controls the engine START/STOP switch. In run mode, engine runs at full speed, voltage regulator operates, and generator circuit breaker can be closed. Right switch on bottom row of switches and warning lights.

2-10.3 Switchboard distribution panel. This panel controls two functions: fault detection and power

a. 440 volt ground fault detection. This panel shows three lights labeled: PHASE 1, PHASE 2, and PHASE 3. A fourth light is a press-to-test check for these three indicator bulbs.

b. Barge 1 power distribution panel has 13 active and 1 spare circuit breaker (Figure 2-12). Barges 2 and 3 distribution panel has 13 active and 3 spare circuit breakers (Figure 2-13).

2-10.4 Paralleling and control panels. These panels (Figure 2-14) are located in center of switchboard below SSG 2 control panel. They include the following controls and indicators:

a. VOLTMETER. Reads incoming generator voltage selected with the INCOMING GENERATOR switch. Left gauge in top row of three gauges.

b. FREQUENCY METER. Reads generator output frequency selected with INCOMING GENERATOR switch. Center gauge in row of gauges.

c. SYNCHROSCOPE. Shows synchronization between the incoming generator selected with INCOMING GENERATOR switch and the switchboard bus. Right gauge in row of gauges.

d. INCOMING GENERATOR SWITCH. Switch has four positions: OFF, GEN 1, GEN 2, and GEN 3. Switch selects which generator is being synchronized with the bus. That generator's voltage and frequency are shown on gauges above the switch. Place switch in OFF position when not being used for synchronization.

e. GENERATOR status lights. These sub panels, just below grab rail on center portion of switchboard, show status of each generator. RUN light shows generator is running. The next two lights show generator circuit breaker position as OPEN or CLOSED. The sub panels are labeled GENERATOR 1 on the left, GENERATOR 2 in the center, and GENERATOR 3 on the right.

2-10.5 Miscellaneous controls and Indicators. The lower right switchboard panel (Figure 2-15) monitors the three battery chargers that maintain generator battery banks and shows status of the shore power circuit breaker. Panel indicators and controls include the following:

a. DC AMMETERS and DC VOLTMETERS. Placed in pairs across the top of this panel with ammeters on top and voltmeters below. Indicate operation of battery chargers for SSG 1, SSG 2, and SAG.

b. BATTERY CHARGER switches. Three switches are immediately below the corresponding gauges. Each has a two-position toggle switch with FLOAT to left and EQUALIZE to right. FLOAT is normal setting. Each switch controls battery charging for one of the three generator set diesel engines.

c. SHORE POWER status lights. Similar to status lights for generator status. Shows shore power receptacle status with three lights. AVAILABLE indicates power is plugged into shore power receptacle on aft weather deck port side. Next two lights show if shore power circuit breaker is OPEN or CLOSED.

d. SHORE POWER circuit breaker. Circuit breaker P4 connects shore power to switchboard bus. When this circuit breaker is dosed (ON), generator circuit breakers will NOT dose.

e. PHASE ROTATION status lights. These two status lights indicate the shore power phase rotation. The shore power breaker will not dose if the phase is not in proper sequence.

2-11. Prestart procedures from switchboard

NOTE

The following procedures are for operating generator sets from the switchboard. Chapters 4 and 5 provide procedures for operation of generator sets at engine location In voids 4.

a. Perform pre-start procedures in paragraph 4-11 for SSG 1 or SSG 2, or paragraph 5-11 for SAG.

b. Check that circuit breaker for starting generator (Figure 2-14) (P1, P2, or P3) is open (OFF).

c. Check that shore power circuit breaker P4 (Figure 2-15) is open (OFF).

d. Check that INCOMING GENERATOR selector switch (Figure 2-14) is OFF.

e. Check that generator VOLTAGE REGULATOR switch (Figure 2-11) is on IDLE.

f. Check that ENGINE CONTROL SWITCH is OFF (Figure 2-11).

g. Check that battery charger for starting generator is set on FLOAT (Figure 2-15).

h. Make sure Equipment Monitoring System (EMS) is operating by pushing up on Monitor controller left of monitoring processor. It video screen does not come on, turn it on with switch beneath the screen. For more details on EMS, see TM 55-1930-209-14&P-11.

i. Check that 24 Vdc power panel in workshop is active (Chapter 3) and that circuit breaker 8P14 is dosed (ON). This procedure provides voltage to hold open solenoids in generator fuel lines. Emergency shutdown switches activate these shutoff solenoids by removing this 24 Vdc power. If 24 Vdc panel is not active, and circuit breaker 8P1 4 is not dosed, these holding solenoids are dosed and fuel for these generators is shut off. The generator will start and run for about 2 minutes until lack of fuel shuts it off.

CAUTION

Turn off all emergency panel power users and all emergency lights when all power sources are turned off on barge. If not turned off, DC battery bank will be drained of power. Without DC power to hold fuel cutoff solenoids open, generators will not operate to recharge the 24 Vdc battery bank

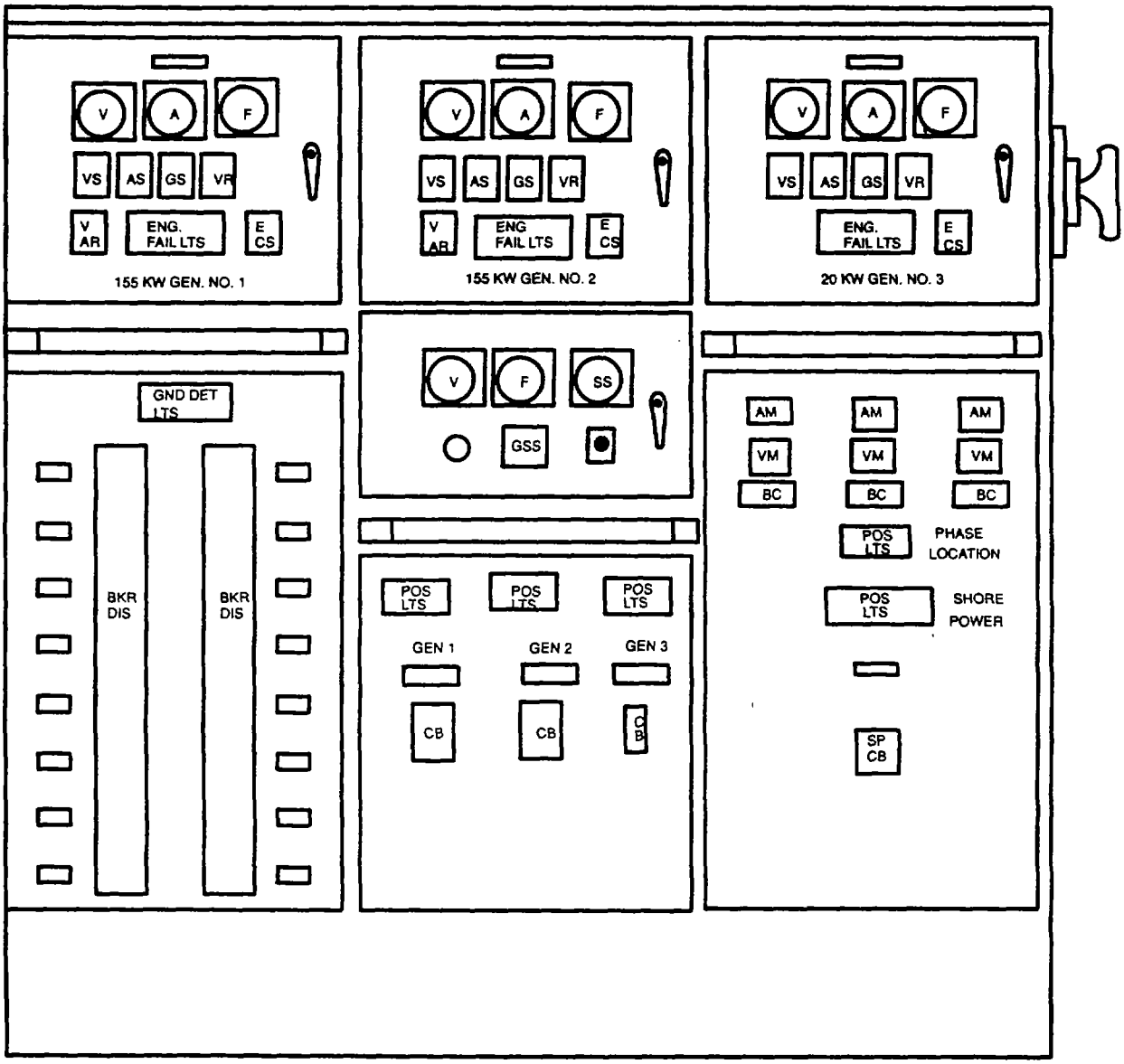


Figure 2-10. Overall View of Switchboard Control Panels

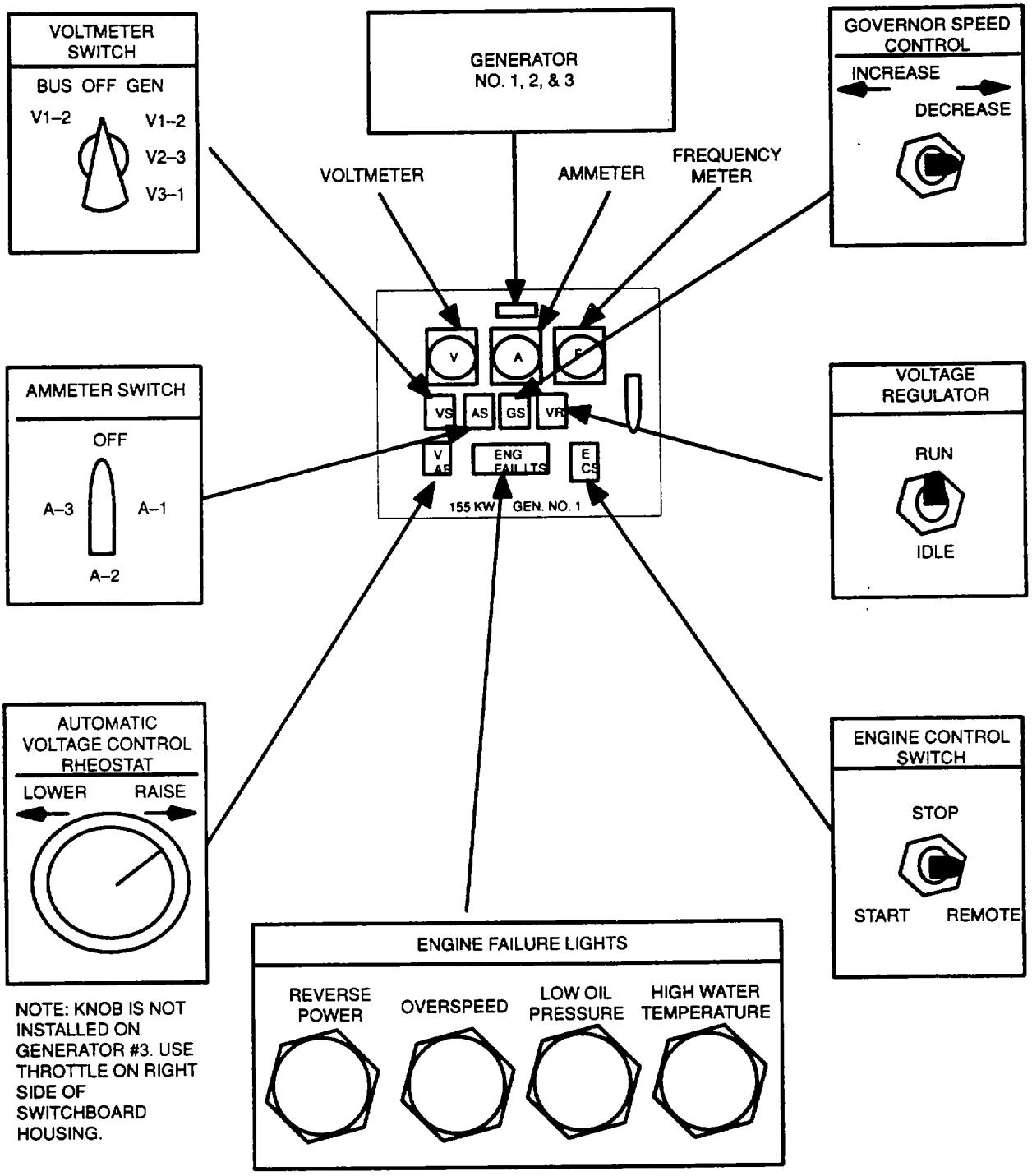


Figure 2-11. Typical Switchboard Generator Control Panel

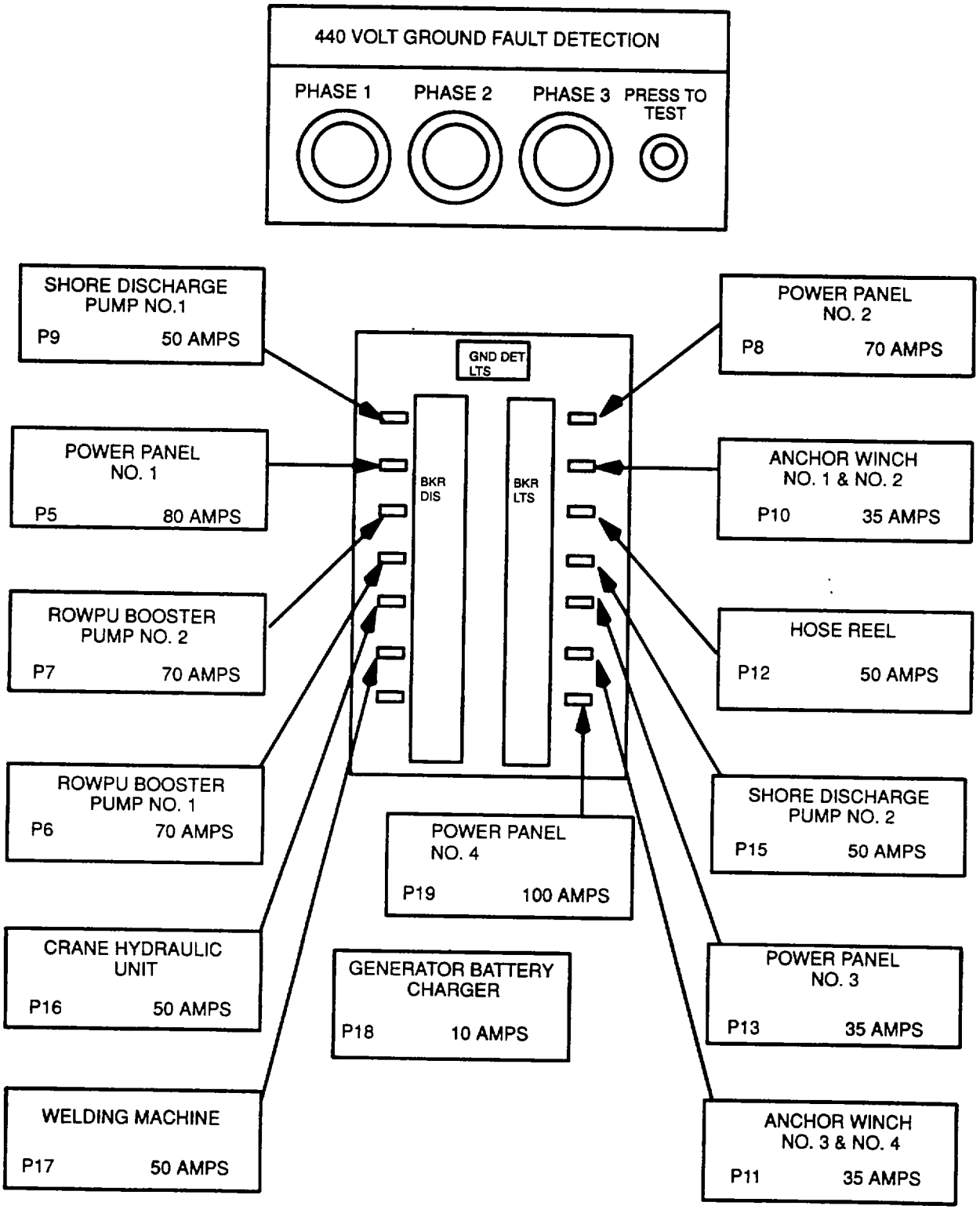


Figure 2-12. Switchboard Distribution Panel (Barge 1)

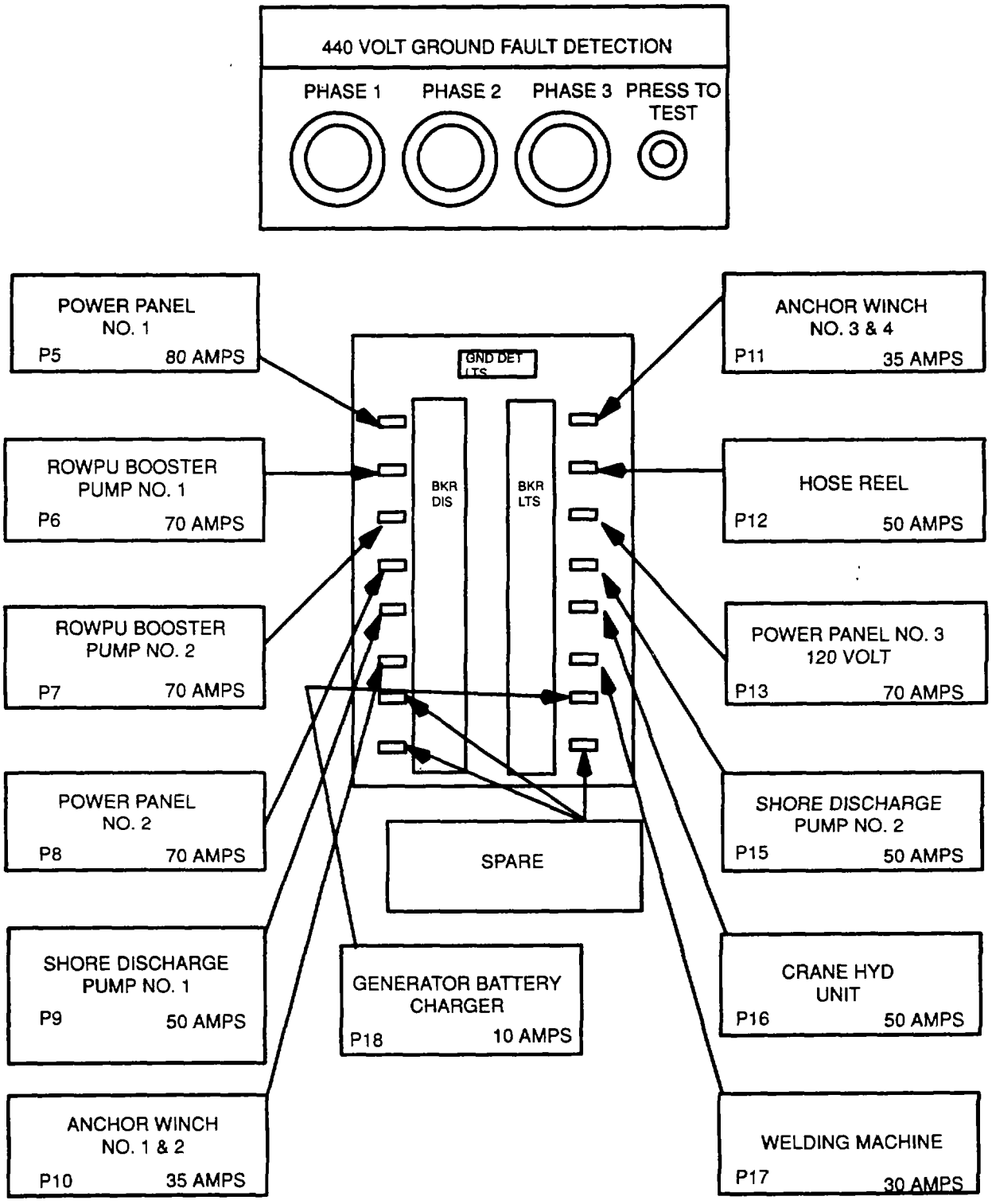


Figure 2-13. Switchboard Distribution Panel (Barges 2 and 3)

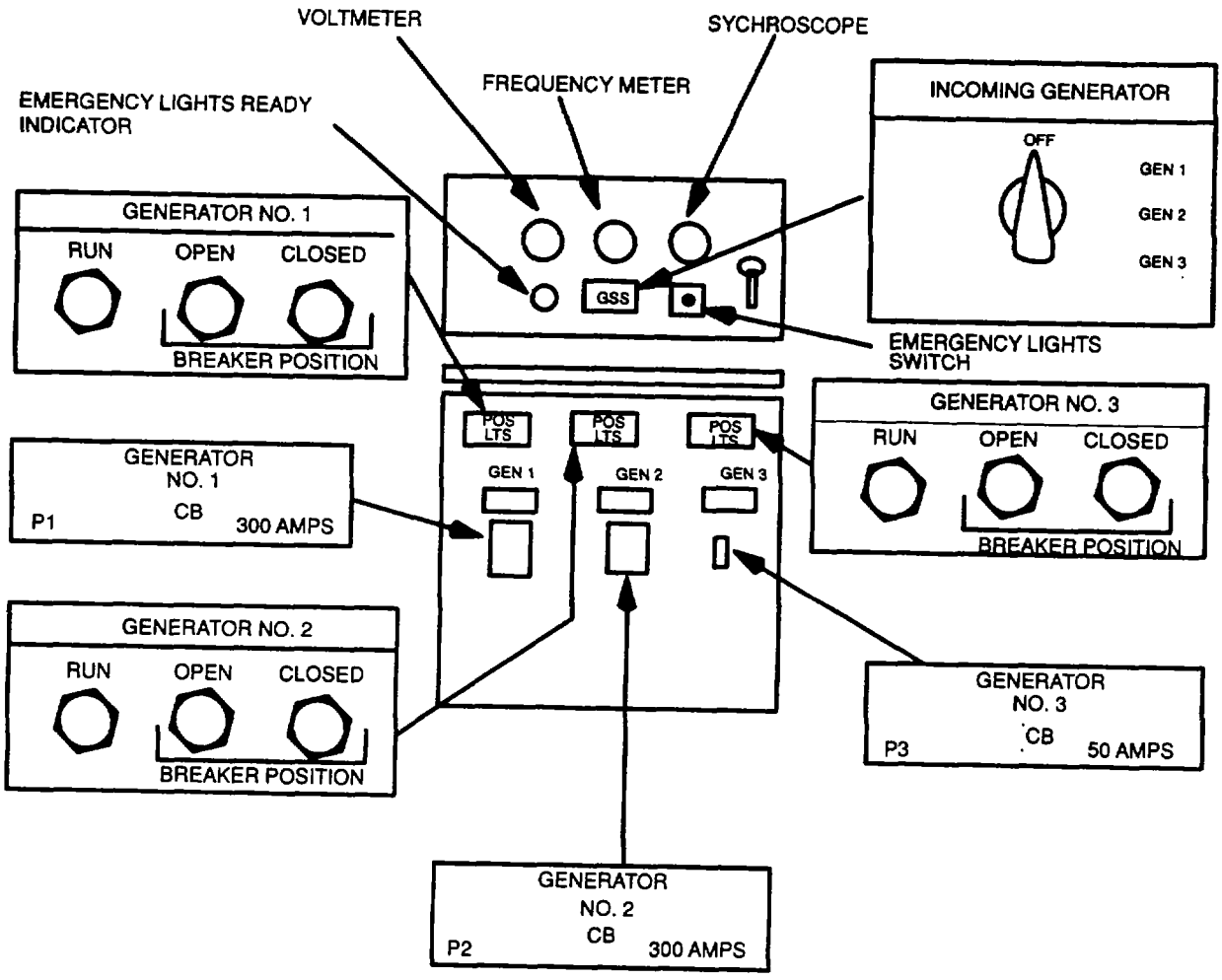


Figure 2-14. Paralleling and Control Panels

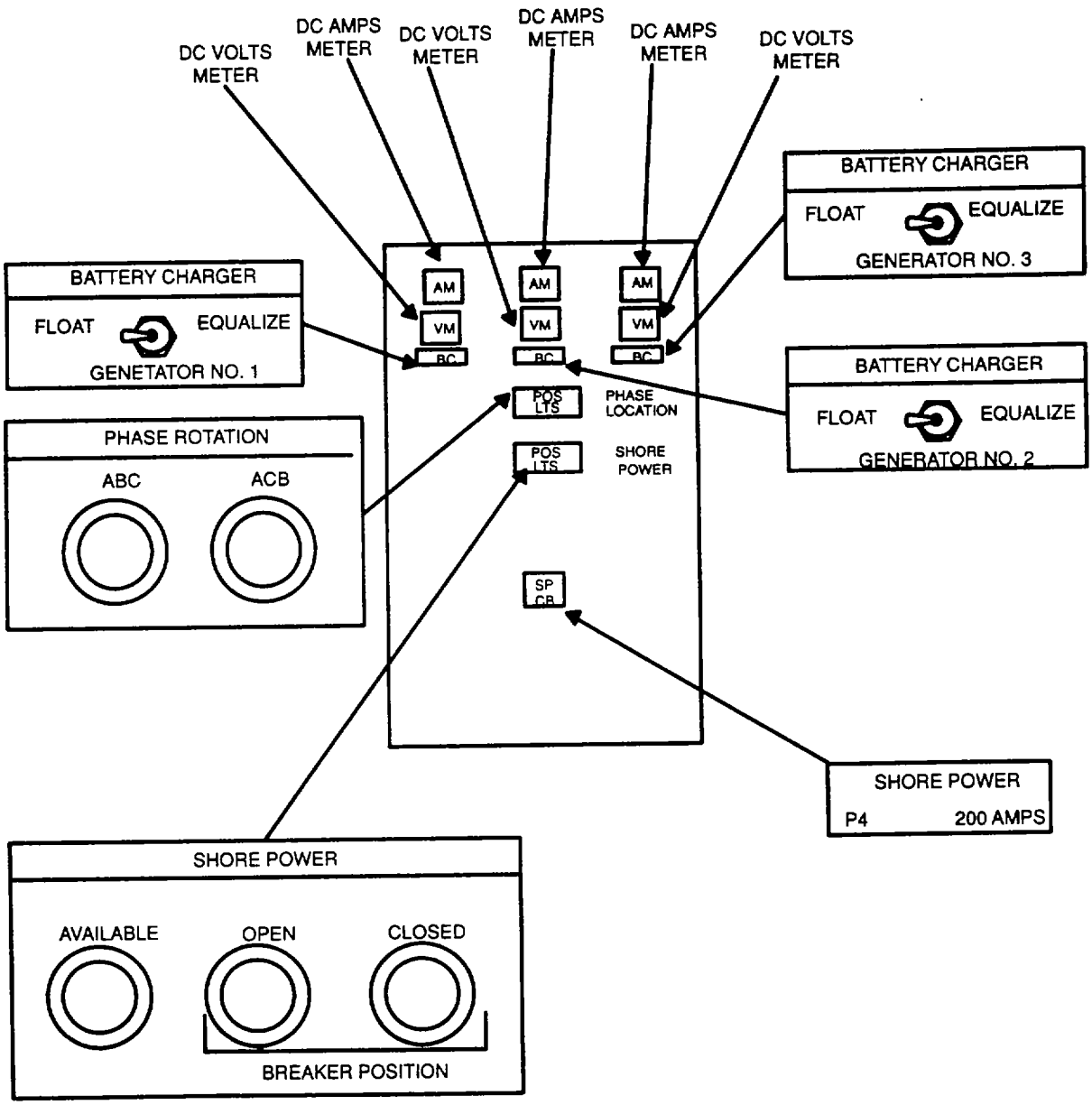


Figure 2-15. Switchboard Miscellaneous Controls and Indicators

2-12. Generator set alarm and shutoff systems The SSG's and SAG have built-in alarm and shutoff systems. Alarms and emergency shutoff systems, discussed in this section, function whether SSG's are operated at the engine or at the switchboard.

2-12.1 Alarm systems Three alarm switches are set at levels of coolant temperature, oil pressure, and rotations per minute (rpm) less critical than the emergency shutoff controls described in paragraph 2-12.2. When alarm conditions exist, three red lights in a row of four ENGINE FAILURE lights (Figure 2-11) on affected generator set switchboard panel, light up. When EMS is on (TM 55 930-209-14&P-1 1), these critical conditions are also made known to the crew by a blinking display on the EMS video monitor on the forward ROWPU bulkhead, by a strobe light and horn in the ROWPU space, a horn on the deckhouse top, and a buzzer in the day room. Alarms warn operators that an unsafe condition is developing and that corrective action must be taken immediately. If action is not taken, an emergency shutoff solenoid will shut down the SSG. Alarms continue until turned off or until the unsafe condition is corrected. When the unsafe condition is corrected, switches automatically reset The fourth alarm condition, reverse power, is discussed in paragraph 2-14.

2-12.2 Shutoff systems. During operation, four electrically-operated shutoff systems function in the following manner. When a critical condition exists, a switch automatically doses the circuit to a shutoff solenoid. This action stops fuel flow to the cylinders and shuts off the engine. The shutoff control either resets itself or must be reset by a crew member before the engine restarts. These shutoff systems are discussed below.

CAUTION

Sensing element must be submerged In coolant to operate. If coolant Is low, engine can overheat and automatic shutoff will not function to prevent damage to engine.

a. High water temperature shutoff switch is located in the water temperature regulator housing. When the water temperature is too high, the solenoid fuel cutoff switch closes and the engine shuts off. When the engine stops, switch the ECS or ENGINE START/STOP switch to STOP. This will prevent the temperature shutoff switch from automatically restarting the engine when this switch resets after the coolant cools. Troubleshoot the cooling system and repair as necessary. Restart the engine by following the procedures in paragraphs 2-11 and 2-13.

b. Low oil pressure shutoff switch is on the side of engine with oil lines connecting to the switch. When engine oil pressure is too low, the solenoid fuel cutoff switch doses and shuts off the engine. When engine stops, switch the ECS or ENGINE START/STOP switch to STOR Troubleshoot lubricating system and repair as necessary. Before restarting engine, reset oil pressure shutoff switch by pushing reset button until it latches. After engine starts and develops oil pressure, pressure will push reset button to extended position. If button remains in reset position, engine is not developing normal oil pressure. Troubleshoot and correct as necessary. Restart engine by following procedures in paragraphs 2-11 and 2-13.

CAUTION

If the oil pressure shutoff switch reset button does not move to extended position after engine Is running, the shutoff switch Is not protecting the engine from low oil pressure.

c. Electronic overspeed shutoff switch protects the engine as follows:

CAUTION

Sudden stopping of engine under load may be hazardous to operations being powered by an online generator self engine overspeeds, however, f must be stopped immediately as a runaway engine will destroy Itself.

(1) Electronic overspeed shutoff switch uses a magnetic pickup mounted in the flywheel housing to sense engine speed. When engine overspeeds, magnetic pickup doses circuit to fuel shutoff solenoid and stops the engine. When engine stops, switch the ECS or ENGINE START/STOP switch to STOP Troubleshoot and repair as necessary. Reset overspeed shutoff switch, either on engine overspeed panel or on switchboard SSG panel. Restart engine by following procedures in paragraphs 2-11 and 2-13.

(2) The overspeed sensing device has a second sensing circuit that prevents the starter pinion from remaining engaged in the flywheel at excessive rpm. After starter has cranked the engine, pinion gear may remain engaged in flywheel as engine speed increases. At 600 rpm, the magnetic sensing device opens a circuit to the starter and disengages pinion. This circuit remains open until flywheel stops. The open circuit prevents starter from energizing while flywheel is turning. This safety device does not require resetting.

2-13. Operating procedures from switchboard. Starting procedures for the engines are in paragraph 4-12 for SSG's and 5-12 for SAG. Operating procedures using shore power are in paragraph 2-15.

a. Turn ENGINE CONTROL SWITCH (Figure 2-11) to START. Engine will crank and run.

b. Allow engine to idle for 2 minutes.

c. Monitor the following:

(1) ENGINE FAILURE LIGHTS do not light (Figure 2-11).

(2) Battery charger ammeter DC AMPS and DC VOLTS meters (Figure 2-15) indicate ammeter is charging batteries.

(3) 440 VOLT GROUND DETECTION lights do not light (Figure 2-12 or 2-13).

d. Turn VOLTAGE REGULATOR switch to RUN (Figure 2-11).

e. Wait 1 minute for engine to stabilize.

f. Monitor items listed in step c above.

g. Using AUTOMATIC VOLTAGE CONTROL RHEOSTAT, set generator voltage to 450 V.

h. Set generator frequency to 60 Hz.

(1) On SSG 1 or SSG 2, use GOVERNOR SPEED CONTROL toggle switch (Figure 2-11). Move it left to increase frequency and right to decrease frequency.

(2) On SAG, GOVERNOR SPEED CONTROL toggle switch is not connected (Figure 2-11). Set SAG generator frequency by adjusting throttle on right side of switchboard. Turn throttle knob clockwise to increase frequency and counterclockwise to decrease frequency.

i. Check ENGINE FAILURE LIGHTS (Figure 2-11) by pressing-to-test. Lights should light when pushed in. If not, make note of bulbs to be changed when that generator is off-line.

CAUTION

If this Is first generator to be started and placed online, proceed with steps thru m. N another generator Is currently providing power, follow procedures In paragraph .2-14

j. When the values in steps g and h are stable, dose appropriate switchboard circuit breaker (Figure 2-14) to provide generator output to switchboard bus:

P3 for SAG
P2 for SSG 2
P1 for SSG 1

k Make sure switchboard GENERATOR status lights (Figure 2-14) for operating generator indicates it is running and its circuit breaker is closed.

CAUTION

With only SAG online, do NOT close circuit breakers P6, P7, P9, P12, or P15. These circuit breakers engage power requirements beyond SAG's capacity. When these circuits are necessary, start one of the SSG's, transfer load to SSG (paragraph 2-14), and shutdown SAG.

l. Apply load by dosing (ON), as required, switchboard circuit breakers P5 thru P13 and P15 thru P18 (Figure 2-13) one at a time.

m. Close (ON) circuit breaker P8 (Figure 2-12) to provide power to power panel 2. Start void(s) 4 port and/or starboard exhaust fans to provide ventilation in generator area Close (ON) circuit breaker 9P8 for void 4 starboard ventilation and circuit breaker 10P8 for void 4 port ventilation (Figure 2-4).

2-14. Paralleling generators and transferring load

NOTE

These procedures can be done only while operating generators from switchboard.

a. Start new generator by following procedures in paragraphs 2-11 and 2-13, steps a thru i.

b. Using AUTOMATIC VOLTAGE CONTROL RHEOSTAT (Figure 2-11), adjust voltage on new generator to a value slightly higher than online generator.

c. Switch INCOMING GENERATOR switch (Figure 2-14) to indicate incoming generator. This action allows SYNCHROSCOPE to indicate frequency of incoming generator.

d. Using GOVERNOR SPEED CONTROL switch (Figure 2-11), adjust frequency of new generator rotation so SYNCHROSCOPE (Figure 2-14) either stops at the 12 o'clock position or turns very slowly in clockwise direction.

e. If synchroscope pointer cannot be stopped at the 12 o'clock position, allow synchroscope to run slowly through several complete rotations before performing step f below.

CAUTION

Before paralleling generators, notify crew members NOT to make any electrical power changes such as turning any electrical motors on or off. Sudden power surges while paralleling may cause a reverse power situation on one generator and may damage that generator.

f. Quickly and forcibly engage new generator circuit breaker (P1, P2, P3) (Figure 2-14) as synchroscope pointer is stopped at 12 o'clock position or as it slowly passes through 11 o'clock position on synchroscope dial.

NOTE

If Incoming generator does not electrically match switchboard bus powered by online generator, circuit breaker will forcibly bounce back to open. When this happens, return to procedures In step 2-14b and try again.

g. Turn SYNCHROSCOPE off by turning INCOMING GENERATOR switch to OFF (Figure 2-14).

CAUTION

Reverse power can occur when two generators are running In parallel. A generator may not accept a load, usually because Its unloaded running speed Is less than the other generator (called speed droop). The other generator will motorize, or reverse power, the drooping generator. This situation creates an undue load on the powering generator and may damage the reverse powered generator.

h. Transfer load from offgoing generator to oncoming generator by using AUTOMATIC VOLTAGE CONTROL RHEOSTAT controls (Figure 2-11). Simultaneously increase load on oncoming generator by turning control clockwise and decrease load of offgoing generator by turning control counter clockwise.

i. Once offgoing generator load has been reduced to a minimum, open that generator's circuit breaker connecting it to switchboard bus.

2-14.1 Correcting reverse power situation. If reverse power situation develops, reverse power indicator **light** for that generator comes on and a safety relay immediately shuts down that generator.

a. Immediately go through shutdown procedures, paragraph 2-17, for generator set that has been shut down by safety relay.

b. Allow loaded generator about 10 seconds to stabilize.

c. Adjust generator voltage to 450 V, if necessary, by using AUTOMATIC VOLTAGE CONTROL RHEOSTAT control (Figure 2-11).

d. Adjust generator frequency to 60 Hz, if necessary, by using GOVERNOR SPEED CONTROL switch.

e. Start the shutdown generator by following procedures in paragraphs 2-11 and 2-13.

f. Parallel generators according to paragraph 2-14 and try load transfer again.

2-15. Operating procedures using shore power. Shore power, if available from an onshore power source or another vessel, is connected to shore power receptacle on aft weather deck bulkhead port side.

a. Verify that shore power is 440 Vac, 60 Hz, 3 ph. If power does not match this requirement, switchboard circuit breaker P4 (Figure 2-15), connecting shore power to switchboard bus, will not close.
b. Verify that all loading circuit breakers (Figure 2-12 or 2-13) on switchboard are open (OFF). Electrically, a dead ship condition must exist prior to engaging shore power circuit breaker.
c. Verify that switchboard circuit breakers for generators (P1 for SSG 1, P2 for SSG 2, and P3 for SAG) (Figure 2-14) are open (OFF).
d. On switchboard panel, dose (ON) circuit breaker P4 (Figure 2-15).
e. Apply load as required by dosing circuit breakers on switchboard panel.

2-16. Operating other electrical panels and controls. Electrical panels and controls, other than those on the switchboard, are self-explanatory and labels show their function. Instructions on when to use these controls are included in chapters covering the affected systems.

CAUTION

Circuit breakers on electrical panels should not be used as switches. All electrical devices onboard have switches, control boxes, and or starters that provide normal control. Circuit breakers should be used only when safety requirements dictate that a circuit be totally Inactive or when that system Is being placed In storage.

2-17. Normal shutdown procedures from switchboard. Procedures for shutting down these generator sets from the engine locations are in paragraph 4-14 for SSG's and 5-14 for SAG.

a. Offload generator either by paralleling and transferring bad to another generator or by opening all switchboard circuit breakers. When this has been completed, check that generator has stabilized.

b. Open (OFF) appropriate switchboard circuit breaker (Figure 2-14) connecting that generator to switchboard bus:

P1 for SSG 1

P2 for SSG 2

P3 for SAG

c. Turn VOLTAGE REGULATOR IDLE/RUN switch (Figure 2-11) to IDLE.

d. Allow engine to idle for 5 minutes to cool.

e. Turn ENGINE CONTROL SWITCH (Figure 2-10) to STOR

2-18. Emergency shutdown

2-18.1 General The barge has two emergency shutdown modes. One mode shuts down individual systems such as the ventilation system or a diesel HP pump, and the other shuts down all barge operating systems.

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

Seven red system shutdown buttons are located on ROWPU space starboard bulkhead just aft of the personnel door. These system shutdown buttons (Figure 2-16) control shore power, ventilation systems, .ROWPU 1 diesel HP pump, ROWPU 2 diesel HP pump, SAG, SSG 2, and SSG 1.

Six red total shutdown buttons are located as follows:

- On ROWPU space starboard bulkhead aft of personnel door, above and forward of row of system shutdown buttons.
- Outside ROWPU space starboard door on weatherdeck.
- Outside ROWPU space port door on weatherdeck.
- Inside ROWPU space port door to weatherdeck.
- Outside dayroom door to weatherdeck.
- Inside dayroom door to weatherdeck

2-18.2 Emergency shutdown procedures

a. In an emergency, push the appropriate red button to shut down either a selected system or all operating systems.
b. When emergency situation has been corrected, reset emergency button by turning collar behind button one-quarter turn clockwise. Button will pop out and again be in the ready position.
c. When emergency button is reset, any systems turned off by that emergency button must be restarted with their individual controls.

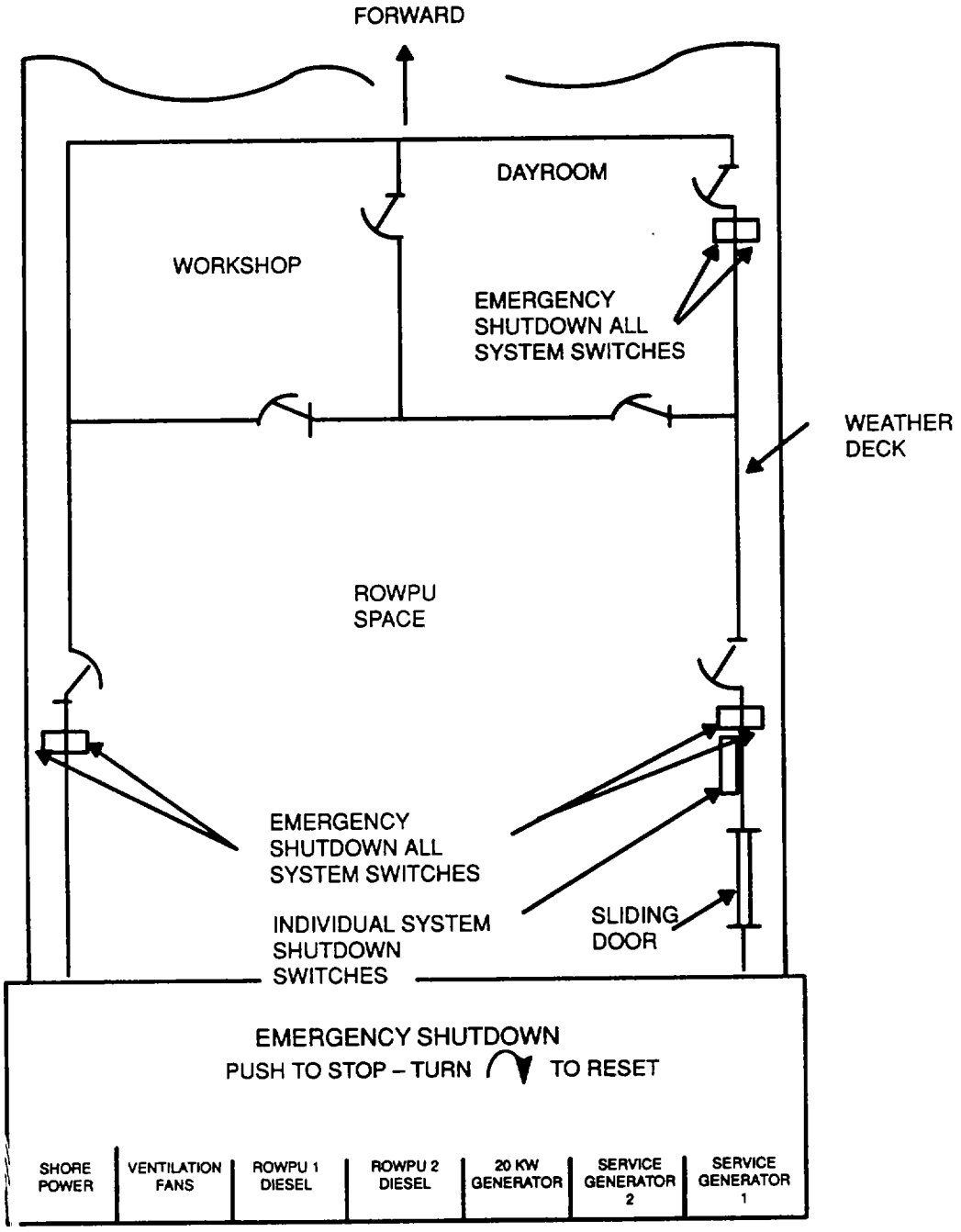


Figure 2-16. Location of Controls for Emergency Shutdown Systems

2-18.3 Electrical power emergency shutdown procedures

a. If abnormal condition threatens injury to people or damage to equipment, push the nearest emergency shutdown button to stop appropriate system or all systems onboard.

NOTE

When one of the six total shutdown buttons Is pushed, solenoids shut down all generators and all electrically powered equipment except that powered by the emergency electrical system.

Loss of power to Inverter will activate the emergency power system which operates with power from the battery bank.

b. Set generator ENGINE CONTROL SWITCH (Figure 2-11) to OFF
c. When emergency situation has been corrected, reset emergency button by turning collar behind button one-quarter turn clockwise. Button will pop out and again be in the ready position.
d. Start normal power system by following procedures in paragraphs 2-11 and 2-13.

2-19. Operation under extreme conditions

2-19.1 General. Information pertaining to generator set operation under extreme conditions of temperature and humidity are provided in paragraph 4-15 for SSG's and 5-15 for SAG. Information pertaining to switchboard and distribution panels are discussed below.

2-19.2 Extreme humidity. Switchboard and distribution panels are not affected by temperature extremes but are susceptible to excess humidity. Primary problems are corrosion on electrical contacts and condensation in gauges.

a. Corrosion is controlled by decreasing intervals between scheduled maintenance cleaning.

b. Condensation in gauges may be eliminated by applying low level heat for several hours to the gauge. To avoid any moisture damage, this should be done as soon as any condensation becomes noticeable.

SECTION IV. Maintenance Instructions

2-20. General

2-20.1 Maintenance concept

2-20.1.1 Unit level and Intermediate Direct Support and Intermediate General Support (IDS/IGS) maintenance on the normal electrical system is performed onboard by barge crew members whenever possible.

2-20.1.2 Any IDS/IGS maintenance beyond capability of crew members is provided by a shore-based area support maintenance unit. This unit also determines if depot support maintenance is required.

2-20.1.3 Intermediate support maintenance is accomplished by replacement of components or major end items.

2-20.1.4 Unless other intermediate support maintenance procedures are directed, IDS/IGS maintenance is normally provided by an Army Transportation Corps floating craft intermediate support maintenance unit serving the terminal operating area. Components to be disposed of are processed by this unit.

2-20.1.5 Maintenance Allocation Chart (MAC) is in TM 55-193G-209-14 & P-18. For maintenance on other equipment onboard, consult appropriate manual.

2-20.2 Maintenance procedures- Maintenance instructions are contained in the following paragraphs: paragraph 2-21, Preventive maintenance checks and services; paragraph 2-22, Troubleshooting; and paragraph 2-23, Maintenance procedures.

2-21. Preventive maintenance checks and services. See TM 55-1930-209-14&P-9-1, Appendix C for preventive maintenance checks and services for the electrical power system. See TM 55-1930-209-14&P-1 9 for complete preventive maintenance checks and services for all ROWPU Barge Systems.

2-22. Troubleshooting. This should be accomplished by following stepson page 13, Section 3: Trouble Shooting Guide, Electric Power Controls Operation Manual, in Appendix B.

2-23. Maintenance procedures. These are general maintenance procedures for components of this system. Detailed repair and maintenance procedures are in manufacturers' manuals in Appendix Bi which is bound in a separate companion volume.

WARNING

Make sure all electrical components are electrically dead before starting any cleaning or Inspection procedures. Circuit breakers must be open (OFF) and appropriately tagged to preclude accidental activation during these procedures.

2-23.1 Cleaning

a. In cleaning electrical equipment, avoid damaging insulation, mounting system, and hardware, or impairing electrical properties of item being cleaned.

b. Vacuum internal portions of switchboard, power panels, electrical controllers, inverters, battery chargers, and receptacles. Vacuum grit, iron dust, and copper particles from enclosed areas.

c. Wipe dirt from external surfaces of electrical equipment with dry cheesecloth or, if necessary, with a damp, soapy cloth.

d. Avoid use of solvents for cleaning internal portions of electrical system. Solvents often leave a greasy film on components that may reduce electrical conductivity.

e. Clean circuit breakers, contacts, and relays with fine sandpaper to remove black discoloration. Do NOT use emery paper or emery cloth to dean these contacts. Clean arc chutes on circuit breakers with a fine file. Vacuum to remove residue.

f. Electrical contacts may be cleaned with silver polish, fine sandpaper, or a burnishing tool. Do NOT use emery paper or steel wool. Vacuum to remove residue.

2-23.2 Inspection. Inspect by feeling with the hands and carefully observing conditions of all hardware, cabling mountings, and hangers. Tighten and/or replace components as necessary.

a. Inspect each cable as it leaves switchboard. Check fastenings as they exit switchboard and all fasteners, mounting hardware, and hangers to make sure they are tight.

b. Check each cable on both sides of its passage through bulkheads. Check that cables and/or electrical conduit are tight, not rubbing or chafing cables, and free of corrosion and dirt. Conduct same inspection of cables as they pass through decks and other structural parts of barge.

c. Check each cable at its destination to make sure it is firmly attached, not rubbing or chafing, and free of corrosion and dirt.

SECTION V. Storage

2-24. Short-term storage. If barge is to be taken out of service for more than 7 days but less than 30 days, and normal electrical system will not be used while in storage, perform the following:

a On SSG's, follow storage procedures provided in paragraph 420.

b. On SAG, follow storage procedures provided in paragraph 520.

c. On switchboard and remaining components, perform cleaning and inspection detailed in paragraph 2-23.

2-25. Administrative storage. if barge is taken out of service for more than 30 days but less than 6 months, barge remains a unit responsibility and shall be maintained by unit personnel.

2-25.1 Administrative storage procedures. If placed in administrative storage, perform the following:

a. On SSG's, follow storage procedures provided in paragraph 4-21.

b. On SAG, follow storage procedures provided in paragraph 5-21.

c. On switchboard and remaining components, perform cleaning and inspection as detailed in paragraph 2-23.

2-26. Long-term storage. If barge is to be taken out of service for 6 months or more, turn it in to depot for preparation and placement into long-term storage. If barge is in administrative storage and is to be taken out of service and placed in depot long-term storage (6 months or more), check normal electrical power system components for normal operation before releasing to depot.

CHAPTER 3 EMERGENCY ELECTRICAL SYSTEM

SECTION I. Description and data

3-1. Description

3-1.1 The emergency electrical system provides a limited amount of 120 Vac and 24 Vdc power for selected essential lighting and power requirements.

3-1.2 This system's central unit is a battery bank on the deckhouse top that is maintained at full charge by a battery charger in the workshop. The charger receives its power from the normal electrical system.

3-1.3 When normal power is disrupted, the battery bank provides 24 Vdc to an inverter. The inverter converts this power to 120 Vac, which is supplied to the 120 Vac emergency lighting panel. In addition, this battery bank provides continuous 24 Vdc power directly to a DC power panel.

3-1.4 Components of this system are listed in Table 3-1 and shown in drawings referenced in Appendix A. Schematic of the system's operations is shown in Figure 3-1.

3-2. Capabilities. This system automatically provides 120 Vac power for emergency lighting in the ROWPU space and voids and 24 Vdc power for direct current equipment.

3-3. Special limitations. The battery bank, under optimum conditions, provides only 305 ampere hours of electrical power. This equates to about 5 hours of operating lights and equipment connected to the 120 Vac emergency lighting panel and/or very limited use of equipment powered from the 24 Vdc power panel.

3-4. Performance characteristics

a.	Battery charger	
	AC input	120 Vac
	DC output	24 Vdc
	b. Inverter power	
	DC input	24 Vdc
	AC output	115 Vac
c.	Battery	
	Volts	6
	Ampere hours	305
	Quantity	4
d.	Battery bank	
	Volts	24 Vdc
	Number of banks	1
	Ampere hour per bank	305
	Total ampere hours	305

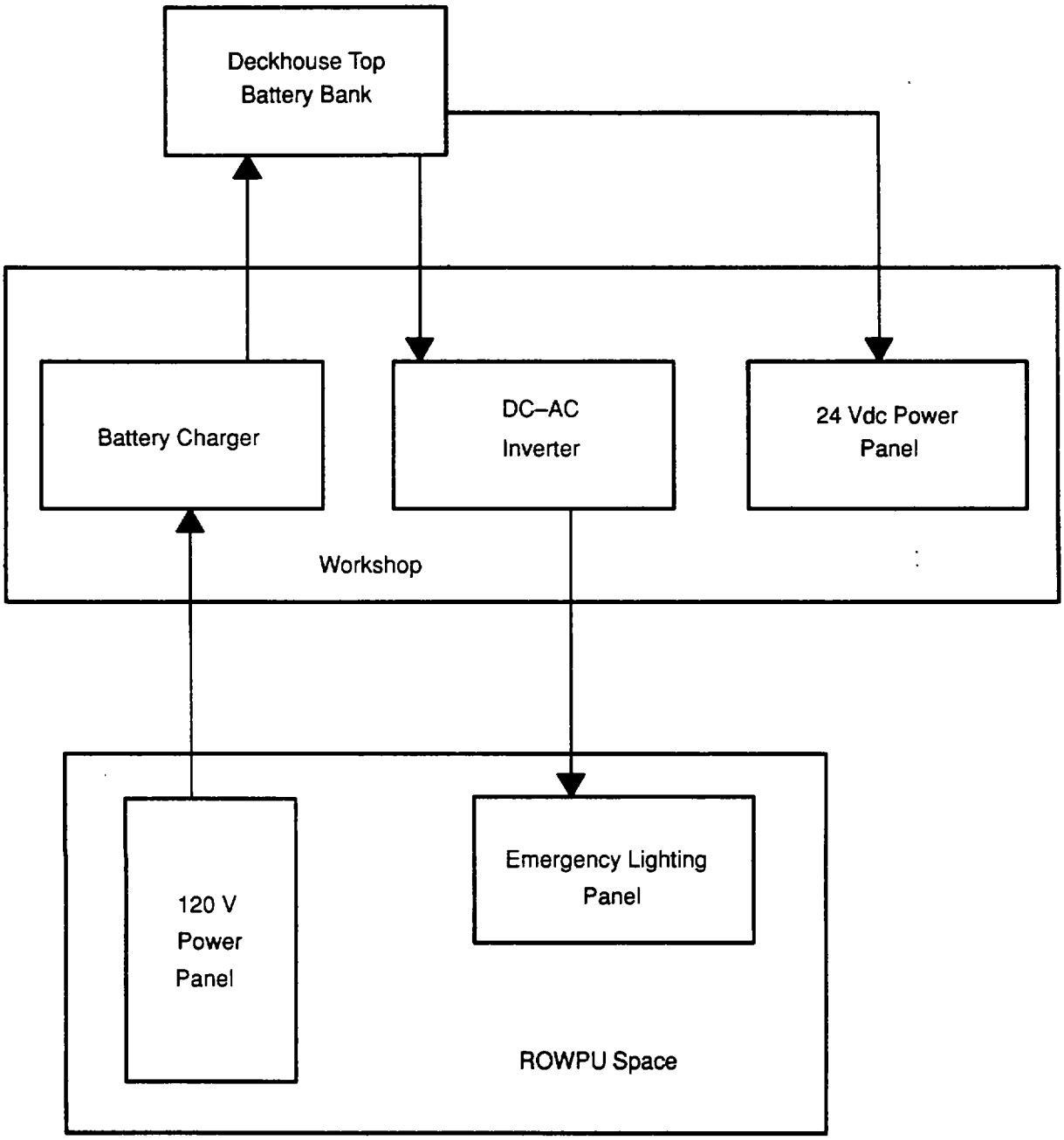


Figure 3-1. Emergency Electrical System Diagram

l.	4PST relay	
	Manufacturer	Newark Electronics
	CAGEC	1 F954
	Part no.	10F7866
	Coil	120V
	Rating	259 V/25 A
	Quantity	1
m.	Fuse	
	Manufacturer	Newark Electronics
	CAGEC	1 F954
	Part no.	28F265
	Type	FRN, dual element
	Rating	250 V/20 A
	Quantity	2

3-6. Items furnished

3-6.1 Emergency electrical system components are listed on the parts list of drawings listed in Appendix A and in the Components of End Item List in TM 55-1930-209-14 & P-20.

3-6.2 Common and bulk items onboard are listed in the Expendable Supplies and Materials List in TM 55-1930-209-14 & P-20.

3-6.3 Repair parts and special tools onboard are listed in the Repair Parts and Special Tools List in TM 55-1930-209-14 & P-1 8.

3-7. Items required but not furnished. All required items are furnished.

3-8. Tools and test equipment. Use existing tools and equipment. A complete list of tools and test equipment onboard is in the Tools and Test Equipment List in TM 55-1930-209-14 & P-1 8.

SECTION II. Description of operation

3-9. Description of operation

3-9.1 Normal operations. During normal operating conditions, when electrical power is available from either onboard generators or shore power, circuit breaker 4P1 3 on power panel 3 (120 Vac) (Figure 2-5) provides power to the battery charger. Charger, located in workshop, keeps battery bank on deckhouse top at full charge. Circuit breaker 1 OPI 3, using normal power, provides a holding voltage to one side of inverter to keep inverter inoperative in normal operating mode. This circuit breaker also provides 120 Vac to emergency lighting panel. During normal operations, the battery bank provides 24 Vdc to the other side of inverter. It also provides 24 Vdc to DC power panel for operating army radio, telephone system, bilge alarm module, emergency shutdown system, and navigation and status lights.

3-9.2 Emergency operations. When normal electrical sources fail (or when circuit breaker 1OP13 is open), holding voltage on output side of inverter drops out. Inverter becomes active with 24 Vdc coming from battery bank and 120 Vac going to emergency lighting panel. This panel provides power to fluorescent lights in deckhouse and voids, marine radio, and telephone station buzzers. Battery bank continues to supply 24 Vdc electricity to DC panel in workshop for operating circuits listed in paragraph above. If battery bank is at full charge, it provides emergency electricity, depending upon power load, for about 5 hours.

3-9.3 Restoration of normal source of electricity. When normal power is restored, 120 Vac electricity flows to output side of inverter. Inverter ceases to operate, and 120 Vac, from normal power source, provides power directs b to emergency lighting panel. The 120 Vac also flows to battery charger, which recharges battery bank Battery bank continues to provide 24 Vdc to DC power panel.

SECTION III. Operating Instructions

3-10. Operating controls and Indicators

a. The 24 Vdc power panel in workshop contains eight circuit breakers and one used circuit (Figure 3-2).

b. Emergency lighting panel, in ROWPU space on forward bulkhead, contains eight circuit breakers (Figure 3-3).

c. Battery charger in workshop (Figure 3-4) has HIGHFFLOAT switch on panel. HIGH setting activates fast charging circuit in charger. FLOAT setting activates slower charging circuit than HIGH setting and maintains charge in battery at all times. FLOAT is normal setting. When activating system after a shutdown of more than 3 days, set on HIGH for not more than 24 hours.

d. Battery charger panel displays a DC ammeter and DC voltmeter (Figure 3-4) that indicate charging rate and battery status.

e. Battery charger panel has ON/OFF switch that turns charger on or off.

f. Battery charger panel has RESET button. When pressed it resets internal Circuit breakers on AC input and DC output circuits. Prior to resetting, troubleshoot emergency system to determine why circuit breakers were tripped.

g. Inverter in workshop has ON/OFF switch that turns inverter on or off.

3-11. Prestart checks. Before energizing emergency electrical system, perform following before operation preventive maintenance services:

WARNING

Fumes from batteries may be flammable and explosive. Do NOT smoke or have open flame when checking or working on battery bank.

WARNING

Battery electrolyte presents potential health hazards. Contact with eyes and skin should be avoided. Safety glasses, gloves, and rubber aprons must be worn when handling this chemical. Electrolyte contains sulfuric add, which can cause severe bums, and Is highly toxic to skin, eyes, and respiratory system.

a. Check batteries (Figure 3-5) for proper electrolyte level. Add distilled water or dean water to bring level above the plates.

b. Check that battery bank is secure and that electrical cable fittings are tight and coated with anti corrosion grease. Correct as necessary.

c. Check major components (inverter, battery charger, battery bank 120 Vac emergency panel, and DC panel) for damage and loose fittings or wires. Correct as necessary.

d. Clean major components as necessary.

e. Make sure that inverter switch is OFF.

f. Make sure all circuit breakers on 120 Vac emergency panel and 24 Vdc panel are open.

Table 3-1. Major Components of Emergency Electrical System

Component	Location	Function
24 Vdc battery charger	Workshop	Keeps battery bank charged
DC-AC standby inverter	Workshop	Converts 24 Vdc from batteries to 115 Vac for emergency lighting panel
Battery bank	Deckhouse top forward	Provides 24 Vdc to DC power panel and to input side of inverter
24 Vdc power panel	Workshop	Provides 24 Vdc power for Army radio and telephone system, foghorn, **bilge** alarm module, emergency shutdown system, and navigation and status lights
120 Vac emergency lighting panel	ROWPU space forward bulkhead	Provides power to emergency lights in deckhouse and voids, marine radio and telephone buzzer system

3-5. Equipment specifications

a. Battery charger

Manufacturer	LaMarche Manufacturing Co.
CAGEC	92731
Part no.	A33-60-24 V
AC input	120 V, single ph, 60 Hz
DC output	24 V, 60 amps
Quantity	1

b. DC to AC inverter

Manufacturer	LaMarche Manufacturing Co.
CAGEC	92731
Part no.	A51-1 .5K-24 V
Type	Manual
DC input	24 Vdc, 12.5 amps
AC output	115 Vac, 12.5 amps
Transfer relay	2 to 10 KVA 40 msec
Quantity	1

c. Battery

CAGEC	74309
Part no.	NS305
Type	Marine
Nominal voltage	6 V
Rate 2 capacity	305 amp/hrs
Quantity	4

d. 24 Vdc power panel

CAGEC	81349
Part no.	W3928/2-04-DP
Military specification	MIL-P-23928/2
Class	1
Rating	50 A, 120 Vac
Branches	8
Quantity	1

e. 120 Vac emergency lighting panel

CAGEC	81349
Part no.	M23928/2-WDP
Military specification	MIL-P-23928M
Class	2
Rating	50 A, 120 Vac
Branches	8
Quantity	1

f. Modular power supply

Manufacturer	Newark Electronics
CAGEC	1 F954
Part no.	05F1142
Rating	115 Vactl2 Vdc, 10 A
Quantity	1

g. Voltage suppressor

Manufacturer	RCA Corporation Solid State Division
CAGEC	02735
Part no.	SKMV250J/2V250
Rating	250 V. 10 A
Quantity	1

h. Safety switch

Manufacturer	Square D Co.
Electrical Products Division	
CAGEC	08556
Part no.	DU221 RB
Rating	250 V, 30 A
Quantity	1

i. Latching relay

Manufacturer	Newark Electronics
CAGEC	1 F954
Part no.	60F3112
Rating	120 V10 A
Quantity	1

j. Emergency indicating lamp on switchboard

Manufacturer	Newark Electronics
CAGEC	1 F954
Part no.	35F2806
Type	Slide base
Rating	120 V
Lens:	
Part no.	35F2790
Color	Blue
Quantity	1

k. Holding relay

Manufacturer	Newark Electronics
CAGEC	1F954
Part no.	56F971
Rating	120 V130 A
Quantity	2

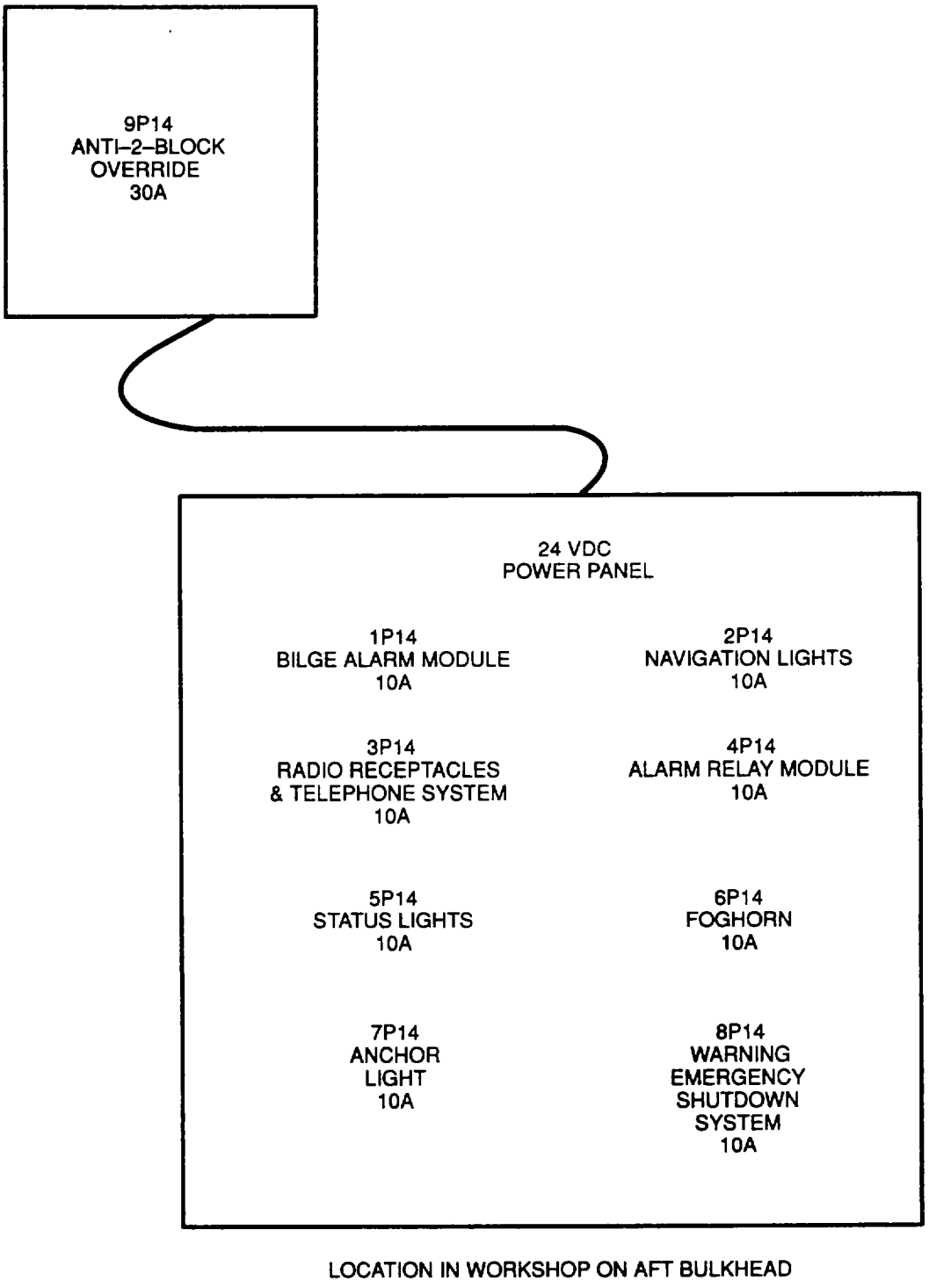


Figure 3-2. 24 Vdc Power Panel

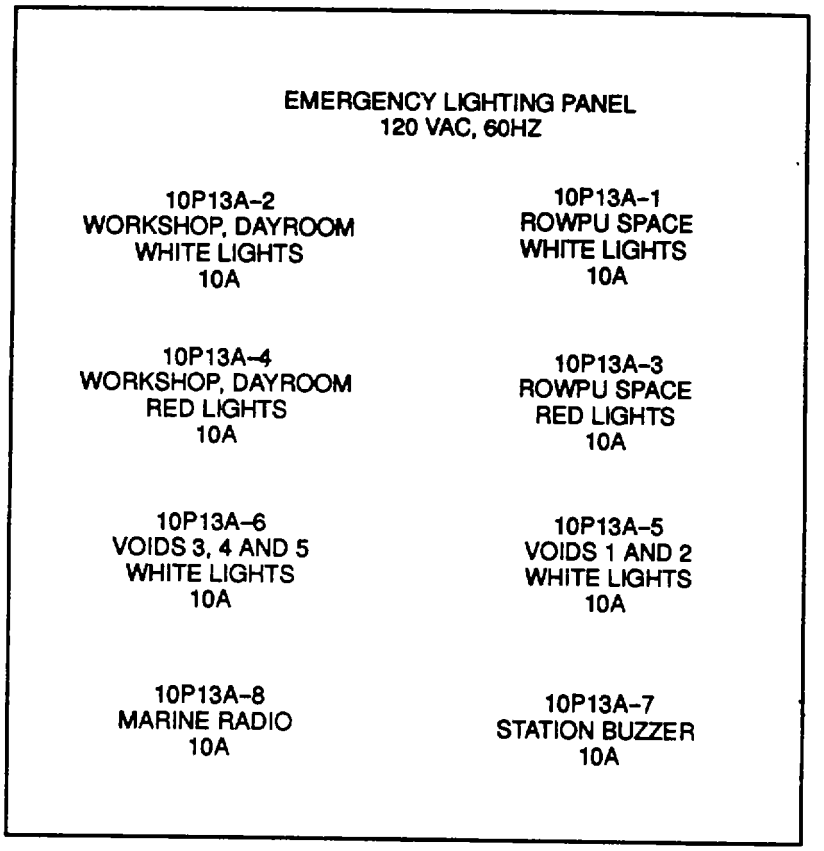


Figure 3-3. Emergency Lighting Panel

3-12. Normal operating procedures

a. Make sure switchboard circuit breaker P13 is closed (ON) to provide power to power panel 3 (120 Vac).

b. On power panel 3(120 Vac), dose (ON) fuse box 13P13 to provide power to battery charger.

c. On battery charger, set HIGHFLOAT switch in FLOAT position for normal charging or in HIGH position for rapid recharging of battery bank.

CAUTION

Do not allow battery charger to operate on HIGH warning for more than 24 hours.

d. On power panel 3(120 Vac), dose (ON) circuit breaker 1 OP13 to provide holding voltage to inverter and 120 Vac power to emergency lighting panel.

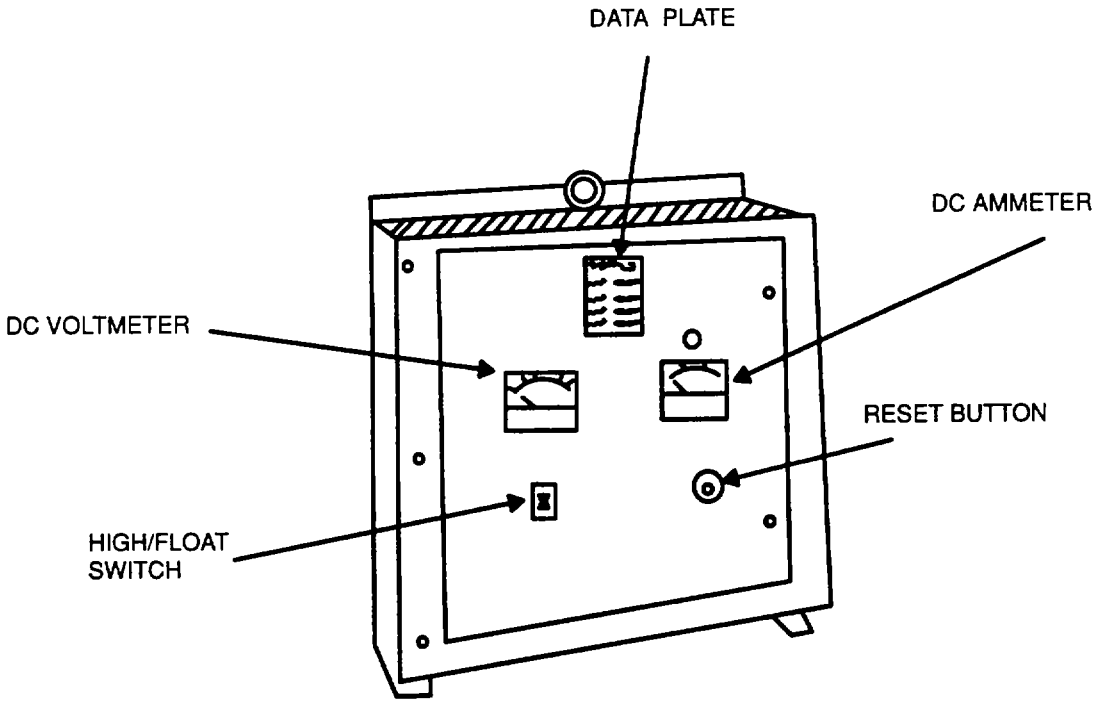
e. On inverter, move ON/OFF switch to ON position to place inverter in active standby.

f. On DC power panel in workshop, close appropriate circuit breakers and fused circuits as required for operations:

1 P14 Bilge alarm module
2P14 Navigation lights
3P14 Radio receptacles and telephone system
4Pl4 Alarm relay
5P14 Status lights
6P14 Fog horn
7P14 Anchor light
8P1 4 Warning emergency shutdown system
9P1 4A Anti 2-block override

NOTE

DC power panel circuit breaker 8P14 must be closed prior to starting any diesel engines onboard. If not closed, solenoids In emergency shutdown system cut off fuel to diesels. Engine will start and run for a few minutes until lack of fuel shuts It off.



Receives power from 120 Vac Power Panel In ROWPU space and charges battery In battery box on port forward comer of deckhouse top.

Figure 3-4. Battery Charger

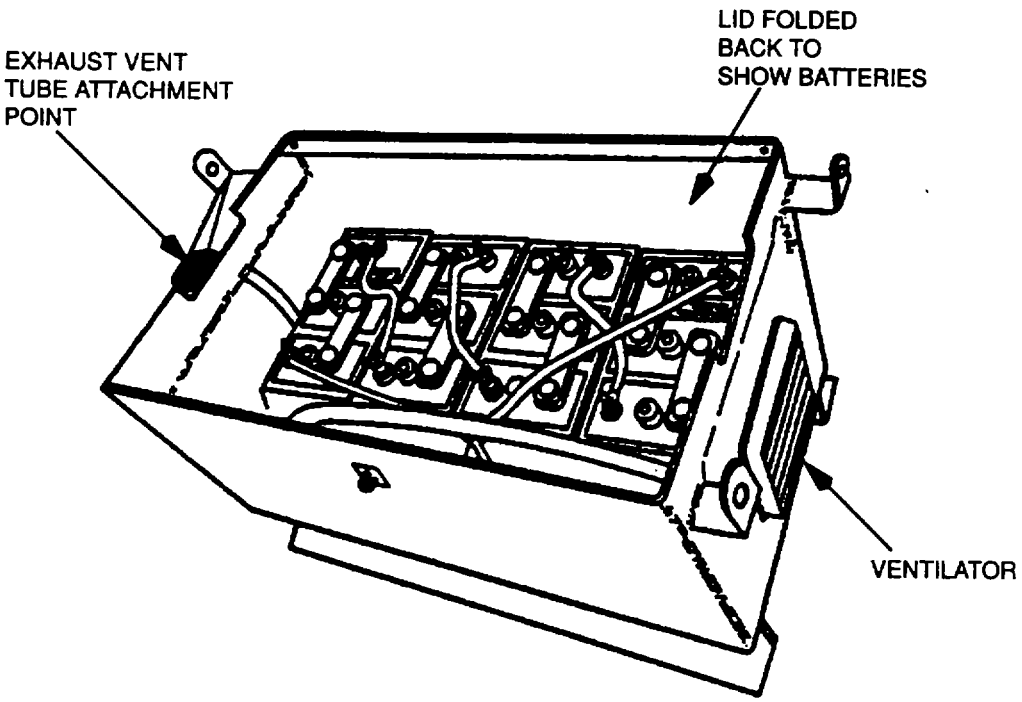


Figure 3-5. Battery Bank

3-13. Emergency operating procedures. When normal power fails, 120 Vac power being supplied through circuit breaker 1 OP13 to the inverter is cut off. The inverter draws power from the battery bank, converts it o 120 Vac, and supplies it to the emergency power panel.

a. Check circuit breakers 10P13A-1 thru 10P13A6 on 120 V emergency lighting panel on ROWPU space forward bulkhead. Open (OFF) any of them not required for emergency lighting. These circuit breakers normally remain closed so that emergency lights are activated immediately when normal lighting is cut off. Make sure that 10P13A-7 and A8 for telephone system buzzers and VHF marine radio are closed (ON).

b. While operating on emergency power, turn off any unnecessary power usage.

NOTE

Workshop Items drawing power from 24 Vdc panel are not Immediately affected by changing from normal to emergency power. If not turned off, however, they will deplete the limited supply of electrical power available from the battery bank.

c. While operating on emergency power, check system to make sure It Is operating property. Inverter may become warm to touch with the open hand but should not become hot.

3-14. Return to normal power source. When normal power becomes available, holding voltage will be returned to one side of inverter Inverter reverts to active standby and normal 120 Vac is again supplied to emergency lighting panel. The 24 Vdc being supplied from the battery bank to the DC panel in the workshop continues without change.

a. Check battery charger instruments to verify that battery bank is being recharged.

b. Check that marine radio and telephone station buzzer system are working properly.

3-15. Shutdown procedures

3-15.1 Normal shutdown procedures. When all electrical power is to be terminated and emergency system is not needed, shut down as follows:

a. On DC panel, open (ON) circuit breakers 10P14 thru 8P14 and fused circuit 9P14A.

b. On emergency lighting panel, verify that circuit breakers 10P1 3A-1 thru 10P1 3A-8 are open (OFF).

c. On inverter, turn ON/OFF switch to OFF.

d. On battery charger, turn to OFF.

e. On power panel 3 (120 Vac) open circuit breaker 1 OP1 3.

WARNING

Fumes from battery electrolyte may be flammable and explosive. Do NOT smoke or have open flames when checking electrolyte or working on batteries.

f. Check batteries in battery bank and make sure electrolyte is above plates in each cell of each battery.

g. Clean all major components of system. See maintenance procedures in paragraph 2-23.1.

3-15.2 Emergency shutdown procedures. Operating either system shutdown or total shutdown buttons does not affect the emergency power system.

3-16. Operation under extreme conditions. Extreme temperatures may have an adverse impact on the battery bank Since it is on the deckhouse top, battery bank is exposed to high dimatic temperatures. This exposure increases evaporation of electrolyte from batteries and requires more frequent checks of electrolyte level and specific gravity.

WARNING

Fumes from battery electrolyte may be flammable and explosive. Do NOT smoke or use open flames when checking electrolyte or working on batteries.

a. Check electrolyte levels daily and make sure it covers plates in each cell of all batteries.

WARNING

Electrolyte presents potential health hazards. Contact with eyes and skin should be avoided. Safety glasses, gloves, and rubber aprons must be worn when handling this material. Electrolyte contains sulfuric add, can cause severe bums, and Is highly toxic to eyes, skin, and respiratory system.

b. Check electrolyte specific gravity weekly. Constant evaporation and adding of water may dilute electrolyte and require complete replacement of electrolyte periodically to rejuvenate a battery.

SECTION IV. Maintenance Instructions

3-17. General

3-17.1 Maintenance concept

3-17.1.1 Unit level and IDS/IGS maintenance on the emergency elect system is performed onboard by barge crew member whenever possible.

3-17.1.2 Any IDSPIGS maintenance beyond the capability of crew members is provided by a shore-based area support maintenance unit. This unit also determines if depot support maintenance is required.

3-17.1.3 Intermediate support maintenance is accomplished by replacement of components or major end items.

3-17.1.4 Unless other intermediate support maintenance procedures are directed, IDS/IGS maintenance is normally provided by an Army Transportation Corps floating craft intermediate support maintenance unit serving the terminal operating area. Components to be disposed of are processed by this unit.

3-17.1.5 Maintenance Allocation Chart (MAC) is in TM 55-1930-209-14 & P-18. For maintenance on other equipment onboard, consult appropriate manual.

3-17.2 Maintenance procedures. Maintenance instructions are contained in the paragraphs that follow: paragraph 3-18, Preventive maintenance checks and services; paragraph 3-19, Troubleshooting; and paragraph 3-20, Maintenance procedures.

3-18. Preventive maintenance checks and services. See TM 55-1930-209-14&P-9-1, Appendix C for preventive maintenance checks and services for the electrical power system. See TM 55-1930209-1 4&P-1 9 for complete preventive maintenance checks and services for all ROWPU Barge Systems.

3-19. Troubleshooting. Perform troubleshooting procedures as contained in manufacturers' service manuals/instructions.

3-20. Maintenance procedures. These include general maintenance procedures for components of the emergency electrical system. Detailed repair and maintenance procedures are in manufacturers' manuals provided in Appendix B, which is bound in a separate cover.

WARNING

Make sure all elements of emergency electrical power system are electrically dead before starting any cleaning and/or maintenance procedures Circuit breakers must be off and labeled to prevent accidental activation while cleaning and maintenance Is being performed.

3-20.1 Cleaning. Follow procedures in paragraph 2-23.1.

3-20.2 Inspection. Feel with hands and carefully observe condition of all hardware and cabling mountings and hangers. Tighten and/or replace components as necessary.

a. Starting from power panel 3 circuit breaker 10P13, inspect each cable as it leaves the panel. Check fastenings as they exit switchboard and all fasteners, mounting hardware, and hangers to make sure they are tight. Inspect by feeling with hands.

b. Check each cable on both sides of its passage through bulkheads. Check that cables and/or electrical conduit are tight, not rubbing or chafing, and free of corrosion and dirt Conduct same ins-on of cables as they pass through decks and other structural parts of barge.

c. Check each cable at its destination to make sure it is firmly attached, not rubbing or chafing, and free of corrosion and dirt.

SECTION V. Storage

3-21. Short-term storage. If barge is to be taken out of service for more than 7 days but less than 30 days, and emergency electrical power system is not used while in storage, follow shutdown procedures in paragraph 3-15.

3-22. Administrative storage. If barge is taken out of service for more than 30 days but less than 6 months, barge remains a unit responsibility and shall be maintained by unit personnel.

3-22.1 Administrative storage procedures. When placed in administrative storage and emergency electrical system is not in use, process system for administrative storage as specified in the following:

a. Perform periodic inspections and services.

b. Shut down emergency electrical system by following procedures in paragraph 3-15.

3-23. Long-term storage. If barge is to be taken out of service for 6 months or more, turn it in to depot for preparation and placement into long-term storage. If barge is in administrative storage and is to be taken out of service and placed in depot long-term storage (6 months or more), check emergency electrical system components for normal operation before releasing to depot.

CHAPTER 4 155 KW SHIP SERVICE GENERATORS

4-1. Description. Two diesel powered generator sets, each rated at 155 kW, serve as primary electrical power sources for the barge. When shore power is not used, one SSG must be online when any of the ROWPU major systems are being operated. These SSG'S, number 1 in void 4 port and number 2 in void 4 starboard, are Caterpillar diesel engine driven generator sets. Each SSG consists of a Caterpillar 3306TA diesel engine and a Caterpillar Model SR4 generator mounted, with isolation isolators, on a common base. The set weighs 3960 pounds dry and 4180 pounds wet and is 118 inches long, 39 inches wide, and 59 inches high. The third generator set, rated at 20 kW, supplies power for the barge when ROWPU major systems are not operating and there is a lower demand for electrical power. Information on the SAG is in Chapter 5. Generator set installation and electrical hookups are shown on drawings listed in Appendix A.

4-1.1 3306TA diesel engine. This engine is a 6cylinder inline, 638-cubic inch displacement, four-stroke cycle diesel. Turbocharged and after cooled, it provides its maximum output at 1800 rpm. It has a 24 Vdc electric starter and battery bank. A battery charger mounted in the switchboard keeps the SSG batteries charged. A heat exchanger provides seawater cooling for both engine coolant and engine lubricating oil. Instrumentation includes an engine service meter calibrated in hours and protective cutoffs that activate in the event engine coolant temperature or oil pressure exceed maximum allowable limits.

4-1.2 SR4 generator. This generator has a revolving field and is statistically regulated with a rotating brushless exciter. It has no brushes or commutator and uses a solid-state automatic voltage regulator. For a more detailed technical description, refer to manufacturers' manuals listed in Section VI of this chapter.

4-2. Capabilities. Either SSG is capable of providing all electrical power for barge operations. For load transfer purposes only, SSG's can be operated in parallel with each other or either one can be operated in parallel with the auxiliary generator. With full barge fuel tanks, the SSG's can operate nonstop for 7 days. The supply of other consumables used by the electrical power system, such as lubricating oil, will last 30 days.

4-3. Special limitations

4-3.1 The SSG's consume fuel at about 12.7 gph at 100 percent of power at 1l80 rpm and as low as 4.2 gph at25 percent of power at the same rpm.

4-3.2 SSG's will not operate in parallel with an external power source.

4-3.3 SSG's are designed to operate at ambient temperatures of -22 to 1 220F

4-4. Performance characteristics. The voltage level can be adjusted within ±5 percent of rated voltage. Voltage droop is adjustable for proper division of reactive kVA when operating in parallel with other generators. Voltage gain is adjustable to compensate for engine speed variation when operating with a speed droop governor. Full load rpm is 1800; low idle is 1200 rpm. Electrical output characteristics at an 0.8 power factor are listed below:

kW	155
kVA 1	93.75
Voltage	440 Vac
Current	255 amps
Phase	3
Hertz	60

4-5. Equipment specifications. Engine and generator specifications are outlined in paragraphs 4-5.1 and 4-5.2. Additional information is in manufacturers' manuals provided in Appendix B.

4-5.1 3306TA diesel engine data

Manufacturer	Caterpillar Tractor Company
CAGEC	OE281
Supplier	Carter Machinery Co., Inc.
CAGEC	1EX21
Part no.	3306TA
Arrangement	1 W3818
Type	Turbocharged, after cooled
Engine weight	2,470 lb dry
Dimensions	
External	57.5 in x 46.8 in x 36.8 in
Internal Bore	4.75 in
Stroke	6.00 in
Displacement	633 cu in
Capacity for liquids:	
Cooling system	10.7 gal (U.S.)
Lube oil	7.3 gal (U.S.)

4-5.2 SR4 generator data

Manufacturer	Caterpillar Tractor Company
CAGEC	OE281
Supplier	Carter Machinery Co., Inc.
CAGEC	1EX21
Generator type	Brushless
Arrangement	3 ph, 10 wire, Y connection
Rating	Prime power, continuous electrical

4-6. Items furnished

4-6.1 Components installed as part of these SSG's are listed on the parts list in drawings referenced in Appendix A and in the Components of End Item List in TM 55-1930-209-14 & P-20.

4-6.2 Common and bulk items onboard are listed in the Expendable Supplies and Materials list in TM 55-1930-209-14& P-20.

4-6.3 Repair parts and special tools are listed in the Repair Parts and Special Tools Used in TM 55-1930-209-14 & P-18.

4-7. Items required but not furnished. All required items are furnished.

4-8. Tools and test equipment. Use existing tools and equipment. A complete list of tools and test equipment onboard is in the Tools and Test Equipment List in TM 55-1930-209-14 & P-20.

SECTION II. Description of operation

4-9. Description of operation. Normal electrical power for barge operations is supplied by one of the two SSG's. By transferring loads between generator sets, barge operations can continue without interruption. While any two of the three generators onboard can be operated in parallel, this procedure is for load transfer only and not for continuous operation. To transfer the electrical lead from one generator to another, start the unused generator. After warm up, parallel its load with the current loaded generator and transfer the load (paragraph 2-14). Run down, cool off, and shut down the now unused generator. This paralleling and transferring of electrical load can be done between the 20 kW auxiliary generator and either of the two SSG's or between SSG's.

4-9.1 Remote control and startup requirements. While the three generator sets are located in voids 4, they are normally operated from the switchboard in the ROWPU space. Normally, one of the first actions upon entering the barge is to start the auxiliary (20 kW) generator to provide power for barge housekeeping activities. This generator does not provide sufficient power to support operation of moor ROWPU components, however, so prior to starting a major ROWPU component, one of the SSG's must be brought online. Start an SSG, parallel it with the SAG, and transfer the load to the SSG. Then shut down the SAG.

SECTION III. Operating Instructions

4-10. Operating controls and indicators

4-10.1 330B A diesel engine

4-10.1.1 Controls for operating engine at the SSG

a. ENGINE CONTROL switch. This switch on SSG switchboard panel has START, REMOTE, and OFF/RESET positions. To start engine from switchboard, move ECS to START and engine will automatically crank and run. To start engine at the engine, move ECS on switchboard to REMOTE and use engine START/STOP switch on the engine. To stop engine from switchboard, move ECS to OFF/RESET.

b. VOLTAGE REGULATOR switch. Located on switchboard. IDLE position allows engine to run at low speed for warm-up and maintenance checks. RUN position allows engine to run at full speed of 1800 rpm. While set on IDLE, generator's circuit breaker connecting its power to the switchboard bus will not close.

c. ENGINE START/STOP switch. Located on engine. ENGINE CONTROL SWITCH on switchboard must be in REMOTE for this switch to start the engine. Push switch up to start engine. Push switch down to stop engine. When stopping engine, ENGINE CONTROL SWITCH may be in any position.

d. EMERGENCY STOP button. Located on engine. Push to stop engine. Resetting this button will start engine cranking and running unless ENGINE CONTROL SWITCH is set to OFF

e. Seawater valves control flow of cooling seawater to SSG 1 and SSG 2 to cool engine coolant and lubricating oil. These valves must be open for engines to operate.

(1) Seawater valve SW37. Located in void 4 port next to seawater strainer. When open, provides water from seawater strainer to manifold piping, which provides cooling seawater to all generators in voids 4.

(2) Seawater valve SW49. Located in void 4 starboard on starboard bulkhead. When open, provides outlet for used cooling water to flow overboard.

(3) SSG 1. Open SW valves SW38 and SW39 on side of engine.

(4) SSG 2. Open SW valves SW40 and SW41 on side of engine.*

• These SW valves have temperature gauges with each valve to indicate ingoing and outgoing water temperatures.

4-10.1.2 Engine indicators. Engine indicators are on switchboard SSG engine panel, with exception of the following which are on the engine: fuel pressure gauge indicator, oil dipstick, engine alternator ammeter, oil pressure gauge, service meter, coolant level indicator, and coolant temperature gauge.

a. Oil pressure gauge. Left-hand gauge on engine instrument panel indicates oil pressure in pounds per square inch (psi) on the bottom scale. Scale reads 0-10-30-50-70. When engine is new, its normal oil pressure indication is obtained by operating engine at normal temperature and maximum rpm. Mark this oil pressure reading on gauge rim to indicate normal operating range.

b. Oil dipstick Shows amount of oil in engine crankcase. Oil level must be between ADD and FULL marks on dipstick.

c. Fuel pressure gauge. Gauge is marked with red zone on the left, an overlapping red and green section in the middle and a green zone on the right. When fuel filter becomes clogged, needle will move to red zone. When needle indicates in the center section of red and green, primary fuel filter must be washed and secondary fuel filter element replaced.

d. Hour service meter. Located on end of governor, this device indicates number of hours engine has operated.

e. Water temperature gauge. Right-hand gauge on instrument panel indicates temperature of coolant circulating in engine block Bottom scale reads in degrees Fahrenheit from left to right (1 O0-140-180-200), and gauge is marked in red from 200 to right end of scale. A thermostat in dosed-circuit portion of system keeps coolant within designed limits.

f. Coolant filler cap. On top of coolant tank When removed, shows level of coolant in closed coolant portion of engine cooling system.

4-10.2 SR4 generator controls. SR4 generator controls are on the main switdhboard and are discussed in Chapter 2.

4-11. Prestart procedures

a. In ROWPU space, make sure EMS is operating by pushing up on monitor controller left of monitoring processor. If monitor does not come on, turn it on with switch beneath the screen. For more details on EMS, see TM 55-1930-209-14 & P-I1.

b. Check maintenance records to make sure all required maintenance checks and services have been completed.

c. In void 4, conduct walk-around inspection of generator set to detect visible deficiencies that, if not corrected, could become hazardous to people or equipment.

WARNINGS

At operating temperatures, engine coolant Is hot and under pressure. It also contains alkaline materials harmful to eyes and skin. To avoid personal Injury, check coolant level only when engine Is stopped and filler cap Is cool enough to be touched with a bare hand. Should engine coolant come In contact with eyes or skin, Immediately flush affected area with dean water and seek medical assistance If necessary.

CAUTION

Sensing element must be submerged In coolant to operate. If coolant Is low, engine can overheat and automatic shutoff will not function to prevent damage to engine.

d. When engine is cool, slowly open coolant tank filler cap. Check that engine coolant is not more than 112 inch below top of filler pipe. I it is, fill to required level with dean fresh water (low in scale-forming minerals but not softened water) and cooling system conditioner. Always add conditioner to water. Never use plain water. Conditioner should be 3 percent by volume of total coolant F - about 1/2 pint of conditioner per 2 gallons of water. If cap gasket is tom or damaged, repair or replace gasket.

e. Check that crankcase oil shows between ADD and FULL marks on dip stick If oil shows below ADD mark, add oil at oil fill, ;coated above oil dipstick on accessory end of engine. Oil must meet engine service classic CD (MIL-L-2104D) or CDfrO-2. Diesel engines onboard use 15W40 as standard crank case lubricant for normal temperatures. If temperatures in voids consistently exceed 1200F, use SAE 40.

f. Check that batteries are dean of corrosion, all cable connections tight and covered with anti-c n grease, and electrolyte covers plates.

g. Check that fuel pressure gauge indicates NORMAL. If gauge indicates CAUTION or OUT, wash primary fuel filter and replace secondary fuel filter element. (Refer to step 4-1 8.3a for details.)

h. Drain water and sediment from fuel water separator (it SSG is so equipped).

i. Check that engine has fuel oil (for further information on fuel oil system, see TM 55-1930-209-14 & P-8) by setting fuel oil valves as follows:

(1) For SSG1: Close fuel oil valves F013-FO15, FO17, Fo18, F20, 1021, F24-F27, and open fuel valves F016, F019, and F023.

(2) For SSG2: Close fuel oil valves F013-FO16, Fo18, F020,10)21,F0O23, F025-F027 and open Fo17, F019, and F024.

j. Check that 24 Vdc power panel in workshop is active (Chapter 3) and circuit breaker 8P1 4 is closed (ON). This action provides voltage to hold open solenoids in generator fuel lines. Emergency shutdown switches activate these shutoff solenoids by removing this 24 Vdc power. If 24 Vdc panel is not active and circuit breaker 8P1 4 is open (OFF), these holding solenoids are closed and fuel for these generators is shut off. The generator will start and run for about 2 minutes until lack of fuel shuts it off.

CAUTION

Turn off all emergency panel power users and all emergency lights when all power sources are turned off on barge. If not, DC battery bank will be drained of power. Without DC power to hold these fuel cutoff solenoids open, generators will not operate to recharge the 24 Vdc battery bank

k. Check that seawater is available for heat exchanger.

(1) Make sure both stern seawater strainer baskets are dean and operable. For details on servicing these strainers, see TM 55-1930-209-14 & P-2, Seawater System.

(2) Open seawater valves SW45 and SW46 in void 4 port to monitor pressure drop across strainers. If pressure difference during operation becomes greater than 8 in Hg, turn handle to direct water through other basket. Clean dirty basket (TM 55-1930-209-14 & P-2, Seawater System).

(3) Open seawater valve SW37 in void 4 port and SW49 in void 4 starboard.

(4) For SSG 1: Open seawater valves SW38 and SW39 in void 4 port.

(5) For SSG 2: Open seawater valves SW40 and SW41 in void 4 starboard.

l. On SR4 generator, if SSG has not run under load within last 3 months or SSG has been in storage, follow procedures provided on page 20, Caterpillar Operation and Maintenance Manual for SR4 and SRCR Generators, SEBU571 7-02.

4-12. Starting procedures at the engine

NOTE

Normally, SSG's are started at switchboard In ROWPU space. Starting these engines at the engines In voids 4 can be done when necessary, such as Initial starting after storage or after maintenance or repair. Following procedures are for starting SSG's, with no load, from engine locations In voids 4. For starting from switchboard In ROWPU space, see Chapter 2.

a. On switchboard control panel for starting SSG, set ENGINE CONTROL SWITCH to REMOTE.

b. On switchboard control panel for starting SSG, set VOLTAGE REGULATOR switch to IDLE.

c. On switchboard, check that GENERATOR circuit breaker (Pi or P2) for starting generator is OPEN.

d. On switchboard, set AMMETER SWITCH to ON.

WARNING

Ear protection must be worn In vWs 4 when generators are operating.

e. On starting SSG, push ENGINE START/STOP SWITCH up and hold until engine starts. Release switch when engine starts. Engine should start and operate at idling speed.

NOTE

If engine does not start within 30 seconds, release ENGINE START/STOP SWITCH. Wait 2 minutes for starter motor to cool. Then, try again. Release SWITCH when engine starts. I engine does not start after three attempts, troubleshoot by following procedures on page 53, Caterpillar Systems Operation Testing and Adjusting for 33048 & 3306B Generator Set Engines, Form No. SENR2797.

f. With engine idling, check that oil pressure gauge shows positive pressure. If not, stop engine. Troubleshoot according to paragraph 418 and correct problem.

g. With engine idling, check that fuel pressure gauge on engine is in normal (green) range.

h. With engine idling, check that coolant temperature gauge is registering. As engine warms up. gauge starts to move toward higher reading. Engine can be switched from IDLE to RUN and a load applied. Refer to Chapter 4.

i. On switchboard, set battery charger FLOAT/EQUALIZE switch to FLOAT.

j. On switchboard control panel for starting SSG, check that:

VOLTMETER reads 440 Vac

FREQUENCY METER reads 60 Hz

AMMETER reads 0.

4-13. Operating procedures. While engine is idling for 5 minutes, check operations as given in step 2-13c.

NOTE

See paragraph 2-12 for operation of generator set alarms and shutoffs.

4-14. Shutdown procedures

4-14.1 Shutdown procedures at engine. While SSG's are normally operated and shutdown from the switchboard, these procedures provide for shutting down SSG's at the engine from an idling no-load status.

a. Make sure all electrical loads have been transferred to other generator sets and applicable SSG circuit breaker (P1 for SSG1 or P2 for SSG 2) is open (OFF).

b. Operate engine at idle speed for 5 minutes.

c. At engine, push ENGINE START/STOP switch to STOP

4-14.2 Emergency shutdown. For operating total barge shutdown and system shutdown systems, see paragraph 2-17.2. For emergency shutdown of the SSG at the engine:

a. Push red EMERGENCY STOP button on side of generator housing.

b. Turn ENGINE START/STOP switch to STOR

c. Reset EMERGENCY STOP button by turning clockwise and pulling out.

d. Troubleshoot and correct problem requiring emergency shutdown.

4-15. Operation under extreme conditions

4-15.1 Temperature extremes. Ship service generator sets are designed to operate at ambient air temperatures of -22 F to 1 220F. Standard lubricating oil is SAE 1 5W40. SAE40 is used if temperatures in voids consistently exceed 120DR Additional information on lubricants for operating in extreme temperatures is provided in the manufacturer's manual.

4-15.2 High humidity. High humidity increases probability of fuel oil becoming contaminated with moisture. For details on combating this problem, see TM 55-1930-209-14 & P-8, Fuel Oil System.
Section IV. Maintenance instructions

4-16. General **SECTION IV.**

4-16.1 Maintenance concept

4-16.1.1 Unit level and IDS/IGS maintenance on the SSG's is performed onboard by barge crew member whenever possible.

4-16.1.2 Any IDS/IGS maintenance beyond the capability of crew member is provided by a shore-based area support maintenance unit. This unit also determines if depot support maintenance is required.

4-16.1.3 Intermediate support maintenance is accomplished by replacement of components or major end items.

4-16.1.4 Unless other intermediate support maintenance procedures are directed, IDSAGS maintenance is normally provided by an Army Transportation Corps floating craft intermediate support maintenance unit serving terminal operating area. Components to be disposed of are processed by this unit.

4-16.15 Maintenance Allocation Chart (MAC) is in TM 55-1930-209-14 & P-1 8. For maintenance on other systems onboard, consult appropriate manual.

4-16.2 Maintenance procedures. Maintenance instructions are contained in the following paragraphs: Appendix C, Preventive maintenance checks and services; paragraph 4-18, Troubleshooting; and paragraph 4-19, Maintenance procedures.

4-17. Preventive maintenance checks and services. See TM 55-1930-209-14&P-9-1, Appendix C for preventive maintenance checks and services for the electrical power system. See TM 55-1930-209-1 4&P-1 9 for complete preventive maintenance checks and services for all ROWPU Barge Systems.

4-18. Troubleshooting

4-18.1 3306TA engine. Perform troubleshooting as shown on pages 53-64, Caterpillar Systems Operation Testing and Adjusting Manual for 3304B and 3306B Generator Set Engines.

4-18.2 SR4 generator. Perform troubleshooting as shown on pages 61-72, Caterpillar Service Manual for SR4 Generator, SENR7968-03.

4-19. Maintenance procedures. Detailed repair and maintenance procedures for SSG's are in manufacturers' manuals provided with this TM and listed in Section VI of this chapter.

SECTION V. Storage

4-20. Short-term storage. If barge is to be taken out of service for more than 7 days but less than 30 days and SSG's will not be used while in storage, follow normal shutdown procedures and perform the following:

a. SSG's must be started and warmed up to normal operating temperature every seventh day of short-term storage.

b. Keep voids 4 as dry as possible. Keep all moisture out and keep bilge dry. Manufacturer recommends using a dry space and/or space heaters to minimize condensation in generator windings and possible damage to insulation.

4-21. Administrative storage. If barge is taken out of service for more than 30 days but less than 6 months, barge remains a unit responsibility and shall be maintained by unit personnel.

4-21.1 AdmlnIstrative storage procedures. To place barge SSG's in administrative storage, perform the following:

4-21.1.1 3306TA engine

a. Perform 500 service meter unit maintenance checks and services contained in Caterpillar Operation and Maintenance Manual for 3304, 3306, 3304B and 3306B, Industrial Engines, SEBU5779-01.

b. Disconnect battery cables.

c. Follow procedures on page 12, Caterpillar Operation and Maintenance Manual for 3304, 3306, 3304B, and 3306B, Industrial Engines, SEBU5779-01.

4-21.1.2 SR4 generator. During storage, moisture condensation in generator windings causes damage to insulation and subsequent malfunction. See page 20, Caterpillar Operation and Maintenance Manual for SR4 and SRCR Generators, SEBU5717-02, for procedures to minimize condensation and for testing and corrective action after removal from storage.

4-22. Long-term storage. If barge is to be taken out of service for 6 months or more, turn it in to depot for preparation and placement into long-term storage. If barge is in administrative storage and is to be taken out of service and placed in depot long-term storage (6 months or more), check SSG's for normal operation before releasing to depot.

SECTION VI. Manufacturers' service manuals/instructions

4-23. General. Manufacturers' service manual instructions listed below provide additional information on the Caterpillar 3306TA engine and SR4 generator. A copy of each manual set of instructions is in Appendix B. It may be necessary to refer to both these manuals instructions and drawings listed in Appendix A while performing procedures in this TM.

Component	Document title	Manufacturer
3306TA engine	Caterpillar Operation and Maintenance Manual for 3304, 3306, 3304B and 3306B Industrial Engines, SEBU5779-01	Caterpillar Tractor Co, 100 N.E. Adams St. Peoria, IL 61629
	Caterpillar Specifications for 3304B and 3306B Generator Set Engine Attachments, SENR2798	
	Caterpillar Systems Operation Testing and Adjusting Manual for 3304B and 3306B Generator Set Engine Attachments, SENR2799	
	Caterpillar Disassembly and Assembly Manual for 3304B and 3306B Generator Set Engines, SENR2800	
	Caterpillar Parts Manual for 3306 Generator Set Engine, SEBP1 406	
SR4 generator	Caterpillar Operation and Maintenance Manual for SR4 and SRCR Generators, SEBUS571 7-02	
	Caterpillar Service Manual for SR4 Generator SENR7968-03	
	Caterpillar Special Instructions for Alignment of Single Bearing Generators, SMHS7259	
Spring isolators	Ace Mounting Co. Series 630 Spring Isolators for Seismic, Marine, & Mobile Applications, catalog 83A-1 70	Ace Mountings Co., Inc. 11 Cross Avenue South Amboy, NJ 08879 Ph: (201) 721-6200
Battery charger	Master Control Systems Bulletin for Regulated Two Rate Battery Charger, Model MBC8, 474-2	Master Controls Systems 910 N. Shore Drive Lake Bluff, IL 60044 Ph: (312) 295-101 0 Telex: 25-4636
	Master Control Systems Installation and Operation Instructions for Models MBC8, MBC819(1 OD0D)-3	
Engine crankcase filter system, Oildex XCAD-1 3T	Oildex - How It Operates, Installation, Instructions, Dwg no. XCAD-12T/XCAD-14T	Oildex Corporation P.O. Box 3755 Long Beach, CA 90803

SECTION VII. Manufacturers' warranties/guarantees

4-24. General. Information on SSG component warranties/guarantees is supplied below.

Component	Manufacturer	Duration	Coverage
3306TA engine from	Tractor Co. 100 N.E Adams St. Peoria, IL 61629	Caterpillar Defects in materials date of delivery	12 months and workmanship
SR4 Generator from	Tractor Co. 100 N.E. Adams St. Peoria, IL 61626	Caterpillar Defects in materials date of delivery	12 months and workmanship

CHAPTER 5 20 KW SHIP AUXILIARY GENERATOR SET

SECTION I. Description and data

5-1. Description. The 20 kW SAG set supplies limited amounts of electrical power for the barge when ROWPU systems are not in operation. It provides sufficient power for operating normal lighting, dayroom equipment, workshop equipment, and battery chargers. It must never be used to provide power for any major system onboard.

5-1.1 This generator set consists of a Perkins Model 4.236M engine and a Newage Stamford SC144E generator mounted, with vibration isolators, on a common base. It has free standing switching gear and is capable of parallel operations. The set weighs 1300 pounds dry and 1451 pounds wet and is 74 inches long, 26 inches wide, and 40 inches high. Installation is shown in engineering drawings listed in Appendix A.

5-1.2 The Perkins 4.236M engine is a 236-cubic inch inline, four cylinder, four-stroke diesel specifically built for use in a maritime environment. It has direct injection, with a 16:1 compression ratio and is rated at 72 horsepower (hp) at about 2500 rpm. The engine has a heat exchanger using seawater to cool both engine coolant and engine oil and a 24 V electric starter. The battery pack on the engine is charged by a battery charger built into the switchboard in the ROWPU space.

5-1.3 The Newage Stamford SC1 44E generator is a brushless, revolving field machine. It is based on a fabricated frame and cast iron end brackets with a large sheet metal terminal box mounted on the non-drive end. The stator/rotor is made from low loss electrical grade sheet steel laminations with special building techniques to provide an extremely rigid core to withstand vibration and load impulses. A high-grade, precision-machined shaft carries the rotor assembly. For a more detailed technical description, refer to manufacturers' manuals listed in Section VI of this chapter.

5-2. Capabilities. This auxiliary generator set provides electrical power necessary for normal occupancy of the barge when major ROWPU systems are NOT operating. It will provide continuous power under these conditions. For load transfer purposes only, it may be operated, for a very short time, in parallel with either of the two SSG's.

5-3. Special limitations. This generator set cannot be operated in parallel with power from the shore power receptacle. It cannot be used to provide power for any major systems onboard. It must be used only to provide power for normal nonoperating occupancy and housekeeping equipment.

5-4. Performance characteristics. The auxiliary generator's voltage regulation is maintained within the limits of t2 percent from no load to a full load. This includes cold to hot variations at any power factor between 0.8 lagging and unity and inclusive of a speed variation of 4.5%. Total distortion of the voltage waveform, with open circuit between phases or between phases and neutral, is on the order of 2%. On a 3-phase, balanced, harmonic-free load, total distortion is on the order of 3.5%. Electrical output characteristics at an 0.8 power factor are listed below:

kW	20
kVA	25
Voltage	440 Vac
Current	32
Phase	3
Hertz	60

5-5. Equipment specifications SECTION II.

a. Engine

Manufacturer	Perkins Engine, Inc.
Supplier	Carter Machinery Co., Inc.
CAGEC	IEX21
Part no.	4.236M
Engine type	4"cylinder, inline, 4-stroke cycle, direct injection
Maximum shaft Hp	72 @ 2500 rpm
Displacement	235.9 cu in
Bore and stroke	3.875 in x 5.0 in
Compression ratio	16:1
Firing order	1,3,4, 2
Lube oil capacity	8.4 qt
Coolant capacity	3.5 gal

b. Generator

Manufacturer	Newage Engineers, Ltd.
Supplier	Carter Machinery Co., Inc.
CAGEC	IEX21
Part no.	SC144E
Arrangement	3 ph, 4 pole

c. Engine crankcase filter system with mounting hardware

Manufacturer	Oildex Corporation
CAGEC	31714
Part no.	XPERK-1
Quantity	1

5-6. Items furnished

5-6.1 Components installed as part of SAG are listed on the parts lists on drawings listed in Appendix A and in the Components of End Item List in TM 55-1930-209-14 & P-20.

5-6.2 Common and bulk items onboard are listed in the Expendable Supplies and Materials List in TM 55-1930-209-14 & P-20.

5-6.3 Repair parts and special tools onboard are listed in the Repair Parts and Special Tools List in TM 55-1930-209-14 & P-1 8.

5-7. Items required but not furnished. All required items are furnished.

5-8. Tools and test equipment. Use existing tools and equipment onboard. A complete list of tools and test equipment onboard is in the Tools and Test Equipment List in TM 55-1930-209-14 & P-1 8.

Section II. Description of operation

5-9. Description of operation. Normally, this generator set is started as soon as the barge is activated. When major ROWPU systems are not operating, SAG provides power for normal housekeeping functions such as lighting, heating, air conditioning, ventilation, operation of dayroom and workshop equipment, and initial startup of chlorination system. This auxiliary generator set cannot provide sufficient power to operate any of the major ROWPU systems. One of the two SSG's must be online to provide sufficient power for operating any major ROWPU system. When one of the SSG's is online, the 20 kW set is normally shut down.

5-9.1 This generator, like the two SSG's, is normally started and operated from a control panel on the switchboard in the ROWPU space.

5-9.2 Like the two SSG's, this generator can operate in parallel with either of the two SSG's for load transfer.

SECTION III. Operating Instructions

5-10 . Operating controls and Indicators

5-10.1 4.236M diesel engine

5-10.1.1 Engine instruments. These are on a small instrument panel on top of the engine block

a. Engine oil pressure gauge. Located on upper left portion of this small panel, gauge indicates oil pressure on its upper scale. Normal oil pressure is 30/60 psi when engine is new at normal operating temperature and engine is at maximum speed. During the life of the engine, as bearing surfaces wear, pressure will gradually decrease. When oil is hot or wrong grade of oil is used for certain dimatic conditions, oil pressure may decrease slightly.

b. Engine cool and temperature gauge. Located on upper right portion of panel, this gauge indicates temperature of engine block coolant in degrees Fahrenheit on upper scale. A thermostat in the dosed circuit portion of the cooling system keeps this temperature between 168 and 197"F

c. Coolant pressure gauge. Located on lower left side of panel, this gauge reads from 0 to 15 psi. Low pressure is an indication of possibly blocked water passage.

d. Hour meter. Located on lower right portion of panel, this meter indicates number of hours generator set has operated and provides the basis for scheduling maintenance and services.

5-10.1.2 Engine Indicators

a. Fuel pressure gauge. On top of fuel oil filtering system, this gauge indicates fuel pressure in psi and indicates when fuel oil filters should be changed.

b. Oil dipstick. Located on left side of engine block (looking at engine from generator). This dipstick shows amount of oil in crankcase. Oil level must be between maximum and minimum marks on dipstick. Never fill above maximum level.

c. Coolant filler cap. Located at top front (accessory end) of engine on top of coolant tank. When removed, cap shows level of coolant in closed coolant portion of engine cooling system.

5-10.1.3 Engine controls

a. ENGINE CONTROL SWITCH. This switch, on SAG switchboard control panel, has START, REMOTE, and OFF/RESET positions. To start engine from switchboard, place switch in START. To stop engine from switchboard, place switch in OFF/RESET. To operate engine from engine, place switch in REMOTE and use ENGINE START/STOP switch on engine.

b. VOLTAGE REGULATOR switch. The SAG controls on the switchboard control panel do not include this switch to control engine speed. It is found on the SSG control panels only.

c. Throttle. Black knob on right side (as you face switchboard) of switchboard housing. Large changes in speed are obtained by pushing in on center button and then pulling out on throttle knob to increase speed and pushing in to decrease speed. For fine throttle adjustments, turn knob counterclockwise to increase speed and clockwise to decrease speed. Most throttle adjustment will be done by turning throttle knob rather than by pushing or pulling.

d. ENGINE START/STOP switch. Located on engine. Push down on this switch to stop engine regardless of ENGINE CONTROL SWITCH setting. When ENGINE CONTROL SWITCH is in REMOTE, push up on this switch to start engine.

e. Red EMERGENCY STOP button on engine control panel. Push to stop engine. When emergency situation has been corrected, reset by turning clockwise and button will pop out to normal position. Start engine by following normal starting procedures.

f. Seawater valves control flow of seawater to SAG 1 for cooling engine coolant and lubricating oil. These valves must be open for engine to operate.

(1) Seawater valve SW37. Located in void 4 port next to seawater strainer. When open, provides water from seawater strainer to manifold piping, which provides cooling seawater to all generators in voids 4.

(2) Seawater valve SW49. Located in void 4 starboard on starboard bulkhead. When open, provides outlet for used cooling water to flow overboard.

(3) Seawater valve SW42. Controls flow of cooling seawater from aft seawater seachest strainer to inlet into engine cooling exchanger. Valve piping also includes a temperature gauge indicating inlet water temperature. Valve must be open for engine to operate.

(4) Seawater valve SW43. Controls flow of cooling seawater from engine cooling exchanger to overboard outlet. Valve piping also includes a temperature gauge indicating temperature of water leaving the engine heat exchanger (Barges 2 and 3 only). Valve must be open for engine to operate.

5-10.2 SC1 44E generator. Controls and indicators are on switchboard in ROWPU space. These are discussed in Chapter 2, paragraph 2-10.2, as part of the normal electrical system.

5-11 . Prestart procedures

a. In ROWPU space, make sure EMS is operating by pushing up on monitor controller left of monitoring processor. If video monitor screen does not come on, turn it on with switch beneath the screen. For more details on EMS, see TM 55-1930-209-14 & P-11.

b. Check maintenance records to make sure all required maintenance checks and services have been completed and no deficiencies exist that would prevent safe and proper equipment operation.

c. In void 4 starboard, inspect generator set for visible deficiencies that, if not corrected, could become hazardous to people or equipment.

CAUTION

Never overfill crankcase. Fill only to maximum level as indicated on dipstick.

d. Check crankcase engine oil level on dipstick on left side of engine. N not up to full mark, add lubricating oil through filler on top of engine. Use SAE 1 5W40 that meets Military Specification MIL-L-21 04C (API “CD”). If temperature in the voids consistently exceeds 1200F, use SAE 40.

e. Check coolant level in heat exchanger (header) tank Level should be less than 1 inch below bottom of neck opening. If necessary, add dean fresh water to bring to required level. Cooling system has an anti-corrosion zinc anode in coolant heat exchanger. Water conditioner, therefore, is not required or desirable.

f. Check that seawater is available for heat exchanger.

(1) Make sure both stern seawater strainer baskets are dean and operable. For details on servicing these strainers, see TM 55-1930-209-14 & P-2, Seawater System.

(2) Open seawater valves SW45 and SW46 (on Barges 2 and 3 only) to monitor pressure drop across strainers. H pressure difference during operation becomes greater than 8 in. Hg, turn handle to direct water through other basket. Clean dirty basket according to TM 55-1930-209-14 & P-2, Seawater System.

(3) Open seawater valve SW37 in void 4 port and SW42, SW43, and SW49 in void 4 starboard.

g. Check that fuel oil is available by setting fuel oil valves as follows:

Open: F018, F019, and F025
Close: F013 thru F017, F020 thru F024, F026, and F027.'

• Fuel oil valve settings above are for operating auxiliary generator only. As other diesel engines are needed, some of those valves listed as dosed may be opened to supply fuel oil to other diesels. This will not have any impact on fuel oil supply for this diesel.

h. Check that 24 Vdc power panel in workshop is active and circuit breaker 8P1 4 is dosed (ON) (Chapter 3) (Figure 3-2) to provide holding voltage to solenoids in fuel lines to generators. Emergency shutdown switches activate these shutoff solenoids by removing this 24 Vdc power. It 24 Vdc panel is not active, these holding solenoids are closed. The generator will start and run for a few minutes until lack of fuel shuts it off.

CAUTION

Turn off all emergency panel power users and all emergency lights when all power sources are turned off. It not, battery bank will be drained of power. Without power from this battery bank to hold fuel shutoff solenoids open, generators will not operate to recharge the 24 Vdc batteries.

i. Check that generator set batteries are dean of corrosion, cable connections are tight and covered with anti-corrosion grease, and electrolyte covers the plates.

5-12 Starting procedures

NOTE

Following procedures are for starting SAG engine from its location in void 4 starboard. For remote starting from switchboard in ROWPU space, see Chapter 2.

a. On switchboard auxiliary generator control panel, make sure ENGINE CONTROL SWITCH is set to REMOTE.

b. Make sure switchboard circuit breaker P3 is open (OFF).

c. On switchboard, make sure throttle knob is pushed all the way in and turned clockwise as far as it will go. This sets throttle for starting and idling at about 900 rpm. Throttle cannot be set until engine has started. After engine start, throttle arm can be moved manually to momentarily increase engine speed. When released, it will return to idle set with throttle knob on switchboard.

d. On switchboard, set AMMETER SWITCH to ON.

WARNING

Ear protection must be worn in voids 4 when any generator is operating.

e. On SAG, push ENGINE START/STOP switch up and hold until engine starts.

NOTE

If engine does not start within 20 seconds, release ENGINE START/STOP SWITCH and wait 2 minutes for starter motor to cool. Then, try again. Release switch when engine starts. If engine does not start after three attempts, troubleshoot by following troubleshooting procedures on page 67, Perkins Engines Operators Manual for Marine Diesel Engines, 4.236M, found in Appendix B. Correct as indicated by chart.

f. With engine idling, check that lubricating oil pressure gauge shows positive pressure. If not, stop engine. Troubleshoot according to paragraph 5-18 and Troubleshooting Chart on page 67, Perkins Engines Operations Manual for Marine Diesel Engines. Correct trouble before proceeding.

g. With engine idling, check that fuel oil pressure gauge shows normal fuel pressure. I not, change fuel oil filters as provided in Perkins Engines Operations Manual for Marine Diesel Engines.

h. On switchboard, set battery charger FLOAT/EQUALIZER switch to FLOAT.

i. With engine idling, check that coolant temperature gauge is registering. When gauge starts to move toward higher reading, engine speed may be increased, using throttle on side of the switchboard.

j. On SAG switchboard control panel, check that;
(1) VOLTMETER reads 440 Vac.
(2) FREQUENCY METER reads 60 Hz.
(3) AMMETER reads 0.

5-13. Operating procedures. After starting, the SAG is difficult to operate from the engine location, due to limited throttle control. It is normally operated from the switchboard. For operating procedures from the switchboard, see paragraph 2-13.

NOTE

See paragraph 2-12 for operations of generator set alarms and shutoffs.

a. During operation, perform during operation checks according to paragraph 2-12 and 2-13.

b. During operation, make sure that lubricating oil pressure, fuel oil pressure, and coolant temperature gauges indicate normal range of operation.

5-14. Shutdown procedures

5-14.1 Shutdown procedures at engine. While this auxiliary generator set is normally operated from switchboard, it can be shut down at the engine location by following these procedures:

a. Make sure all electrical loads have been transferred to other generator sets and SAG circuit breaker P3 is open (OFF).

b. At switchboard, decrease throttle setting to idle (900 rpm) by pushing in on central button and then pushing throttle knob all the way in and turning clockwise as far as it will go.

c. Operate engine at idle speed for 5 minutes.

d. At engine, push ENGINE START/STOP switch to STOP.

5-14.2 Emergency shutdown. For operating total barge shutdown and system shutdown systems, see paragraph 2-18. For emergency SAG shutdown at the engine:

a. Push red EMERGENCY STOP button on side of generator housing.

b. Turn ENGINE START/STOP switch to STOP.

c. Troubleshoot according to procedures in paragraph 5-18 and page 67 of Troubleshooting Chart in Perkins Engines Operators Manual for Marine Diesel Engines 4.236M.

d. When corrections have been completed, reset EMERGENCY STOP button by turning clockwise. Button will pop out and be in ready position.

5-15. Operation under extreme conditions

5-15.1 Temperature extremes. Auxiliary generator set is designed to operate at ambient air temperatures from O to 122°F. Normal lubricating oil is SAE 15W40. If temperature in the voids consistently reaches or exceeds 120"F, use SAE 40. Additional information on lubricating oils is on page 58, Perkins Engines Operators Manual for Marine Diesel Engines 4.236, in Appendix B.

5-15.2 High humidity. High humidity increases probability of fuel oil becoming contaminated with moisture. For details on combating this problem, see TM 55-1930-209-14 & P-8, Fuel Oil System.

SECTION IV. Maintenance Instructions

5-16. General

5-16.1 Maintenance concept

5-16.1.1 Unit level and IDS/IGS maintenance on SAG is performed onboard by barge crew member whenever possible.

5-16.1.2 Any IDS/IGS maintenance beyond the capability of crew member is provided by a shore-based area support maintenance unit. This unit also determines if depot support maintenance is required.

5-16.1.3 Intermediate support maintenance is accomplished by replacement of components or major end items.

5-16.1.4 Unless other intermediate support maintenance procedures are directed, IDSIIGS maintenance is normally provided by an Army Transportation Corps floating craft intermediate support maintenance unit serving terminal operating area. Components to be disposed of are processed by this unit.

5-16.1.5 Maintenance Allocation Chart (MAC) is in Appendix C of TM 55-1930-209-14 & P-18. For maintenance on other equipment onboard, consult appropriate manual.

5-16.2 Maintenance procedures. Maintenance instructions are contained in the following paragraphs: paragraph 5-17, Preventive maintenance checks and services; paragraph 5-18, Troubleshooting; and paragraph

5-17. Preventive maintenance checks and services. See TM 55-1930-209-14&P-9-1, Appendix C for preventive maintenance checks and services for the electrical power system. TM 55-1930-209-14&P-19 for complete preventive maintenance checks and services for all ROWPU Barge Systems.

5-18. Troubleshooting

5-18.1 4.236M diesel engine. Perform troubleshooting as shown in troubleshooting chart on page 47, Perkins Operators Manual for Marine Diesel Engines.

5-18.2 SC144E generator. Perform troubleshooting as described on pages 9 and 10, in Newage Stamford 'C' Range Frames 1, 2, & 3 Series 4 A.V.R. Controlled Operation and Maintenance Manual Machine Designations PC164, SC and MSC 144,244,344.

5-19. Maintenance procedures. Detailed repair and maintenance procedures for this auxiliary generator set are in manufacturer's manuals provided with this manual and listed in Appendix B.

SECTION V. Storage

5-20. Short-term storage. If barge is to be taken out of service for more than 7 days but less than 30 days and SAG will not be used while in storage, perform the following:

a. Operate SAG for at least 30 minutes and then shut down in accordance with procedures in paragraph 5-14.

b. Perform next scheduled periodic check and service.

c. Operate SAG for at least 30 minutes every 7 days.

d. Make every effort to keep voids 4 as dry as possible during storage to reduce condensation in engine and generator.

CAUTION

Condensation in generator windings and insulation may seriously damage generator. This problem is difficult to detect visually and may become apparent only when generator set starts and malfunctions.

5-21. Administrative storage. If barge is to be taken out of service for more than 30 days but less than 6 months, barge remains a unit responsibility and shall be maintained by unit personnel.

5-21.1 Administrative storage procedures. To place SAG into administrative storage, perform the following:

a. Follow procedures on pages 42-44, Perkins Engines Operators Manual for Marine Diesel Engines, 4.236M, and pages C.3-C.5, Perkins Engines Workshop Manual, 4.236M.

b. Make every effort to reduce relative humidity and condensation inside engine and generator.

c. Disconnect battery cables and wrap ends with dean, dry cloth. Clean batteries and make sure electrolyte is at proper level.

5-22. Long-term storage. If barge is to be taken out of service for 6 months or more, turn it in to depot for preparation and placement into long-term storage. If barge is in administrative storage and is to be taken out of service and placed in depot long-term storage (6 months or more), check SAG for normal operations before releasing to depot.

SECTION VI. Manufacturers' service manuals/instructions

5-23. General. Manufacturers' service manuals/instructions listed below provide additional information on the Perkins 4.236M engine and SC1 44E generator. A copy of each manual set of instructions is in Appendix B. It may be necessary to refer to these manuals/instructions and drawings listed in Appendix A, while performing procedures in this TM.

Component	Document title	Manufacturer
4.236M engine	Perkins Engines Operators Manual for Marine Diesel Engines, 4.236M Perkins Engines Workshop Manual, 4.236M Perkins Engines Parts Manual, 4.236M	Perkins Engines Inc. 32500 Van Bom Rd. P.O. Box 697 Wayne, Ml 48184 Ph: (313) 595-9600 Telex: 234002
SC144E generator	Newage Stamford 'C' Generator Range Frames 1, 2, & 3 Series 4 A.V.R., Controlled Operation and Maintenance Manual Machine Designations PC164 SC and MSC 144, 244, 344, publication no. 1 H-059 1st edition Newage Stamford 'C' Range Frames 1, 2, & 3 Series 4 A.V.R. Parts Manual	Newage Engineers, Ltd. 3 Independence Court Foicraflt, PA 19032 Ph: (215) 534-9500 Telex: 43551
Spring Isolators	Series 630 Spring Isolators for Seismic, Marine, & Mobile Applications, catalog 83A-1 70	Ace Mounting Co., Inc. 11 Cross Avenue South Amboy, NJ 08879 Ph: (201) 721-6200
Battery charger	Master Control Systems Bulletin for Regulated Two Rate Battery Charger, Model MBC8, 474-2 Master Control Systems Installation & Operation Instructions for Models MBC8, Regulated Two Rate Battery Charger, MBG8/9(1 0000)-3	Master Controls Systems, Inc. 910 N. Shore Drive Lane Bluff, IL 60044 Ph: (312) 925-101 0 Telex 25-4636
Gages	Murphy A20T Series Temperature Switch-gages Bulletin A20T-7974, effective 5-15-79, Catalog Section 10, Class R Murphy A20 Series Pressure Murphygages and Switchgages, Bulletin A20P-7973, revised 12-30-81, Catalog Section 05, Class (5) Murphy Instructions for Installation & Maintenance of Pressure & Vacuum Switchgages, Series 20-P, 25-P, A20-P, A25-P, Instruction Booklet 2025P-INS, revised 9-28-84 Murphy Instructions for Installation & Maintenance of Temperature Switchgages, Installation Sheet 2520T-INS, revised 2-1-85	Frank W. Murphy & Co. RO. Box 470248 Tulsa, OK 74147 Ph: (918) 627-3550 Telex: 492332
Exhaust silencers	Nelson Industrial "100' Level Exhaust	Nelson Manufacturing Silencers, two page fact sheet
Oildex crankcase	Oildex - How It Operates, Installation filter system Long Beach, CA 90803	Oildex Corporation Instructions, Dwg. No. XPERK-1 RO. Box 3755

SECTION VII. Manufacturers' warranties/guarantees

5-24. General. Information on ship auxiliary generator set component warranties/guarantees is supplied below.

Component	Manufacturer	Duration	Coverage
4.236M engine	Perkins Engines Inc. 32500 Van Bom Rd. Wayne, MI 48184 (313) 595-9600 Telex: 234002	1 year from date of sale to first retail purchaser or 3 years from shipping date from Perkins	Defects in materials and workmanship
SC144E generator	Newage Engineers Ltd. 3 Independence Ct P.O. Box 103 Foicraft, PA 19032 (215)534-9500 Telex: 43551	12 months from installation	Defects in materials and workmanship

APPENDIX A

REFERENCES

A-1. Drawings

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

13226E1892	ROWPU/Barge Arrangement
13226E1893	List of Label Plates
13226E1911	Generators Cooling System
13326E1922	Diesel Generators and Foundations
13226E1927	Engine Exhaust System
13226E1932	Electrical Power Schematic Diagram
13226E1934	Load, Cables, and Circuit Breakers Data
13226E1935	Electrical Power System Layout
13226E1936	Void No. 4 Ventilation System
13226E1939	Motor Controllers, Schematic and wiring Diagram
1 3226E1944	Equipment Shut Down System

A-2. Painting

TB 43-0144	Painting of Vessels

A-3. Demolition to Prevent Enemy Use

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

A-4. Maintenance

DA PAM 738-750	The Army Maintenance Management System (TAMMS)

APPENDIX B

MANUFACTURERS' SERVICE MANUALS/INSTRUCTION

B-1. Normal Electric System

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found In TM 551930-209-14&P-9-2	
Switchboard	Electric Power Controls Operation Manual for Main Service Generation and Distribution Switchboard Ph: (217) 629-8506	Electric Power Controls RC. Box 5146 Springfield, IL 62705

B-2. Emergency Electrical System

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found In TM 55-1930-209-14&P-9-2	
Inverter	LaMarche Instruction Manual for Model A-51 Inverter with Trouble Shooting Information	LaMarche Manufacturing Co. 106 Braddock Drive Des Plaines, IL 60018 Ph: (312) 299-1188
Battery charger	LaMarche Installation Instruction Manual for Model A33-60-24V-A1	

B-3. 155 kW Ship Service Generators

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found In TM 55-1930-209-14&P-9-2	
3306TA engine	Caterpillar Operation and Maintenance Manual for 3304, 3306, 3304B and 3306B Industrial Engines, SEBU5779-01	Caterpillar Tractor Co, 100 N.E. Adams St. Peoria, IL 61629
	Caterpillar Specifications for 3304B and 3306B Generator Set Engine Attachments, SENR2798	
	Caterpillar Systems Operation Testing and Adjusting Manual for 3304B and 3306B Generator Set Engine Attachments, SENR2799	

Component	Document title	Manufacturer
	NOTE **The following document can be found In TM55-1930-209-14&P-9-2**	
	Caterpillar Disassembly and Assembly Manual for 3304B and 3306B Generator Set Engines. SENR2800	
	NOTE **The following documents can be found In TM 551930-209-14&P-9-3**	
	Caterpillar Parts Manual for 3306 Generator Set Engine, SEBP1406	
	NOTE **The following documents can be found In TM 55-1930-209-14&P-9**	
SR4 generator	Caterpillar Operation and Maintenance Manual for SR4 and SRCR Generators, SEBUS571 7-02	
	Caterpillar Service Manual for SR4 Generator SENR7968-03	
	Caterpillar Special Instructions for Alignment of Single Bearing Generators, SMHS7259	
Spring isolators	Ace Mounting Co. Series 630 Spring Isolators	Ace Mountings Co., Inc.
	for Seismic, Marine, & Mobile Applications, catalog 83A-170	11 Cross Avenue South Amboy, NJ 08879 Ph: (201) 721-6200
Battery charger	Master Control Systems Bulletin for Regulated Two Rate Battery Charger, Model MBC8, 474-2	Master Controls Systems 910 N. Shore Drive Lake Bluff, IL 60044 Ph: (312) 2951010 Telex: 25-4636
	Master Control Systems Installation and Operation Instructions for Models MBC8, MBC8/9(10000)-3	
Engine crankcase filter system, Oildex XCAD-13T	Oildex - How It Operates, Installation, Instructions, Dwg no. XCAD-12T/XCAD-14T	Oildex Corporation RO. Box 3755 Long Beach, CA 90803

B-4. 20 kW Ship Auxillary Generator Set

Component	Document title	Manufacturer
	NOTE	
	The following documents can be found In TM 551930209-14&P-9-4	
4.236M engine	Perkins Engines Operators Manual for Marine Diesel Engines, 4.236M Perkins Engines Workshop Manual, 4.236M Perkins Engines Parts Manual, 4.236M	Perkins Engines Inc. 32500 Van Bom Rd P.O. Box 697 Wayne, Ml 48184 Ph: (313) 595-9600 Telex: 234002
SC1 44E generator	Newage Stamford 'C' Generator Range Frames 1, 2, & 3 Series 4 A-V. R., Controlled Operation and Maintenance Manual Machine Designations PC1 64SC and MSC 144, 244, 344, publication no. 1 H-059 1 st edition Newage Stamford 'C' Range Frames 1, 2, & 3 Series 4 A.V.R. Parts Manual	Newage Engineers, Ltd. 3 Independence Court Folcraft, PA 19032 Ph: (215) 534-9500 Telex: 43551
Spring Isolators	Series 630 Spring isolators for Seismic, Marine, & Mobile Applications, catalog 83A-170	Ace Mounting Co., Inc. 11 Cross Avenue South Amboy, NJ 08879 Ph: (201) 721-6200
Battery charger	Master Control Systems Bulletin for Regulated Two Rate Battery Charger, Model MBC8, 474-2 Master Control Systems Installation & Operation Instructions for Models MBG8, Regulated Two Rate Battery Charger, MBC8/9(1 0000)-3	Master Controls Systems, Inc. 910 N. Shore Drive Lane Bluff, IL 60044 Ph: (312) 925-1010 Telex 25-4636
Gages	Murphy A20T Series Temperature Swich-gages Bulletin A20T-7974, effective 5-1-5-79, Catalog Section 10, Class R Murphy A20 Series Pressure Murphygages and Swichgages, Bulletin A20P-7973, revised 12-30-81, Catalog Section 05, Class (5)	Frank W. Murphy & Co. P.O. Box 470248 Tulsa, OK 74147 Ph: (918) 627-3550 Telex: 492332

Component	Document title	Manufacturer
	Murphy Instructions for Installation & Maintenance of Pressure & Vacuum Swichgages, Series 20-P, 25-P, A20-P, A25-P, Instruction Booklet 2025P-INS, revised 9-28-84	
	Murphy Instructions for Installation & Maintenance of Temperature Swichgages, Installation Sheet 2520T-INS, revised 2-1-85	
Exhaust silencers	Nelson Industrial "100" Level Exhaust Silencers, two page fact sheet	Nelson Manufacturing
Oildex crankcase filter system	Oildex - How It Operates, Installation Instructions, Dwg. No. XPERK-1	Oildex Corporation P.C. Box 3755 Long Beach, CA 90803

APPENDIX C

Preventive maintenance checks and services (PMCS) for the Electrical Power System

C-1. Introduction to PMCS

NOTE

TM 55-1930209-14&P-19 contains PMCS FOR ALL SYSTEMS ON THE ROWPU Barge. This appendix contains only PMCS for the Electrical Power System

a. General.

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

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

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

b. PMCS columnar entries.

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

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

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

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

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

NOTE

The terms "Ready/Available" and "Mission Capable" refer to the same status: equipment Is on hand and Is able to perform its combat missions. (See DA PAM 738750).

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

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

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

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

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

(b) Class II - Leakage of fluid great enough to form drops, but not enough to cause drops to drip from the item being checked/inspected.

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

CAUTION

Equipment operation is allowable with minor leakages (Class I or II). However, the fluid level or operating pressure of the item being checked/inspected must be considered. When in doubt, notify the shift leader or bargemaster.

When operating with Class I or Class II leaks, continue to check fluid levels as required by PMCS and operating Instructions.

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

WARNING

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

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

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

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

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

C-2. Major components. The Electrical Power Systems consists of the Normal Electrical System, the Emergency Electrical System, the 155 kW Ship Service Generators and the 20 kW Ship Auxiliary Generator Set.

C-3. System description.

C-3.1 Normal electrical system description. The normal electrical system provides electrical power for the operation of major auxiliary systems on the barge including the emergency system battery charger.

Normal electrical power is generated onboard by one of three diesel-powered generator sets. These generators, located in voids 4, are normally operated and controlled from a master switchboard in the ROWPU space. When all generator sets are shut down, a shore-based powerplant or another vessel can be used to provide electrical power to operate onboard equipment. This outside source is connected to the barge through electrical cabling to a watertight shore power receptacle on aft weatherdeck portside. These sources provide 440 Vac, 60 Hz, 3 ph electrical power.

Power control and distribution is provided by a main switchboard on the port bulkhead aft of diesel high pressure (HP) pumps in the ROWPU space. This unit has six panels, three above the grab rail and three below. The three panels above the grab rail are controls and indicators for the three diesel generators in voids 4. The lower left (as operator faces the switchboard) distribution panel has two rows of circuit breakers that provide initial normal power distribution. Two lower right panels contain controls and indicators for the electrical systems. This panel also has indicators for ground detection system.

C-3.2 Emergency electrical system. The emergency electrical system provides a limited amount of 120 Vac and 24 Vdc power for selected essential lighting and power requirements. This system's central unit is a battery bank on the deckhouse top that is maintained at full charge by a battery charger in the workshop. The charger receives its power from the normal electrical system. When normal power is disrupted, the battery bank provides24 Vdc to an inverter. The inverter converts this power to 120 Vac, which is supplied to the 120 Vac emergency lighting panel. In addition, this battery bank provides continuous 24 Vdc power directly to a DC power panel. This system automatically provides 120 Vac power for emergency lighting in the ROWPU space and voids and 24 Vdc power for direct current equipment.

C-3.3 155 kW ship service generators. Two diesel powered generator sets, each rated at 155 kW, serve as primary electrical power sources for the barge. When shore power is not used, one SSG must be online when any of the ROWPU major systems are being operated. These SSG's, number 1 in void 4 port and number 2 in void 4 starboard, are Caterpillar diesel engine driven generator sets. Each SSG consists of a Caterpillar 3306TA diesel engine and a Caterpillar Model SR4 generator mounted, with isolation isolators, on a common base. The set weighs 3960 pounds dry and 4180 pounds wet and is 118 inches long, 39 inches wide, and 59 inches high. The third generator set, rated at 20 kW, supplies power for the barge when ROWPU major systems are not operating and there is a lower demand for electrical power.

C-3A 20 kW service auxiliary generator. The 20 kW SAG set supplies limited amounts of electrical power for the barge when ROWPU systems are not in operation. It provides sufficient power for operating normal lighting, dayroom equipment, workshop equipment, and battery chargers. It must never be used to provide power for any major system onboard.

This generator set consists of a Perkins Model 4.236M engine and a Newage Stamford SC144E generator mounted, with vibration isolators, on a common base. It has free standard switching gear and is capable of parallel operations. The set weighs 1300 pounds dry and 1451 pounds wet and is 74 inches long, 26 inches wide, and 40 inches high.

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems

B - Before
D - During
A - After

D - Daily
W - Weekly
M - Monthly

Q - Quarterly
S - Semiannually
A - Annually

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
										NORMAL ELECTRICAL POWER SYSTEM	**NOTE** **Only qualified personnel, using proper and authorized test equipment, are authorized to work on electrical power system components. This system has been designed and constructed to be primarily maintenance free between major shipyard overhauls.** **NOTE** **If electrical system fails to operate, troubleshoot according to TM 55-1 930-209-14&P-9. Report deficiencies and failures to shift leader or bargemaster. Keep electrical power systems operational and PMCS logs current.** **WARNING** **Make sure electrical components and circuits are turned OFF before starting any Inspection and/or cleaning. Observe all posted warnings and safety precautions. Circuit breakers must be open (OFF). Red-tag appropriate switches and circuit breakers with: "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE."**	
1	•			•						Cables	a. Visually check for loose or damaged cables. Make sure all cables are firmly attached, corrosion free, and rot subject to rubbing or chafing.	Loose or damaged cables.
2	•		•	•						Electrical Switches, Mounting Systems and wiring	b. Check for loose or damaged electrical connections. switches, wiring, mounting systems, hangers. and electrical insulating material. Use insulated tools to tighten.	Electrical connections, switches, wiring, mounting systems loose or damaged.

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

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

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
											CAUTION **DO NOT use solvents to clean electrical components. Solvents may leave a greasy film that reduces electrical conductivity.**	
3	•		•	•						Panel Covers, Housings and Metal Surfaces	c. Check components such as panel covers, housing, and metal surfaces for rust corrosion, and worn or chipped paint. Use a wire brush to remove rust and corrosion and paint with zinc chromate primer and finish to match surrounding area in accordance with TB 43-0144. Do rot paint threads or labels.	
4		•								Failure Lights	d. Check engine failure lights by using PRESS-TO-TEST button. H lamps do not light, change bulbs when generator being operated is off-line.	
5						•				All Components	e. Cleaning	
											NOTE **Avoid using solvents for cleaning Internal portions of electrical system. Solvents often leave a greasy film on components that may reduce electrical conductivity.**	
						•					1) Clean electrical equipment. Avoid damaging insulation, mounting system, and hardware, or impairing electrical properties of item being cleaned.	
						•					2) Vacuum internal portions of switchboard, power panels, electrical controllers, inverters, battery chargers, and receptacles. Vacuum grit, iron dust, and copper particles from enclosed areas.	
						•					3) Wipe dirt from external surfaces of electrical equipment with dry cheesecloth or, if necessary, with a damp soapy cloth. Wipe dry.	
						•					4) Clean circuit breakers, contacts and relays with fine sandpaper to remove black discoloration. Do NOT use emery cloth.	
						•					5) Clean arc chutes on circuit breakers with a fine file. Vacuum to remove residue.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before
D - During
A - After

D - Daily
W - Weekly
M - Monthly

Q - Quarterly
S - Semiannually
A - Annually

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
										EMERGENCY ELECTRICAL POWER SYSTEM	**WARNING** **Fumes from battery electrolyte may be flammable and explosive. DO NOT smoke or have open flames when checking electrolyte, or when working on battery bank. Avoid contact with eyes and skin. Wear safety glasses, gloves, and rubber aprons when handling electrolyte. Electrolyte Is highly toxic to skin, eyes and respiratory system and can cause severe burns.**	
1	•		•	•						Batteries	a. Check batteries in bank for proper electrolyte level. Add distilled water or dean. water to bring level above plates.	Electrolyte level low.
	•										b. Check that battery bank is secure and that electrical cable fittings are tight and coated with anti-corrosion grease. Correct as necessary.	
	•										c. Check for damage and loose fittings, wires and fasteners. Replace or tighten as necessary.	Fittings, wires and/or fasteners damaged or loose.
	•										d. Wipe all battery components clean.	
		•									e. Replace defective status lamps.	
				•							f. Check electrolyte level daily and make sure It covers plates in each cell of all batteries.	
				•							g. Visually check for loose or damaged cabling. Make sure cabling is firmly attached, tree of corrosion, and not subject to rubbing or chafing.	Cables loose or damaged.
				•							h. Check for loose or damaged electrical connections, switches, wiring, mounting system, hangers, and insulating material. Repair, replace, or tighten as necessary using insulated tools. or damaged.	Electrical connections, switches, wiring, and mounting systems lose

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before
D - During
A - After

D - Daily
W - Weekly
M - Monthly

Q - Quarterly
S - Semiannually
A - Annually

Item No.	Interval B	D	A	D	W	M	Q	S	A	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				•							i. Wipe any corrosion or dirt from electrical components using dry cheesecloth or wipe with a damp soapy cloth, then wipe dry. Avoid using solvents to dean electrical components. Solvents often leave a greasy film that reduces electrical conductivity.	
					•						j. Check electrolyte specific gravity. **NOTE** **Extreme temperatures may have an adverse effect on the battery banks Since It Is on the deckhouse top, battery bank Is exposed to high temperatures and climatic changes. This exposure increases evaporation of electrolyte from batteries and requires more frequent checks of electrolyte level and specific gravity.**	
2						•				Cables	a. Clean and inspect all components. Starting from power panel 3 circuit breaker 10P13, inspect each cable as it leaves the panel. Check fastenings as they exit switchboard and all fasteners, mounting hardware, and hangers to make sure they are tight.	
						•					b. Check each cable on both sides of its passage thru bulkheads. Check that cables and/or electrical conduit are tight, not rubbing or chafing. and free of corrosion and dirt. Conduct same inspection of cables as they pass thru decks and other structural parts of barge.	Electrical cables and conduits are corroded or dirty.
						•					c. Check each cable at its destination to make sure it is firmly attached, not rubbing or chafing, and is free of corrosion and dirt.	Cables not firmly attached.
3					•					All Components	a. Check that all components are securely fastened. Tighten any loose fasteners.	
					•						b. Check all components for possible damage. Repair or replace as necessary. If emergency system has not been activated for 7 days, activate the system and make sure all components are operational. Troubleshoot and repair as indicated.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
					SHIP SERVICE GENERATOR (SSG) SYSTEM	**WARNING** **Ear protection must be worn In voids 4 when any generator Is operating.** **WARNING** **At operating temperatures, engine coolant Is hot and under pressure. It also contains alkaline materials harmful to eyes and skin. To avoid personal Injury check coolant level only when engine Is stopped and filler cap Is cool enough to be touched by the bare hand.** **If coolant comes In contact with eyes or skin, immediately flush affected area with clean water and seek medical assistance;** **CAUTION** **Sensing element must be submerged In coolant to operate. If coolant is low, engine can overheat and automatic shutoff will not function to prevent damage to engine.**	
1	•			10 hrs	Engine	a. Check engine coolant level-should not be more than 112 in. below filler pipe. Fill with dean, fresh water (low in scale-forming minerals but not softened water) - see table below. Add cooling system conditioner to water before filling. Conditioner should be 3 percent by volume of total coolant capacity (about 112 pint of conditioner per 2 gallons of water). *Water Content* / *50% Antifreeze 50% Water* / *Without Antifreeze* Chlorides: 100 ppm or less / 50 ppm or less Sulfates: 00 ppm or less / 50 ppm or less Hardness as $CaCo_3$: 200 ppm or less / 100 ppm or less Dissolved Solids: 500 ppm or less / 250 ppm or less pH: 6.5 or higher / 6.5 or higher ppm = parts per million	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
	•			10 hrs		b. Check that engine crankcase oil is between ADD and FULL marks on dipstick. If necessary, add oil at oil fill boated above oil dipstick on accessory end of engine. Oil must meet engine service classification CD (MIL-L-2104) or CD/TO-2. See table below for engine crankcase lubrication. Diesel engines on board use 15W40 crankcase lubricant for normal temperatures. Use SAE40 if temperatures consistently exceed 120°F.	
	•			10 hrs		c. Clean air cleaner element by performing the following: 1) On air cleaner, unlatch two rackover latches. Remove air cleaner cover and filter element. 2) Cover turbocharger Intake opening located inside the air cleaner body. 3) Clean inside of air cleaner cover and body with clean cloth and solvent. Wipe dry.	

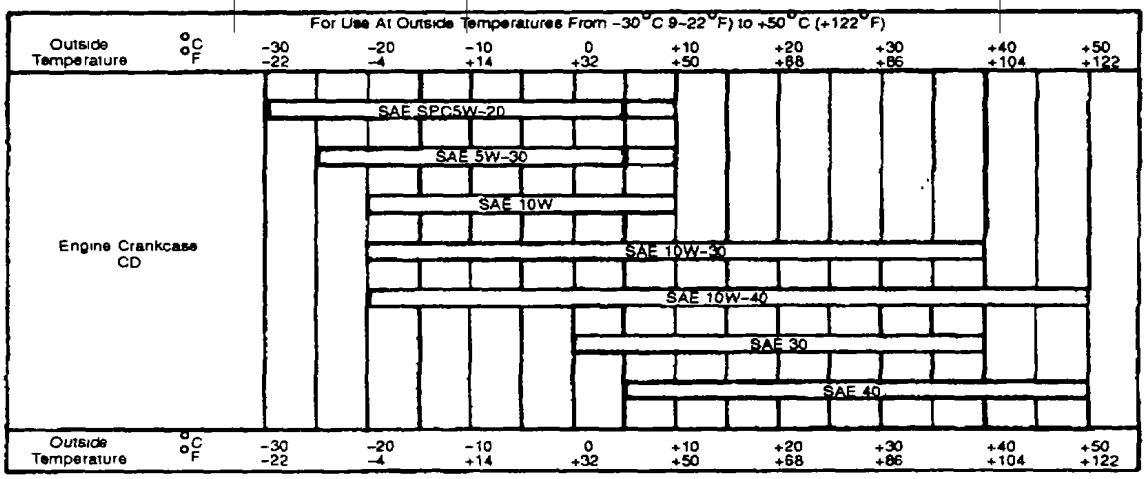


Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
	•			10hrs		**WARNING** **When using compressed air for cleaning filter elements, wear face shield and clothing that completely covers the body and limbs. Shirt-sleeves must be rolled down and buttoned and collar buttons fastened.** **CAUTION** **Do not clean element by bumping or tapping them on hard objects.** 4) Clean filter element with compressed air directed first inside along the length of pleats in the element and then outside along the length of pleats and again on the inside. Filter elements may also be cleaned with a vacuum cleaner if element is not too. greasy. **NOTE** **If compressed air does not clean elements, wash In a warm soapy water solution. Rinse and blow dry.** 5) Inspect filter element by placing a light inside a clean, dry element. Check for rips, tears, or holes in element material. If damaged, discard and obtain new. **NOTE** **If excessive exhaust smoke and/or loss of power continue after servicing air cleaner, discard that element and Install a new one.** 6) Remove covering from turbocharger inlet inside air cleaner body. 7) Install cleaned or new element. Place cover on body and lock in place with two rackover latches.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
		•				d. With generator load applied, check from switchboard: 1) PRESS-TO-TEST Engine Failure Lights. 2) PRESS-TO-TEST 440-Voltt Ground Detection Light. 3) Report failures to shift leader or bargemaster.	
		•				e. With engine idling, check that oil pressure gauge shows positive pressure. If not, stop engine and report problem to shift leader or bargemaster.	Oil pressure gauge does not indicate positive level.
						f. With engine idling. check that fuel pressure gauge on engine is normal (green) range. If not, report problem to shift leader or bargemaster.	Fuel pressure gauge does not indicate normal (green) range.
		•			exceeds	g. With engine idling, check that coolant temperature gauge is registering. As engine warms up, gauge should move to higher reading. H gauge does not register or it temperature exceeds operating limits, stop engine and report problem to shift leader or bargemaster.	Gauge does not register or temperature operating limits.
	•			50 hrs		h. Check that batteries and battery cables and connections are tight, corrosion free and coated with anti-corrosion grease. **WARNING** **Fumes from batteries may be flammable and explosive. Do NOT smoke or have open flame when checking or working on battery bank. Battery electrolyte presents potential health hazards. Contact with eyes and skin should be avoided. Safety glasses, gloves, and rubber aprons must be worn when handling this chemical. Electrolyte contains sulfuric acid which can cause severe burns and Is highly toxic to skin, eyes, and respiratory system.**	
	•			50 hrs		i. Check batteries for proper electrolyte level. Add distilled or clean tap water to bring level above plates.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
		•				J. From switchboard, with generator load applied, check that battery charger ammeter indicates batteries being charged. Report failures to shift leader or bargemaster.	
	•			10 hrs		k. Drain water and sediment from fuel/ water separator (on barges 2 and 3 only).	
	•					l. Check that seawater is available for heat exchanger. Make sure both stem seawater strainer baskets are clean and operable.	Seawater is not available for heat exchanger.
	•			250 hrs		g. Change crankcase oil and oil filter element by performing the following: 1) Run engine until oil is hot. Turn off engine by following procedures: (a) Make sure electrical load has been transferred to other generator sets and that applicable circuit breaker *(P1* for SSG 1 or P2 for *SSG* 2) is open (OFF). (b) Operate engine at idle speed for 5 minutes. (c) At engine, push engine START/ STOP switch to STOR 2) Redtag affected SSG on switchboard panel indicating, "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE." 3) Open bilge drain valve (BD16 for SSG 1, BD17 for SSG 2) below oil dipstick. Drain at least 1 pint of oil into dean container for Army Oil Analysis Program (AOAP). Close valve. Send marked oil sample to IDS or IGS unit for analysis.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		4) Plug flexible utility hose from bilge pump into quick-disconnect connection below oil dipstick Open engine oil drain valve (BD16 or BD17). Set bilge drain valves as follows: (a) Open valves BD7 and BD11. (b) Close valves BD1 thru BD6, BD8 thru BD10, and BD14. 5) Start bilge pump. 6) When oil has been pumped out of crankcase, dose valves BD16 or BD1 7. Disconnect bilge utility hose and dean any oil spills. Drain and clean bilge utility hose before storing. 7) Above oil dipstick, unscrew cylindrical oil filter element by turning from right to left. Discard old filter element. 8) Clean oil filter housing and lip where oil filter element fits into housing. Make sure all of old gasket is removed and gasket seat on housing is dean. 9) Lubricate new gasket with clean oil and place on seat of new filter element. Screw on new filter element until gasket contacts base of filter housing. Hand tighten filter an additonal 314 turn. 10) Fill engine with 7.3 gal of lubricating oil that meets engine service classificaton CD (MIL-L-2104) or CDFTO-2. For operating in normal temperatures, use SAE 15W40. H temperature in the voids consistently exceeds 120'F. use SAE 40. Filler cap is above oil filter and at the accessory end of the engine. 11) Start engine and run for 5 minutes at idle. Shut down and check oil level. Top off if necessary.	Filter element leaks.

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		h. Check and maintain the crankcase ventilation system as follows: 1) Empty and clean glass collecting bowl located at bottom of filtering system. (a) Remove bowl by pulling down metal tab of cage holding the bowl. (b) Unsnap wire cage on each side of bowl bottom. (c) Remove bowl, wipe with clean cloth. Do not use abrasives. (d) Replace bowl in reverse order. 2) Change engine crankcase filter system vapor filter element. (a) Snap off two metal clips on top of filter body. (b) Lift off top and replace element. Discard and replace with new element. (c) Reinstall in reverse order.	
				250 hrs		**CAUTION** **Never add coolant to an overheated engine. Allow engine to cool first.** i. Check engine coolant level and add as required. 1) Mix antifreeze to provide protection to the lowest expected ambient temperature. **NOTE** **When filling cooling system, allow for addition of conditioner.**	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		2) To avoid air pockets, add coolant slowly, at 5 US gal (19 L) per minute or less. Cooling system holds 5.25 US gal. **WARNING** **Cooling system conditioner contains alkali. Avoid contact with skin and eyes.** **CAUTION** **Never use both the liquid cooling system conditioners and coolant conditioner elements at the same time.** **Do not use cooling system conditioner or coolant conditioner elements with Dowtherm 209 Full-Fill coolant** 3) Add cooling system conditioner to achieve a 3 percent concentration or insert the proper precharge element." 4) Bring the coolant level to within 1/2 in (1 cm) of the bottom of the fill pipe. **NOTE** **When refilling cooling system, coolant level must be rechecked when engine reaches operating temperature.** 5) Start engine with coolant cap off. Add coolant, if necessary, when engine reaches operating temperature and coolant level stabilizes.	
				250 hrs		j. Test, as required, for defective glow plugs and replace as follows (on barges 2 and 3 only): 1) Disconnect the wire lead from the glow. plug terminal on the HEAT-START switch. 2) Install an ammeter with a capacity of over 75 A, in a series, between the disconnected lead and the terminal on the HEAT-START switch.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		3) Turn HEAT-START switch to HEAT. 4) Observe the ammeter. Each 12 V glow plug draws approximately 12.5 A and each 24 V glow plug draws approximately 6.5 A The ampere draw of one glow plug multiplied by the number of engine cylinders will be the total ampere draw of the glow plugs in the engine. A low reading indicates one or more defective glow plugs. 5) If a defective glow plug is indicated, disconnect one glow plug lead at a time. 6) Turn switch to the HEAT position. Observe the ammeter. Reconnect the lead. 7) The glow plug that does not change the reading on the ammeter, when the switch is turned on, is the defective glow plug. 8) To replace the defective glow plug, disconnect the lead wire at the defective glow plug. 9) Remove the defective glow plug. 10) Apply ant-seize compound to the threads of the new glow plug. 11) Install the new glow plug and tighten to a torque of 45 to 53 N (10 to 12 lb/ft). 12) Turn the HEAT-START switch to the HEAT position and observe the ammeter reading. 13) Release the switch. 14) Install the lead wire. 15) Turn the HEAT-START switch to the HEAT position. The reading should be increased. If the reading is the same, check the glow plug wiring. 16) Disconnect the test ammeter.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		k. Check zinc anode module on right side of heat exchanger (Figure 3-20). Unscrew plug. Remove anode and compare to new anode. If 50 percent or more has been consumed, replace anode. l. Remove red tag from SSG switchboard panel.	
				250 hrs		m. Drain, flush it necessary, and refill cooling system. 1) Remove coolant filler cap and engine block drain plug between oil filter and power end of block Also remove drain plug from coolant interchange tank Allow coolant to drain to bilge. When operation is completed, pump bilge dry. 2) Clean drain plug and install. 3) Check filler cap gasket. If damaged,' obtain new cap or install new gasket in cap. 4) Fill coolant system slowly with 5 gal of clean fresh water. 5) Drain fresh water from cooling system and check for impurities and discol-oration. 11 water is dean, install drain plug and proceed. If water is exces-sively dirty or cloudy, flush using the following procedures: (a) Remove engine block and radiator drain plugs to completely drain system. (b) Install drain plugs. Fill system with a commercially available cleaning solution or 1 kg (2 lb) Sodium Bisulfate (NaHSO4) per 40 L (10 US gal.) water. (c) Start and run for 112 hour. Stop engine and drain cleaning solution. (d) Flush system with clean water until draining water is dean. Do not run engine while flushing.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		(e) Install all drain plugs. Fill system with neutralizing solution or 250 g (1/2 lb) Sodium Carbonate Crystals (Na2CO.H20) per 40 L (10 US gal.) water. (f) Start and run engine for 10 minutes. Stop engine and drain neutralizing solution. (g) Flush system with clean water, until draining water is dean. Do not run engine while flushing. (h) Install all drain plugs. (i) Fill engine with clean water. Run the engine for 10 minutes and drain. Repeat until drained water is clean. (j) Add 1 L (1 qt) of Caterpillar Cooling System Conditioner, or equivalent. for each 30 L (8 gal) of cooling system capacity so cooling system will have a 3 percent to 6 percent concentration of conditioner. Most systems will require 2 L (2 qt) of conditioner at initial fill and .50 L (1 pt) every 250 service hours. (k) Mix antifreeze and water to provide protection to the lowest expected ambient temperature. (I) To help avoid air locks, add coolant slowly, at 19 L (5 US gal) per minute or less. 6) Fill cooling system with 5 gal of clean fresh water. Add 2 qt of coolant system conditioner. 7) Bring coolant level to within 112 in of bottom of filler pipe. 8) Start engine with radiator cap off. When coolant level stabilizes, add additional water if necessary.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		9) When coolant is at proper level and level stabilizes, replace radiator cap.	
				250 hrs		n. Check tubes in heat exchanger expansion tank for scaling. 1) If obstructed or scaled, clean tubes by passing a rod slightly smaller than the internal tube bore thru the tubes. Do not use excessive force. 2) If expansion tank tubes are so clogged that a rod cannot be passed thru them, completely remove the core and clean by boiling in a caustic soda solution or with a commercial cooling system cleaner. 3) Reassemble the heat exchanger and activate. o. Remove red tag from generator switchboard.	
				500 hrs		a. Service primary and final fuel filters by performing the following: 1) Redtag affected SSG on switchboard panel indicating, “WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE.” 2) Shut off fuel tank supply valve on engine. 3) Loosen nut on top center of primary filter body. Lower filter case. 4) Remove filter element. Wash both element and filter case in clean, non-flammable solvent. 5) Reinstall element in reverse order. 6) Remove and discard final filter element by turning from left to right (right-hand thread). 7) Remove all old gasket material. Clean gasket sealing surface in filter mount.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				500 hrs		8) Lubricate gasket of new filter with clean fuel. 9) Install new filter and tighten by hand until gasket contacts base. Then tighten 1/2 to *3/4* turn more.	
				500 hrs		b. Prime engine fuel system by performing the following: 1) Move governor control to OFF. 2) Open vent valve on fuel injection pump housing and spread spill cloths to absorb fuel from vent valve. 3) Unlock fuel priming pump by turning knurled knob counterclockwise. Operate priming pump until fuel flows from vent valve in a continuous stream without bubbles. 4) Close vent valve. Lock fuel priming pump by turning knurled knob dockwise. Clean any spilled fuel oil. 5) Move governor control to RUN. **NOTE** **If engine misfires or has excessive exhaust smoke, further bleeding of fuel system Is necessary. Loosen fuel lines at the cylinder head and crank engine until fuel flows free of air bubbles. Tighten fuel lines. Clean any spilled fuel oil.**	
				500 hrs		c. Change air cleaner element. Instead of cleaning old element, replace with new element.	
				500 hrs		d. Lubricate fan bearing fitting NLGL No. 2 Grade Multipurpose-type Grease. e. Remove red tag from SSG switchboard panel.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				1000 hrs		a. Notify Direct(General Support for 1000 hours service requirements for operational check of engine shutoff controls for: 1) High water temperature 2) Low oil pressure 3) Overspeeding 4) Overcranking 5) Reverse power b. Redtag affected SSG on switchboard panel indicating, 'WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE." c. Lubricate governor linkage. d. Fill the oil cup on the synchronizing motor for the Woodward PSG Governor. e. Lubricate one fitting on the tachometer drive. f. Change fuel filter.	
				2000 hrs		a. Notify Direct/General Support for 2000 hour service meter requirement for measuring and if necessary, adjusting valve lash and valve rotation as follows: 1) Redtag affected SSG on switchboard panel indicating, “WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE." 2) Stop engine and dean the base of the valve cover to prevent dirt from getting into valve mechanism. 3) Remove the valve cover. 4) Remove the flywheel housing timing plug.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				2000 hrs		5) Using flywheel Engine Turning Tool 5P7307, turn the flywheel to close No. 1 exhaust and inlet valves, aligning plug hole in the flywheel housing with the hole in the flywheel. The engine is now on Number 1 Top Center Compression Stroke. 6) Install a 63.5 mm (2 112 in) long 9.40 mm (3/8 in) NC bolt into the flywheel through the flywheel housing. 7) Measure the lash for the valves shown in the Compression Stroke Charts. If valve clearance is within i .003 in (0.07 mm of the clearance given), adjustment is not required. d clearance is not within these limits, adjust the valves. **3306** **COMPRESSION STROKE** VALVES — CYLINDERS INLET — 1-2-4 EXHAUST — 1-3-5 **EXHAUST STROKE** VALVES — CYLINDERS INLET — 3-5-6 EXHAUST — 2-4-6 8) Remove the timing bolt from the flywheel. 9) Rotate the flywheel 3600 and install the timing boy in the flywheel. 10) Measure the ash for the valves shown in the Exhaust Stroke Charts. 11) Remove bolt from flywheel and install plug in flywheel housing. 12) Remove the engine turning group and install the staring motor. 13) To adjust valves, loosen the locknut on the adjusting screw.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				2000 hrs		14) Turn the adjusting screw to obtain the proper valve lash. 15) Hold the adjusting screw and tighten the locknut to 29 ± 7 Nom (21 ± 5 lb/ft). 16) Measure the valve lash and adjust as necessary. 17) After adjusting valve lash, and before installing the valve cover, start the engine and run at low idle. 18) Watch the valve rotocoils for rotation. 19) Each valve rotocoil should turn slightly each time the valve opens. I a valve fails to rotate, IDS/IGS maintenance should remove valves and make necessary repairs. 20) Stop the engine. Inspect the valve cover gasket. Use a new gasket if the used gasket is damaged. 21) Install the valve cover. Tighten bolts to 11±3 N•m (8±2 lb/ft).	
				4000 hrs		a. Lubricate inboard and rear bearings as follows: 1) Redtag affected SSG on switchboard panel indicating, “WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE." 2) To lubricate the rear bearing, remove the two lower panels from the rear of the generator housing and: (a) Remove the upper and lower grease fitting plugs. (b) Install a grease fitting in the upper threaded hole.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				4000 hrs		(c) Lubricate with grease gun, two pumps. Use MPG. NLGI No. 2 grade is suitable for most temperatures. Use NLGI No. 1 or 0 grade for extremely low temperatures. (d) Install the lower plug. Wipe off excess grease. (e) Remove the fitting from the upper threaded hole. (f) Start the engine and allow the grease to expand. (g) Stop the engine. Install the plug in the lower hole and wipe off excess grease. (h) Install the two panels. 3) To lubricate the inboard bearing, remove the cowl cover from the rear of the generator housing and: (a) Remove the right side and lower grease pipe plugs. (b) Install a grease fitting in the right side threaded grease pipe. (c) Using a grease gun, lubricate tow pumps. Use Multipurpose-type Grease (MPG). NLGI No. 2 grade is suitable for most temperatures. Use NLGI No. 1 or 0 Grade for extremely low temperatures. (d) Install the lower plug. Wipe off excess grease. (e) Remove the fitting from the right side grease pipe.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						(f) Start the engine and allow the grease to expand. (g) Stop engine. Install the plug in the lower grease pipe and wipe off excess grease. (h) Install the cowl cover. b. Remove red tag from affected SSG switchboard panel.	
					SHIP AUXILIARY GENERATOR (SAG) SYSTEM	**WARNING** **Make sure all electrical components are electrically dead before starting any cleaning or Inspection procedures. Circuit breakers must be open (OFF) and appropriately tagged to avoid accidental activation during these procedures.** **CAUTION** **Never overfill crankcase. Fill only to maximum level as indicated on dipstick.**	
1	•			•	Engine	a. Check crankcase engine oil level on dipstick on left side of engine. If not up to FULL mark, add lubricating oil through filler on top of engine. Use SAE 15W40 that meets MIL-L-2104 (API "CDI"). If temperature in voids consistently exceeds 120^{o}F, use SAE 40. **WARNING** **At operating temperature, engine coolant is hot and under pressure. To avoid personal injury, check coolant level only when engine Is stopped and the filler cap is cool enough to be opened with a bare hand.**	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	Interval D	Interval A	Interval H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						NOTE **Cooling system has an anticorrosion zinc anode in coolant heat exchanger. Do not use water conditioner.**	
	•		•			b. Check coolant in heat exchanger (header) tank Level should be less than 1 in below bottom of neck opening. If necessary, add clean fresh water to bring to required level. If cap gasket is torn or damaged, repair or replace gasket.	
		•				c. With engine idling, check that oil pressure gauge shows positive pressure. If not, stop engine and report problem to shift leader or bargemaster.	Oil pressure gauge does not show positive pressure.
		•				d. With engine idling check that fuel pressure gauge on engine is normal (green) range. If not, report problem to shift leader or bargemaster.	Fuel Pressure gauge on engine does not read normal (green).
		•				e. With engine idling check that coolant temperature gauge is registering. As engine warms up, gauge should move to higher reading. If gauge does not register or H temperature exceeds operating limits, stop engine and report problem to shift leader or bargemaster.	Gauge does not register or temperature exceed operating limits.
2		•			Switchboard Control Panel	a. Check that VOLTMETER reads 440 Vac. if not report to shift leader or bargemaster.	Voltmeter does not read 440 Vac.
		•				b. Check that FREQUENCY METER reads 60 Hz. If not, report to shift leader or bargemaster.	Frequency meter does not read 60 Hz.
		•				c. Check that AMMETER reads 0. If not, report to shift leader or bargemaster.	Ammeter does not read 0.
	•		•			d. In extreme humidity, check for condensation buildup which causes corrosion. Apply low level heat for several hours as soon as condensation becomes noticeable.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
3					Batteries	**WARNING** **Fumes from batteries may be flammable and explosive. Do NOT smoke or have open flame when checking or working on battery bank. Battery electrolyte presents potential health hazards. Contact with eyes and skin should be avoided. Safety glasses, gloves, and rubber aprons must be worn when handling this chemical. Electrolyte contains sulfuric acid which can cause severe burns and is highly toxic to skin, eyes, and respiratory system.**	
	•		•			a. Check batteries and battery cables and connections are tight and corrosion tree and coated with anti-corrosion grease.	Batteries, cables and connections are loose or corroded.
	•		•			b. Check batteries for proper electrolyte level. Add distilled or clean tap water to bring level above plates.	
4	•		•		Crankcase	Check and maintain the crankcase ventilaton system as follows: 1) Empty and clean glass collecting bowl located at bottom of filtering system. (a) Remove bowl by pulling down metal tab of cage holding the bowl. (b) Unsnap wire cage on each side of bowl bottom. (c) Remove bowl, wipe with clean cloth. Do not use abrasives. (d) Replace bowl in reverse order. 2) Change engine crankcase filter system vapor filter element. (a) Snap off two metal dips on top of filter body. (b) Lift off top and replace element. Discard and replace with new element. (c) Reinstall in reverse order.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
5				250 hrs	Primary and Fuel Pump Filters	Service primary and fuel pump filters by performing the following: 1) Shut off fuel tank supply valve on engine. 2) Clean exterior of filter assembly. 3) Loosen setscrew on top of primary filter head. Remove filter and lower base. 4) Make sure all of old gasket material (sealing ring) is removed from inside filter head. 5) Wash both filter head and lower base in clean nonflammable solvent. Dry with lint-free cloth. Make sure parts are free of any lint, threads, dirt, or matter that could plug fuel lines. 6) Lubricate new gasket (sealing ring) with clean fuel oil. Install filter head. Place new filter element on lower body squarely against filter head and tighten setscrew. 7) On fuel pump, loosen screw in center of housing. Remove round cover and pulsator diaphragm. 8) Clean sediment chamber in fuel pump. Clean diaphragm; make sure it is not torn, punctured, or otherwise damaged. If not serviceable, replace with new diaphragm. 9) Refit pulsator diaphragm and cover. Tighten securing screw just sufficiently to make a fight seal. Do NOT use any sealant or lubricant on fuel pump base/diaphragm/cover connection.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
6				250 hrs	Engine Fuel System	After servicing fuel filters, prime engine fuel system by performing the following: **CAUTION** Air must be vented from fuel system whenever any part of system between fuel tank and Injection pump has been disconnected for any reason or when system has been emptied of fuel. Injection pump Is lubricated by the fuel it Is pressurizing and metering. if air enters Injection pump, It may be severely damaged. Never attempt to start engine until Injection pump has been filled and primed. Procedures to make sure Injection Is primed with fuel If system has been run dry, are on pages N.14-15, Perkins Engines Workshop Manual, 4.236M. The following Instructions are only for priming fuel system after a PMCS of fuel filters. 1) Remove vent plug on filter cover. Loosen joint at filter end of filter to tank return pipe. 2) Place shop cloths below filter assembly to absorb fuel oil spills. 3) Operate fuel pump priming lever until fuel oil that comes out of filter cover vent is free from bubbles. **NOTE** If fuel pump priming lever will not operate-, cam on engine camshaft driving fuel pump Is on maximum lift. Engine must be turned by hand one complete revolution before priming lever will operate. 4) Replace vent plug on filter cover. Continue operating priming lever until fuel oil that comes from around threads of the return pipe is free from bubbles. Tighten return pipe joint. 5) Loosen joint at filter to injection pump feed pipe. Operate priming lever until fuel oil that comes from around threads of this pipe Is free from bubbles. Tighten joint.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						NOTE Some 4236M engines May not hove a vent plug on filter we8nibly. In this case, remove, rather loosen, filter end of filter-tank return pipe. Use this as vent plug. If engine misfires or has excessive exhaust smoke, further bleeding of fuel system is necessary. Loosen fuel lines at cylinder head. Crank engine until fuel flows free of *air* bubbles. Tighten fuel lines. Clean any spilled fuel oil.	
7				250 hrs	Cooling System	a. Drain, flush if necessary, and refill cooling 1) Remove coolant filler cap. Open engine block drain on right side of engine block just in front of flywheel housing. Also open drain tap on exhaust manifold housing. Remove drain plug from coolant interchange tank. Allow coolant to drain to bilge. When operation is completed, pump bilge dry. 2) Clean drain plug and reinstall. 3) Check filler cap gasket. If damaged, obtain new cap or install new gasket in cap. 4) Fill cooling system slowly with 3.5 gal of clean, fresh water. 5) Drain fresh water from cooling system Check for impurities and discoloration n water is clean, fti1 drain plug and proceed. If water is excessively dirty or cloudy, flush using the following procedures: (a) Remove engine block and radiator drain plugs to completely drain system.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		(b) Install drain plugs. Fill system with a commercially available cleaning solution or 1 kg (2 lb) Sodium Bisulfate (NaHSO4) per 40 L (10 US gal) water (c) Start and run for 1/2 hour. Stop engine and drain cleaning solution. (d) Flush system with clean water until draining water is dean. Do not run engine while flushing. (e) Install all drain plugs. Fill system with neutralizing solution or 250 g (1/2 lb) Sodium Carbonate Crystals (Na2CO.H20) per 40 L (10 US gal) water. (f) Start and run engine for 10 minutes. Stop engine and drain - neutralizing solution. (g) Flush system with clean water, until draining water is clean. Do not run engine while flushing. (h) Install all drain plugs. (i) Fill engine with clean water. Run the engine for 10 minutes and drain. Repeat until drained water is dean. j) Refill with antifreeze and water to provide protection to the lowest expected ambient temperature. (k) To help avoid airlocks, add coolant slowly, bringing coolant level to within l12 in of bottom of filler pipe. 6) Start engine with radiator cap off. When coolant level stabilizes add additional water if necessary. 7) When coolant is at proper level and level stabilizes, replace radiator cap.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		b. R engine runs cooler or warmer than normal or engine coolant temperature fluctuates , check thermostat. Perform the following: 1) Remove water connection between header tank and exhaust manifold by loosening both hose clips and sliding hose toward exhaust manifold. 2) Remove two setscrews holding water pipe to header tank 3) Remove setscrews holding top cover on thermostat housing. Remove cover and lift out thermostat. 4) Place thermostat in container of water and gradually heat. With an accurate thermometer, check water temperature at frequent intervals. Valve should start to open at temperature stamped on top face of thermostat next to valve seat. 5) If thermostat test shows it is opening and dosing at designated temperature , reinstall in housing in reverse order of removal. 6) If thermostat does not open and close at designated temperature. install new thermostat in reverse order of removal.	
8				125 hrs	Air Intake Filter	**NOTE** Every 125 hours of option or every 3 months (whichever comes first). a Clean air intake filter. 1) Redtag auxiliary generator switch-board control panel Indicating, 'WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE.' 2) Remove air cleaner cover and filter element.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				125 hrs		3) Inside air cleaner body, cover intake	opening.
						4) Clean inside of air cleaner cover and body with clean cloth and solvent. Wipe dry. **WARNING** When using compressed air for cleaning filter elements, wear face shield and clothing that completely covers body and limbs. Shirt sleeves must be rolled down and buttoned and collar buttons fastened. **NOTE** Do not clean elements by bumping or tap- ping them on hard object **NOTE** Air filter element may be either a disposable paper-type element or a reusable wire mesh screen. The following pertains to a reusable filter element	
				125 hrs		5) Clean filter element with compressed air. Direct air first inside along length of pleats in element and next outside along length of pleats. Then clean the Inside again. **NOTE** If compressed air does not clean element, wash In a warm soapy water solution. Rinse and blow dry.	
						6) Inspect filter element by placing a light inside a clean, dry element Check for rips, tears, or holes in element material. H damaged, discard and obtain new element.	
						7) Remove covering from inlet inside air cleaner body.	
						8) Install clean or new element. Place cover on body and tighten in place.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						NOTE	
						Every 125 hours of operation or every 3 months (whichever comes first).	
				125 hrs		b. Check zinc anode (zinc pencil) in power end of heat exchanger on right side of engine. Unscrew cover. Remove anode and compare to new anode. N 50 percent or more has been consumed, replace anode.	
				125 hrs		c. Check engine for oil, fuel, coolant, and Class III leaks. Sea water leaks. Tighten necessary.	
				as			
	•			125 hrs		d. Check exterior of engine for loose screws, nuts, bolts. fittings, and attach-ments. Tighten as necessary.	
	•			125 hrs		a. Check connections to generator and make sure they are tight, but not rubbing or frayed. Correct as necessary.	Connections are rubbing or are frayed.
				250 hrs		f. Remove red tag from SSG switchboard	panel.
						NOTE	
						Every 250 hours of operation or every 6 months (whichever comes first).	
9				250 hrs		a. Change crankcase oil and oil filter element.	
						1) Run engine until oil is hot. Turn off engine	using engine STOP cor
						2) Red tag auxiliary generator switch board	panel indicating. 'WAR
						3) Open valve bilge drain (BD) valve BD18.	Drain at least 1 pt of oil
						4) Using quick-disconnect coupling on bilge	drain BD18 on the SAG
						5) Connect other end of bilge utility hose to	bilge drain quick-discon

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						6) Open engine bilge drain valve BD18 and	set valves as follows:
						(a) Open valves BD7 and BD11.	
						(b) Close valves BD1 thru BD6, BD8 thru	BD10, and BD14.
						7) Start bilge pump by turning on bilge pump controller. Controller is on void 2 starboard bulkhead above bilge pump.	
						8) When oil has been pumped out of crankcase, simultaneously close valve BD18 and turn of bilge pump.	
						9) Disconnect bilge utility hose, clean, and return to storage in void 5.	
						10) Unscrew cylindrical oil filter element by turning from right to left. Discard old filter element.	
						11) Clean oil filter housing and lip where oil filter element fits into housing. Make sure all of old gasket is removed and gasket seat on housing is clean.	
						12) Lubricate new gasket with clean oil. Place on seat of new filter element. Screw on new filter element until gasket contacts base of filter housing. Hand tighten filter an additional 3/4 turn.	
						CAUTION Never overfill crankcase. Fill only to maximum level as Indicated on dipstick.	
						13) Fill engine thru oil filler on top of engine with 8.4 qt of lubricating oil. Use SAE 15W40 that meets Military 8pecifica- ton MIL-L-2104 (API CD for normal temperatures. When temperature in the voids consistently exceeds 1200F, use SAE 40.	
						14) Start engine and run at idle for 5 minutes. Turn off engine.	
						15) Check crankcase oil on dipstick and add oil if necessary to bring to maximum mark on stick Check for leaks around filter. Tighten by hand, if necessary.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		16) Clean all oil spills. 17) Make appropriate entry in maintenance records. NOTE The Perkins diesel 4.236M engine has been modified to accept Installation of the Olidex filtered and controlled crankcase ventilation system. b. Check water pump belts for damage, fraying, improper wear, and correct tension CAUTION When belt replacement Is necessary, belts must be replaced In complete, matched sets. Never replace only one belt. The new belt will carry all the load and fall rapidly. 1) To check belt tension, press down on the longest unsupprted length of the belt without using undue exertion. Normal tension should allow the belt to be depressed approximately 3/8 in. Adjust belt tension, as required as follows: (a) Loosen adjusting setscrews and bracket support bolts. (b) Move the alternator or water pump to obtain the correct belt tension. Hold in correct position. (c) Tighten the adjusting setscrews. 2) To replace water pump belts: (a) Loosen the adjusting lever setscrews and bracket support bolts. Pivot the alternator/water pump towards the cylinder block b) Turn the engine by hand to work the belts of the pulleys. (c) Remove and replace the belts. (d) Reverse the process for refitting the belts on the pulleys.	Belts damaged, frayed, worn.

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				250 hrs		(e) Adjust the belts for proper tension and tighten setscrews and bracket support bolts. (f) At the following daily PMCS inspection, recheck the belts to ensure proper tension. **CAUTION** Under no circumstances should the engine be allowed to operate at a higher than specified speed. Severe engine damage may result. Check engine speed specification when performing PMCS.	
				250 hrs		c. Adjust engine speed by turning the Idling screw clockwise to increase speed and counterclockwise to decrease speed.	
				250 hrs		d. Inspect engine for any fluid leakage. Cor rect as required.	
				250 hrs		e. Remove red tag from switchboard control panel.	
				250 hrs		f. Empty and change glass collecting bowl.	
10				200 hrs		a. Notify Direct Support maintenance of 200 hours of engine operation on auxiliary generator and request check of valve clearances as follows: **NOTE** When rotating engines, they should always be turned In their normal direction of rotation, I.e., counterclockwise when viewing from the gearbox end. The exception Is contra-rotating engines, or rotating them clockwise from the gearbox end.	
				200 hrs		1) The clearance is set between the top of the valve stem rocker and arm and 2) When setting valve clearances, the following should be adopted: (a) With the valves rocking on No. 4 cylinder (i.e., the period between the opening of the intake valve and the closing of the exhaust valve), set the valve clearances on No. 1 cylinder. (b) With the valves rocking on No. 2 cylinder, set the valve clearances on No. 3 cylinder.	should be 0.012 in (0.3(

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						(c) With the valves rocking on No. 1 cylinder, set the valve clearances on No. 4 cylinder. (d) With the valves rocking on No. 3 cylinder, set the valve clearances on No. 2 cylinder. b. Request Direct Support maintenance to service fuel injectors as follows: 1) Normally, defective injectors can be isolated by loosening the pipe union nut on each injector in turn while the engine is running at approximately 800 rpm. As each nut is loosened, fuel will not be injected into the associated cylinder and, as a result, the engine rpm will decrease if the injector was previously functioning normally. N the engine rpm remains constant, the injector is probably defective.	
				200 hrs		2) When installing a replacement injector remember to include also a new copper seating washer. These are special washers and ordinary washers cannot be used for this purpose. The recess in the cylinder head, the faces of the washer, and the corresponding face of the nozzle holder cap must be perfectly dean to ensure a leakproof seal. The importance of injectors being seated squarely and secured with the correct torque cannot be emphasized too strongly. Even a slight 'canting' of the injector can result in fouling and distortion of the nozzle and needle valve. This canting can also result in leakage between injector and cylinder head, with a resultant engine misfire. 3) Torque - To ensure squareness and free entry of the nozzle into its bore, the securing nuts must be tightened evenly until a torque of 12 lb/ft (1.7 Nom) is attained. Overtightening of these securing nuts can result in a fractured injector flange and/or a fouled nozzle needle valve.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
				200 hrs		c. Request Direct Support maintenance support to examine and service accessory equipment, fuel injector pump. alternator, starter, seawater pump, heat exchanger, engine oil cooler, and coolant pump. Service engine crankcase filter system. 1) Remove system and disassemble. 2) Clean all components except filter element. 3) Reassemble with new filter element and all new connecting hoses.	
11				400 hrs		**NOTE** Every 400 hours of operation or every 12 months (whichever comes first). a. Redtag SAG on switchboard panel indicating, 'WARNING - DO NOT ACTIVATE- REPAIRS BEING MADE." b. Check hoses and clamps. Replace hoses if there is any evidence of deterioration to hose material. Tighten clamps as necessary.	
12				400 hrs	Fuel Lift Pump Chamber	a. Notify Direct Support maintenance to dean the fuel lift pump chamber: 1) Remove the fuel lift pump cover and pulsator diaphragm by unscrewing and removing the cover screw. 2) Clean the sediment chamber and check the pulsator diaphragm for condition. Replace if necessary. 3) Refit the pulsator diaphragm and cover. Tighten the securing screw just sufficiently to make a tight sealing joint. 4) Vent and bleed the fuel system as follows:	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						CAUTION **Air must be vented from the fuel system whenever any part of the system between Fe fuel tank and Injection pump has been disconnected for any reason or If the system has been emptied of fuel.** (a) Unscrew by two or three turns, the vent plug on top of the fuel filter cover (not the return pipe to the tank). Later type fuel filters are self venting and do not have a vent plug. Air vent the fuel filter by removing the excess fuel return pipe. to the fuel tank, from the filter head. Operate the fuel feed pump priming lever until diesel fuel. free from air bubbles, issues from the nonreturn valve. Refit fuel return pipe. (b) Loosen the vent screw on the hydraulic head locking screw on the side of the fuel injection pump body. (c) Loosen the air vent screw on the side of the governor control cover. (d) Operate the priming lever of the fuel lift pump. (H the cam on the engine camshaft driving the fuel lift pump is on maximum lift, it will not be possible to operate the hand primer and the engine should be turned one complete revolution.) When diesel fuel, free from air bubbles, Issues from each vent point, tighten the connections in the following order: (1) Filter cover vent screw. (2) Head locking screw vent valve. (3) Governor cover vent valve. (e) Loosen the pipe union nut at the pump inlet Operate the priming device and retighten when diesel fuel, free from air bubbles, issues from around the pipe threads.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						(f) Loosen the unions at the atomizer ends of two of the HP pipes. (g) Set the accelerator at the fully open position and ensure that the %lop' control is in the 'run' position. (h) Turn the engine until fuel oil, free from air bubbles, issues from both fuel pipes. (i) Tighten the unions on both fuel pipes. The engine is ready for starting. (H fuel has been drained from the thermostat teed pipe, the pipe must be disconnected at the thermostat and all air bled from the pipe before the thermostat is operated.) b. Drain and clean fuel tank. c. Remove red tag from switchboard con- trol panel.	
13				800 hrs		Notify Direct Support maintenance to per form the following maintenance: **NOTE** **Every 800 hours of operation.** a. Check and service the heat exchange system for corrosion and scaling. or scaling. b. Redtag auxiliary generator switchboard control panel indicating, 'WARNING - DO NOT ACTIVATE - REPAIRS BEING MADE.' c. Perform check of seawater pump impeller as follows:	Heat exchanger system corroded

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						1) The rubber impeller type water pump is used for raw water circulation. It should never be run in a dry condition (impeller blades will tear). If the engine is not to be operated for any length of time, it will be *necessary* to pack the water pump with MARFAK 2HD grease. (It this is not available, glycerine may be used.) This is effected by removing the pump end plate to give access to the interior of the pump. Insert the grease, or glycerine, thru the top-most pipe connection (after removing the rubber hose). Turn the engine over to spread the lubricant. This treatment is usually effective for about 3 months and should be repeated if stored for a longer period of time. 2) A heat exchanger usually consists of a casing with a core (tube stack), which is the actual heat exchanger. The oil cooler usually has a smaller core and is sometimes an integral part Of the engine heat exchanger. 3) The heat exchanger and coolers should be serviced every season. Depending on operating conditions, this period may have to be reduced. Normal operating temperatures will vary slightly from engine to engine because of design tolerances, installation, and hull variations. Once the normal operating temperature has been established for a particular engine, any excessive rise in temperature should be considered abnormal and immediately investigated. If a cooling system problem is suspected (or confirmed) the following guidelines will provide a means for isolating the cause.	

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						WARNING **The coolant In an operating or recently stopped engine Is very hot and under pressure. if the filter pressure cap IS suddenly removed the liquid may spurt and cause Injury by scalding. Always stop an engine and allow It to cool before removing the cap. Once cool, loosen the cap slowly to relieve the pressure**. (a) Check the coolant level in the header tank and ensure the proper pressure cap is being used. lb) (b) Check the sea cock and strainer for obstructions; clean where necessary. (c) Check the seawater pump impeller. Replace if damaged. Ensure that no pieces of the impeller (it broken) have passed into the connecting pipes (i.e., inlet and outlet) to restrict water flow. (d) Check heat exchanger for obstructions within the cooling core tubes on the seawater side. Once the end cap and/or plates are removed, any scaling within the core tubes can be removed by passing a rod (slightly smaller than the internal bore) thru the tubes. Do not use excessive force when pushing the rod thru the tubes. (e) If the tubes are so dogged that a rod can not be passed thru them, the core will have to be removed from its casing and boiled in a caustic soda solution. Commercial cooling system cleaners can be used for this purpose. Reassemble with new gaskets, seals, and ' rings. (f) If a reduced power and/or excessive smoke condition exists in addition to an increase in coolant temperature with a turbocharged engine having an air charge cooler intercooler), check the intercooler and, if necessary, clean as described for heat exchangers.	Seawater pump impeller damaged.

Table C-1. Preventive Maintenance Checks and Services for Electrical Power Systems (Continued)

B - Before **D - During** **A - After** **H - Hourly Interval**

Item No.	Interval B	D	A	H	Item to be Inspected	Procedures: Check for and have repaired or adjusted as necessary	Equipment Is Not Ready/ Available If:
						(g) Check the exhaust manifold outlet elbows and the exhaust water injection connections for mud or sift, especially i the engine was operated in muddy or silty water. (h) Oil Coolers - both engine and gear box - can also affect engine coolant temperatures. Oil coolers should be checked and cleaned as described for heat exchangers. 4) Reconnect heat exchanger and reactivate. Check for leaks. d. Remove red tag from switchboard control panel.	

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official: 

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
06904

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	newton-meters	1.356	metric tons	short tons	1.102
pound-inches	newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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