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 11

EQUIPMENT MONITORING SYSTEM

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

Approved for public release; distribution Is unlimited

*This manual supersedes TM 55-1930-209-14&P-11, 30 January 1989.

HEADQUARTERS, DEPARTMENT OF THE ARMY
15 OCTOBER 1992

WARNINGS AND SAFETY NOTICES

WARNING

DANGEROUS VOLTAGES AND HAZARDOUS MATERIALS
ARE USED IN THIS EQUIPMENT.
DO NOT TAKE CHANCES!

GENERAL WARNINGS

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

SPECIFIC WARNINGS

- Do not connect any new circuit to an existing circuit.
- Do not energize circuits if water condensation is present.
- If any sparks are seen, stop operation immediately. Determine cause and take corrective action.
- Never touch radio antennas of fixed-base radio transmitters. When transmitting, antennas contain high voltage.
- Always use approved breathing apparatus when handling material in multimedia filters and chlorination unit 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
- Wan 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

INTRODUCTION TO

TM 55-1930-209-14&P-11

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 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 300WPB-3, NSN 1930-01-234-2165. This manual consists of twenty-one volumes

2. REVERSE OSMOSIS WATER PURIFICATION BARGES

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

3. VOLUME 1 -NORMAL OPERATIONS

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

4. VOLUME 2 -SEAWATER SYSTEM

This volume describes operation and maintenance of the seawater system which supplies seawater to the Reverse Osmosis Water Purification Units (ROWPUs) for processing to the air conditioning unit for 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 55-1930-209-14&P-2) to create product water. Chlorine is then added to this product water by the chlorination system (TM 55-1930-209-14&P-4). The resultant drinking water is discharged into four storage tanks that are part of the drinking water system (TM 55-1930-209-14&P-5).

6. VOLUME 4 -CHLORINATION SYSTEM Operation and maintenance procedures for the chlorination system onboard the Water Purification Barges are contained in this volume. This system produces chlorine in a sodium hypochlorite 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 blow down 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 crewmembers that corrective action is necessary.

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

15. VOLUME 13-HANDLING EQUIPMENT This volume contains operation and maintenance procedures for handling equipment used for lifting, transporting and repositioning equipment and materials onboard the barges. The system 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 bilge). 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 II and 24 Type V lifevests and 4 Lifesaving rings.

c. Firefighting Equipment -installed on the barges and consisting of Halon 1301 system, 2 CO2 hose reel units, a smoke detector system, 17 portable CO 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 (PMCS)** Volume 19 contains PMCS 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.

TECHNICAL MANUAL
NO.55-1930-209-14&P-11

HEADQUARTERS
DEPARTMENTOF THE ARMY,
WASHINGTON D.C., 15 OCTOBER 1992

TECHNICAL MANUAL

OPERATORS', UNIT, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST) FOR **WATER PURIFICATION BARGES (NSN 1930-01-234-2165) VOLUME 11 EQUIPMENT MONITORING SYSTEM**

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

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

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* Supersedes TM 55-1930-209-14&P-11, 30 January, 1989

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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 11

LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1 INTRODUCTION
Section I. General

1-1 Purpose. This Technical Manual (TM) describes the operation and maintenance of the Equipment Monitoring System (EMS) on Water Purfication Barges . Information on other systems installed onboard is in TM 55-1930-209-14&P-1 thru P-10 and P-12 thru P-17. TM 55-1930-209-14& P-18 contains appendices common to all TM's. Location of major barge components is shown in Figure 1-1.

1-2 Scope. This onboard EMS monitors operation of several equipment components onboard the Reverse Osmosis Water Purification Unit (ROWPU) barge and displays this data on a video monitor. It also uses alarms to alert crewmembers when an operating condition goes beyond a preset range.

1-3 Warranties and guarantees. Manufacturers' warranty/guarantee information is in Chapter 7.

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 procedures concerning this system, refer to Chapter 5 Section II. Description and data

1-7 Description. EMS main components are the alarm/casualty monitoring equipment, two 12-volt dry cell batteries, a battery charger, two strobe lights, two horns and a buzzer. Additional Information about EMS major components Is In Table 1-1 The alarm/casualty monitoring equipment consists of various sensors and switches, a main processor, keyboard, video monitor, alarm relay module, main power switch and a bilge alarm module. A block diagram of EMS components is shown In Figure 1-2. Figure 1-3 shows the arrangement of these components on the barge The installation Is also shown on drawings listed in Appendix A.

1-8 Capabilities. The EMS main processor unit can accept information from as many as 168 different Inputs (9 rate, 63 analog, and 96 switches) On the barge, however, only 39 are used. 1 rate, 13 analog, and 25 switches Table 1-2 lists the various EMS switches and sensors, their quantities and locations, and type of video monitor display. The keyboard and video monitor make up the station from which an operator selects and views any page of monitored information, acknowledges alarms, and sets or changes alarm conditions

1-9 Special limitations. The system is designed to operate between 32 and 131°F.

1-10 Performance characteristics

Power input	24 Vdc
Analog sensors	63
Switch sensors	96
Rate sensors	9

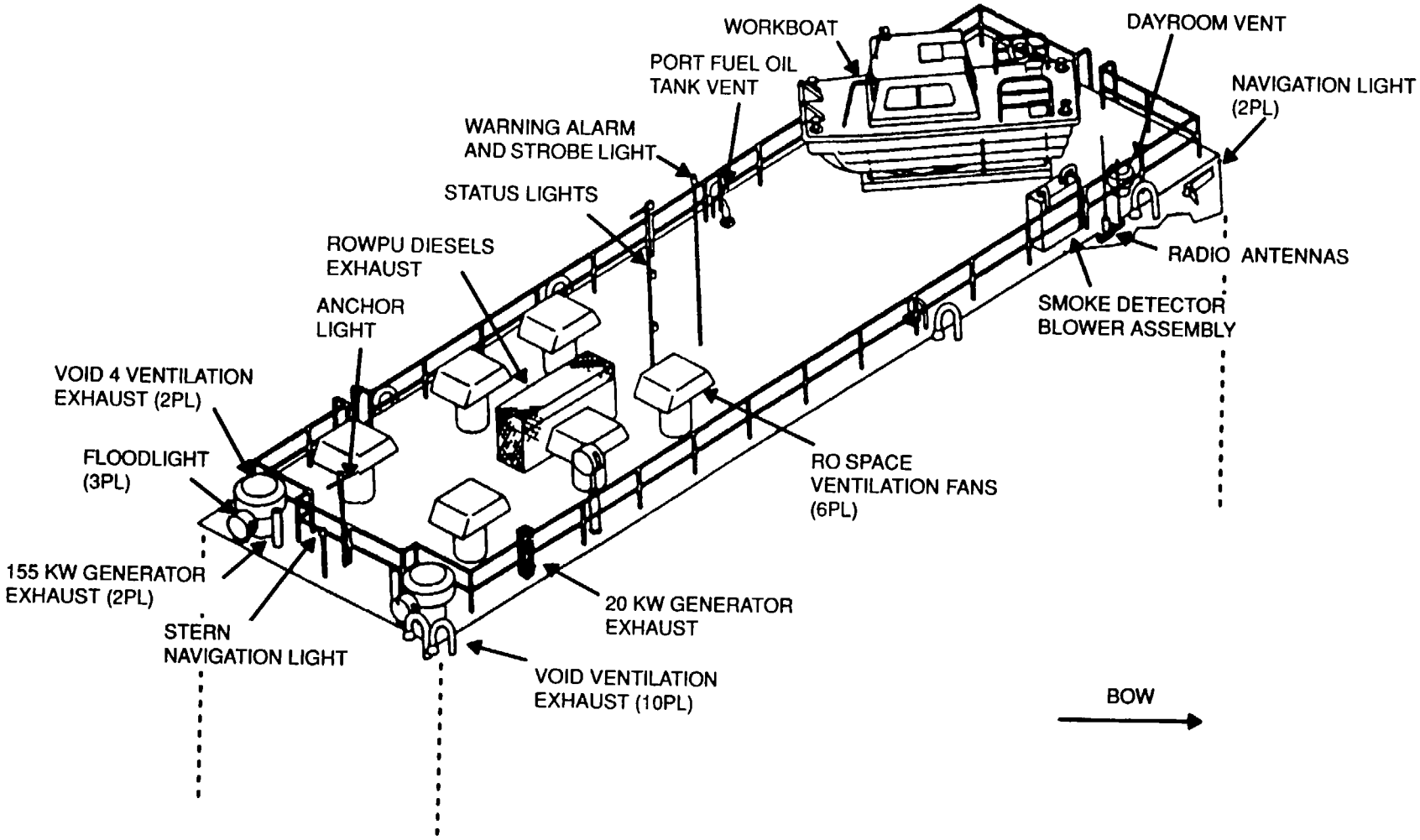


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment- Deckhouse Roof (Sheet 1 of 3)

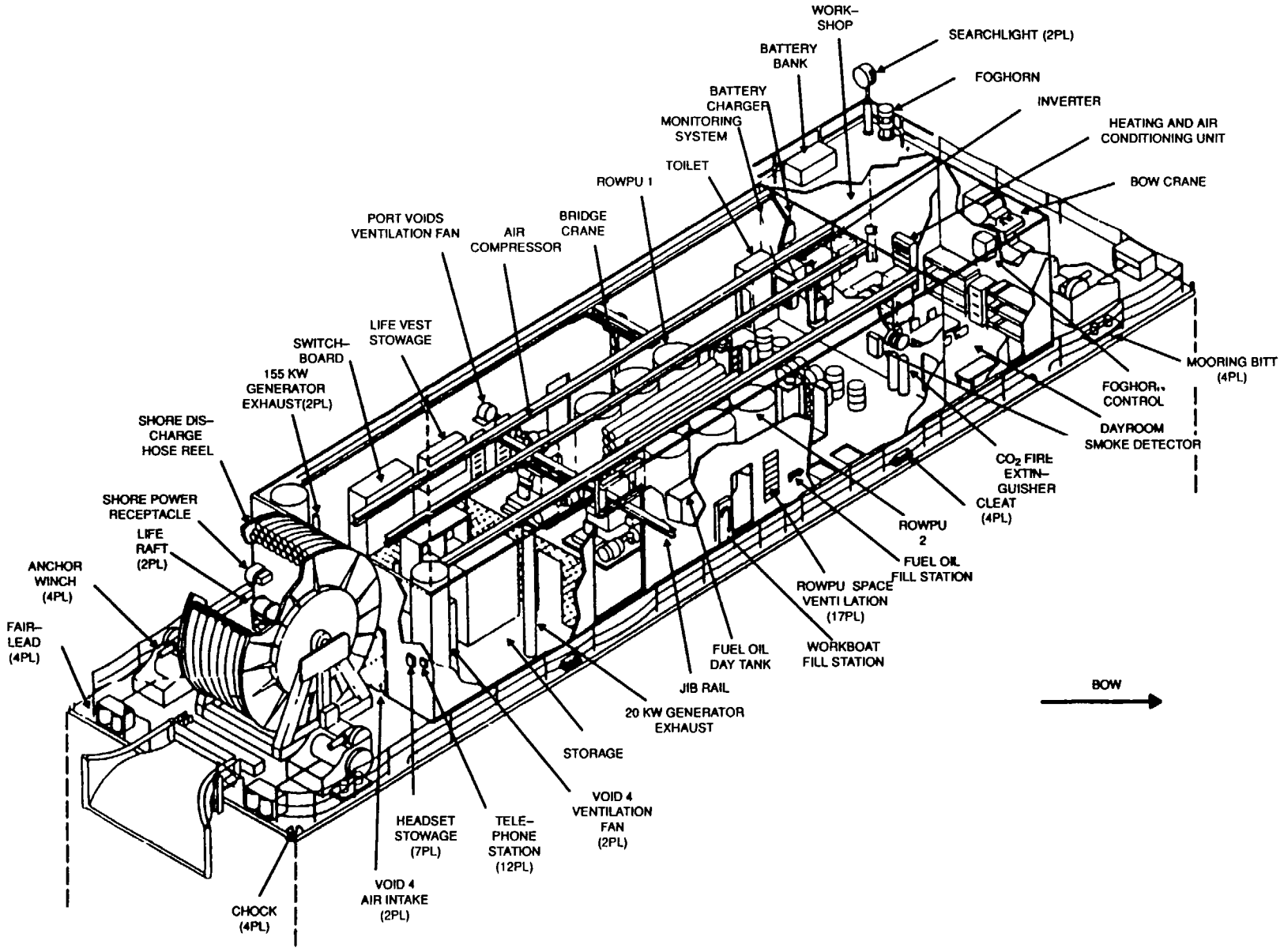


Figure 1-1. Major Components of ROWPU Barge Systems and Equipment- Deckhouse Roof (Sheet 2 of 3)

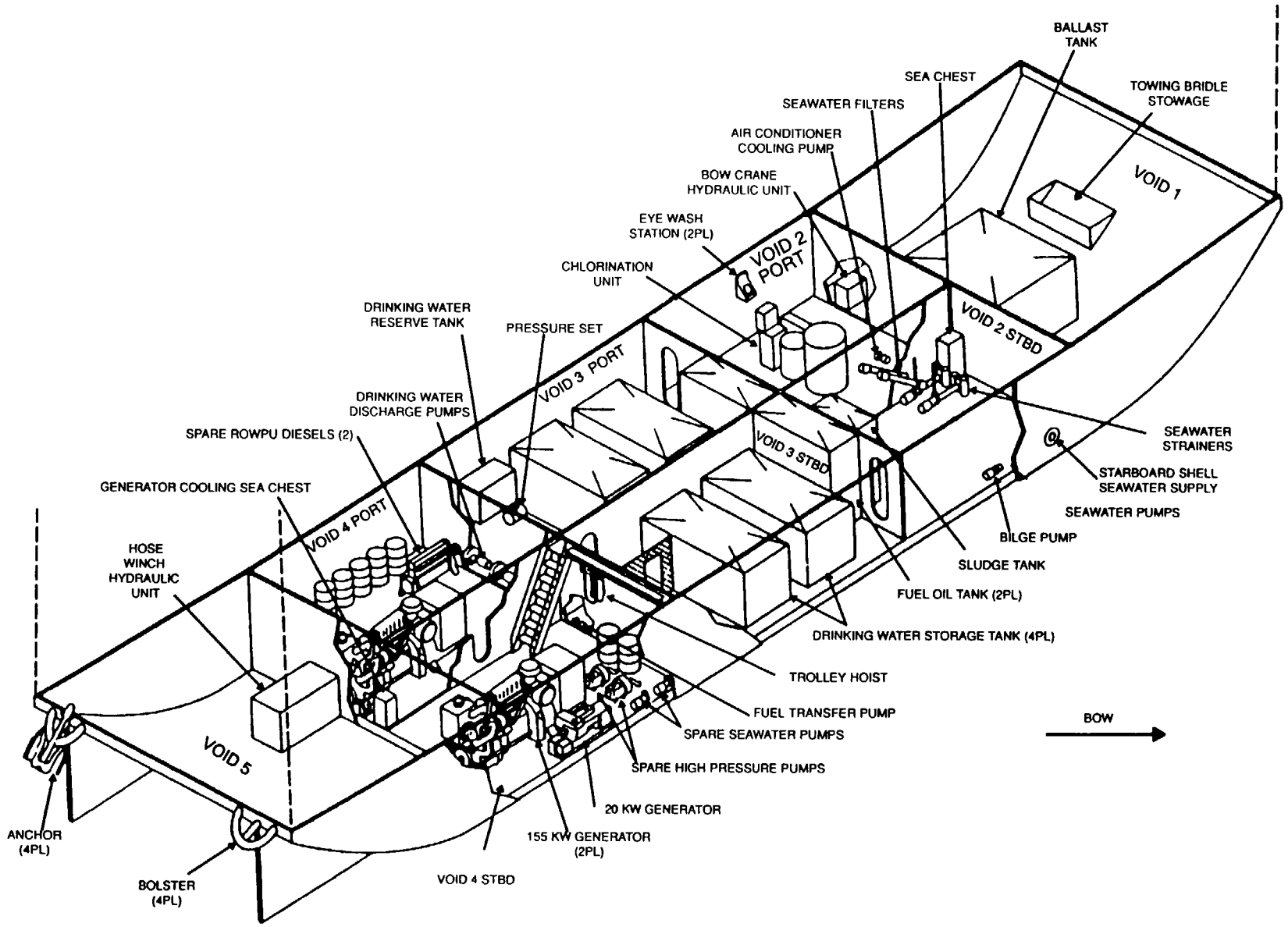


Figure 1-1. Major components of ROWPU Barge Systems and Equipment - Volds (Sheet 3 of 3)

Table 1-1. Equipment Monitoring System Main Components

Component	Quantity	Function	Location
Main processor	1	Receives and processes data from sensors and keyboard, displays data on video monitor and activates two strobe lights, two horns and buzzer	ROWPU space, forward, bulkhead
Keyboard	1	Selects page for viewing on video monitor, acknowledges alarms, In edit mode sets time and date, activates/deactivates sensors and sets alarm and reference points	ROWPU space, forward bulkhead under video monitor
Video monitor	1	Displays data processed by main processor in display page formats above keyboard	ROWPU space, forward bulkhead
Alarm relay	1	Activates alarms In ROWPU space and dayroom on signal from main processor	ROWPU space under keyboard
Bilge alarm module	1	Activates alarms on deckhouse top on signal from bilge sensors processor	ROWPU space, outboard of main
Horn	2	Sounds warning to crew in ROWPU space and weatherdecks that an abnormal condition exists space on forward bulkhead (Barge 1) and on overhead (Barges 2 and 3)	One on mast on deckhouse top, one in ROWPU
Strobe light	2	Flashes warning to crew that an abnormal condition exists	One with each horn
Buzzer	1	Sounds warning to crew In dayroom that abnormal condition exists	Dayroom, aft bulkhead
1'2-volt gel cell battery	2	Connected In series, provides 24 Vdc power to EMS processor	ROWPU space, under main
Battery charger	1	Maintains batteries at full charge under main processor	ROWPU space,
Main power switch	1	Maintains batteries at full charge Provides or disconnects power to monitoring system from batteries	ROWPU space, near main processor

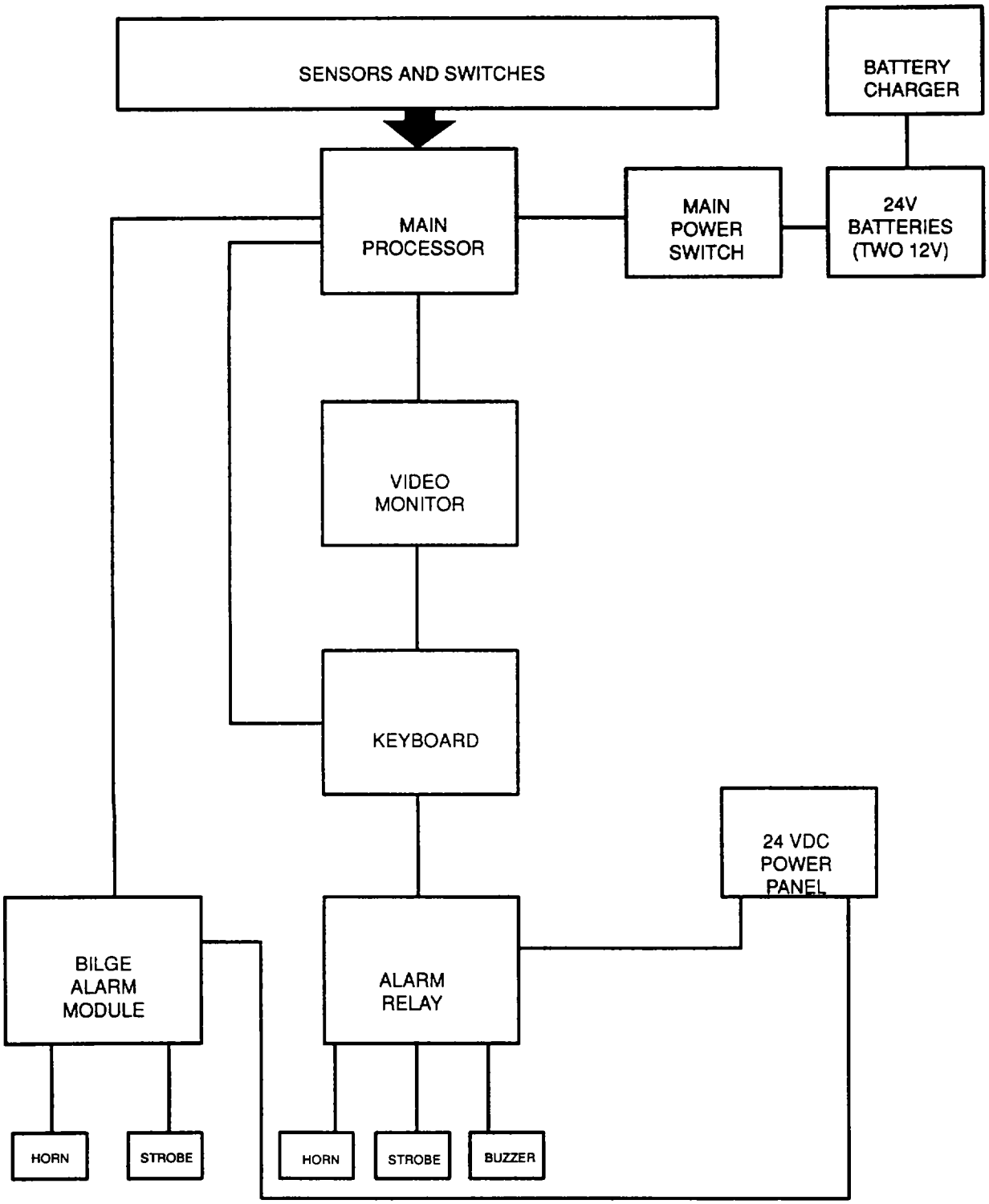


Figure 1-2. Equipment Monitoring System Block Diagram

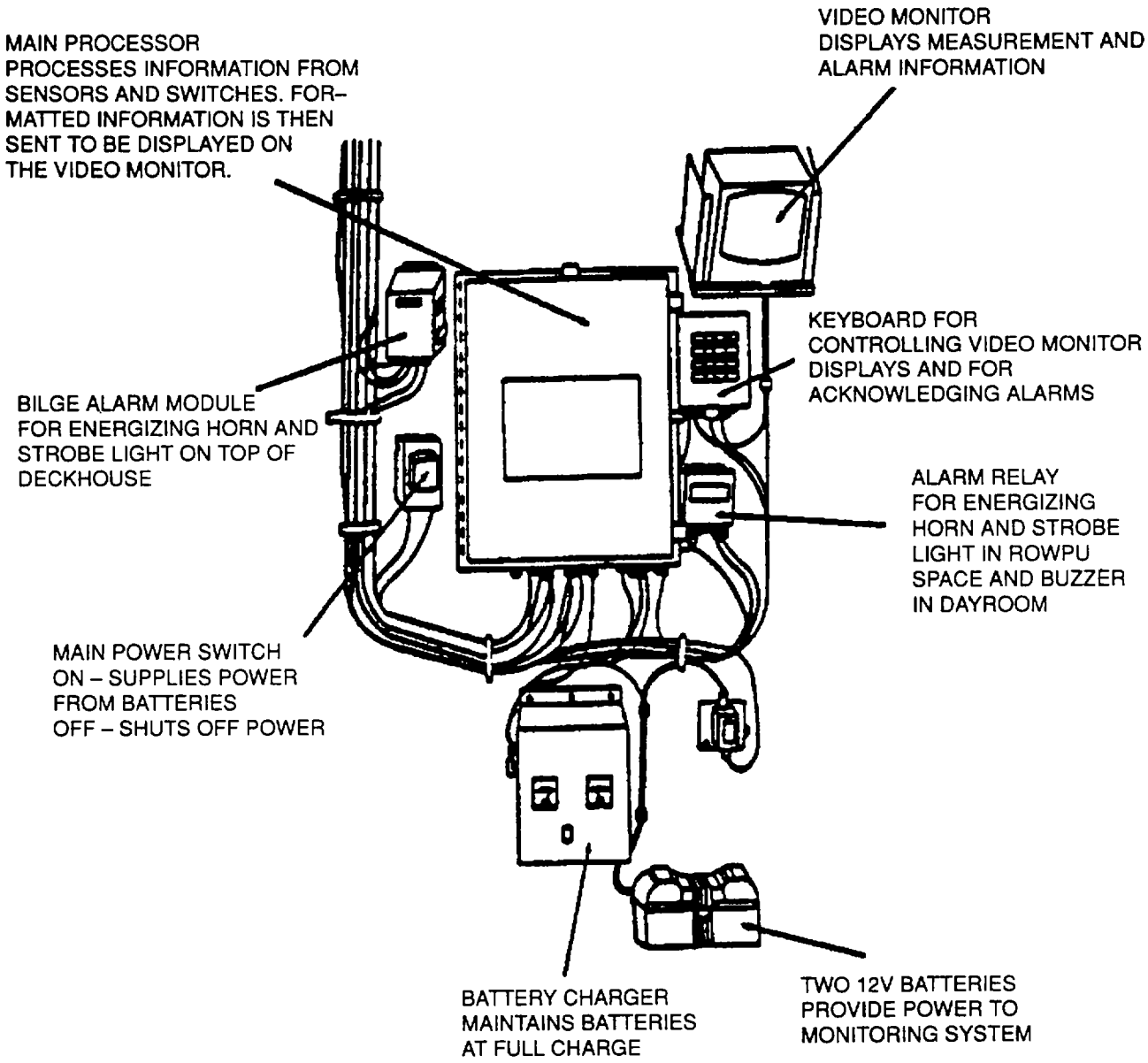


Figure 1-3. Equipment Monitoring System Arrangement

Table 1-2. Equipment Monitoring System Sensor Data

Type	Data Sensed	Qty	Location	Display
Analog	Amount of drinking water In storage tanks	4	One in each drinking water storage tank	Fig. 3-5
Analog	Product water salinity (ROWPU #1 & ROWPU #2)	2	One on each RO block	Fig 3-6
Analog	Drinking water salinity (FW DISCHG)	1	Discharge pump output	Fig. 3-6
Switch	Chlorination unit operating status	1	Chlorination unit	Fig 3-7
Switch	Chlorination unit power supply failure	1	Chlorination unit	Fig 3-7
Switch	Recirculating pump operating status	1	Chlorination unit	Fig. 3-7
Rate	Drinking water discharge rate	1	Discharge pump output	Fig 3-7
Analog	Drinking water discharge pressure	1	Discharge pump output	Fig 3-7
Switch	High sludge tank level	1	Sludge tank	Fig 3-7
Switch	High fuel oil level tank	2	One In each fuel oil storage	Fig 3-8
Switch	High water temperature	5	One on each diesel engine	Figs 3-8 & 3-9
Switch	Low oil pressure	5	One on each diesel engine	Figs 3-8 & 3-9
Switch	High bilge liquid level	9	One In each void except 2 In void 1	Fig 3-10
Analog	Drinking water chlorine content	1	Drinking water line downstream of mixer	Fig 3-11
Analog	Metering pump percentage of stroke capacity	1	Chlorination system metering pump	Fig 3-11
Analog	Amount of fuel In main fuel tanks	2	One on each fuel oil main storage tank	Fig. 3-12
Analog	Amount of water in ballast tank	1	On ballast tank	Fig 3-12

1-11 Equipment specifications

a.	EMS system	
	Manufacturer	Tracor Marcon, Inc.
	CAGEC	1 U276
	Model No	PMS II/J119B
	Configuration	J11 OB
	Power required	24 Vdc
	Quantity	1
b.	Main processor	
	Manufacturer	Tracor Marcon, Inc.
	CAGEC	1U276
	Model No.	PMS II
	Part No.	6050D
	Voltage	24 Vdc
	Quantity	1
c.	Video monitor	
	Manufacturer	Tracor Marcon, Inc
	CAGEC	1 U276
	Part no.	6450A
	Size	9 In
	Voltage	24 Vdc
	Quantity	1
d.	Keyboard	
	Manufacturer	Tracor Marcon, Inc.
	CAGEC	1 U276
	Part no	6350E/6380E
	Voltage	24 Vdc
	Quantity	1
e.	Alarm relay module	
	Manufacturer	Tracor Marcon, Inc
	CAGEC	1 U276
	Part no.	6370C
	Voltage	24 Vdc
	Quantity	1
f.	Bilge alarm module	
	Manufacturer	Tracor Marcon, Inc
	CAGEC	1 U276
	Part no.	23232-01
	Voltage	24 Vdc
	Quantity	1
g.	Strobe light	
	Manufacturer	Whelen Engineering Co, Inc
	CAGEC	10402
	Part no.	WMB-R
	Rating	500,000 candlepower
	Color	Red
	Flashes/minute	60
	Voltage	24 Vdc
	Quantity	2

h.	Horn	
	Manufacturer	Henschel Corp A Unit of General Signal Corp.
	CAGEC	2819S
	Part no.	1C/H3D3
	Rating	112 dB
	Voltage	24 Vdc
	Quantity	2
	Buzzer	
	Manufacturer	Henschel Corp. A Unit of General Signal Corp
	CAGEC	2819S
	Part no	1 C-Z1 D3
	Rating	70 dB
	Voltage	24 Vdc
	Quantity	1
j.	Inverter/battery charger	
	CAGEC	92731
	Manufacturer	LaMarche Manufacturing Co
	Model no.	A46-20-24V-A1
	Type	Constant float
	Input	120 Vac, 6 A, 1 Ph, 60 Hz
	Output	24 Vdc, 10 A
	Quantity	1
k.	Battery	
	Manufacturer	Globe Electric Manufacturing Co
	CAGEC	99028
	Part no	GC1260-1
	Type	Rechargeable, gel cell, Type A
	Voltage	12 Vdc
	Number of cells	6
	Quantity	2
l.	Main power switch	
	Manufacturer	Square D Co.
	Bell Electrical Products Division	
	CAGEC	08556
	Part no	D221
	Type	2 wire, 240 Vac, 30 A
	Quantity	1

1-12 Items furnished

1-12.1 Components installed as part of EMS are listed in the parts list of drawings referenced in Appendix A and in Components of End Item List In Appendix F of TM 55-1930-209-14&P-18

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

1-12.3 Repair parts and special tools onboard are listed In Repair Parts and Special Tools List in Appendix G of TM 55-1930-209-14&P-1 8.

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

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

CHAPTER 2 DESCRIPTION OF OPERATION

2-1 General. Sensors and switches monitor operating conditions of various Items of equipment onboard, such as amount of drinking water In storage tanks, temperature of diesel engine cooling water, etc. This data is sent to main processor, which displays it on one of eight display pages on video monitor. The system In normal operation continuously displays each display page for approximately 9 seconds and then automatically moves on to a new page. A display page Is either a to indicate a varying quantity (e. g. , amount of drinking water) or a lighted block to indicate that an item Is being monitored and Is operating normally. In an alternate mode, the operator selects a specific display page to observe by pressing the appropriate keyboard button. When a sensor detects a value that exceeds acceptable operating conditions, main processor starts flashing that particular display at double intensity It also activates remote alarms (horns, strobe lights and buzzer) alerting crewmembers that corrective action Is required. When the crew acknowledges the situation, alarms stop and displays on video monitor stop flashing They continue to be displayed at double intensity until condition that caused the alarm Is corrected.

2-2 Power supply. Two rechargeable 1 2-volt gel cell batteries connected in series provide a 24 Vdc supply for the EMS. A battery charger keeps these batteries fully charged The 24 Vdc power panel provides power for horns, strobe lights and buzzer When an abnormal condition exists, main processor energizes a relay that connects this power source to these alarms

CHAPTER 3 OPERATING INSTRUCTIONS

Section I. Operating controls and indicators

3-1 Operating controls and Indicators. See Table 3-1.

Section II. Prestart procedures

3-2 Prestart procedures. Before starting EMS, do the following:

a. Check that batteries are secure, electrical cable fittings are tight and coated with anti-corrosion grease. Correct as necessary.

b. Check major components (EMS components, battery charger, battery bank) for damage and loose fittings or wires. Correct as necessary

c. Clean components as necessary Section III. Operating procedures

3-3 Startup procedures

a. Before pushing main switch ON in step b, do the following-

(1) Make sure 24 Vdc power panel circuit breakers 1P14 and 4P14 are closed (ON)

(2) On battery charger (Figure 34), set HIGH/FLOAT switch to FLOAT position for normal charging or HIGH position for rapid recharging of batteries. Check that voltage is in appropriate range

CAUTION
Do not allow battery charger to remain on HIGH setting for more than 24 hours of operation.

b. Push main power switch ON (Figure 1-3).

c. If red POWER ON light on video monitor does not come on, turn video monitor on by using switch behind lower front panel.

d. If still no display on video monitor, main processor Is turned off Turn on main processor by opening main processor door and use switch on edge of the door (Figure 3-2).

e. If these switches are on, and video monitor does not turn on, troubleshoot according to Table 4-1.

f. When turned on, allow EMS about 5 to 10 minutes before display pages appear on video monitor

g. Perform keyboard lamp test as follows:

NOTE

Keyboard lamp test may be run anytime edit mode is not in use without affecting monitoring.

(1) Press EDIT key.

(2) Press keyboard key 6 (option KEYBOARD LAMP TEST)

(3) Make sure all keyboard keys except ACK key light and alarms activate. Replace any bad lamps according to paragraph 4-7.

(4) Press EDIT key to complete test and initiate monitoring.

h. Check EMS internal temperature by following these procedures:

CAUTION

Optimum operating conditions require temperature Inside processor be maintained between 32 and 131 degrees F.

(1) Press EDIT key on keyboard. Video monitor displays a menu listing 6 options.

(2) Press keyboard key 4 (option SYSTEMS STATUS PAGE) and EMS internal temperature shows on video monitor

(3) If temperature is not within acceptable range, shutdown EMS according to paragraph 3-9and take corrective action to cool main processor. See Section IV, Operating under extreme conditions.

(4) Press EDIT key to return to normal monitoring function.

(5) Check temperature inside main processor anytime temperature in ROWPU space indicates possible damage to EMS.

3-4 Normal operating procedures

NOTES

When EMS starts operating, each of eight display pages shows on video monitor for about 9 seconds and then EMS automatically moves to next display page. This automatic scanning continues until a keyboard display page key is pressed or EMS activates alarms.

If EMS detects an abnormal condition, video monitor stops scanning display pages, shows ALARM SUMMARY display page and EMS activates alarms.

a. If EMS activates alarms, acknowledge alarms by following procedures in paragraph 3-5

b. For continuous viewing of one display page rather than the 9 second viewing per display page shown on automatic scanning, press keyboard key for desired display page

NOTE

Selected display page remains on video monitor for 2 or 3 minutes before automatic scanning starts again.

c. While viewing display page, make sure time and date displayed on screen are correct. If not correct, reset according to procedures in paragraph 3-. 2. 5.

d. If more time is needed to view selected display page, press PAGE LOCK keyboard key. Make sure PAGE LOCK key turns blue.

e. To unlock display page, press another display page key or press PAGE LOCK key. Make sure PAGE LOCK key blue light goes out.

NOTE

If PAGE LOCK key is pressed, automatic scanning will begin Immediately. If display page key is pressed, automatic scanning will begin 2 to 3 minutes after key is pressed.

Table 3-1. EMS Operating Controls and Indicators

Control/Indicator	Figure	Location
24 Vdc power panel	3-1	Workshop, aft bulkhead
Main power switch	1-3	ROWPU space, forward bulkhead
Main processor power switch	3-2	Edge of unit door
Video monitor switch	*	Behind front panel below screen
Video POWER ON light	*	Right side of video monitor below screen
Keyboard	3-3	Below video monitor
Battery charger voltmeter	3-4	Front of battery charger
Battery charger ammeter	3-4	Front of battery charger
HIGH/FLOAT charge switch	3-4	Front of battery charger
POTABLE WATER TANKS display page	3-5	Video monitor
SALINITY display page	3-6	Video monitor
SYSTEM STATUS display page	3-7	Video monitor
GENERATORS display page	3-8	Video monitor
HIGH PRESSURE WATER PUMPS display page	3-9	Video monitor
BILGE ALARMS display page	3-10	Video monitor
CHLORINE STATUS display page	3-11	Video monitor
TANK LEVELS display page	3-12	Video monitor
Horn	*	One on deckhouse top, one on ROWPU space forward bulkhead
Strobe light		One at each horn
Buzzer	*	Dayroom bulkhead

*Figure not provided

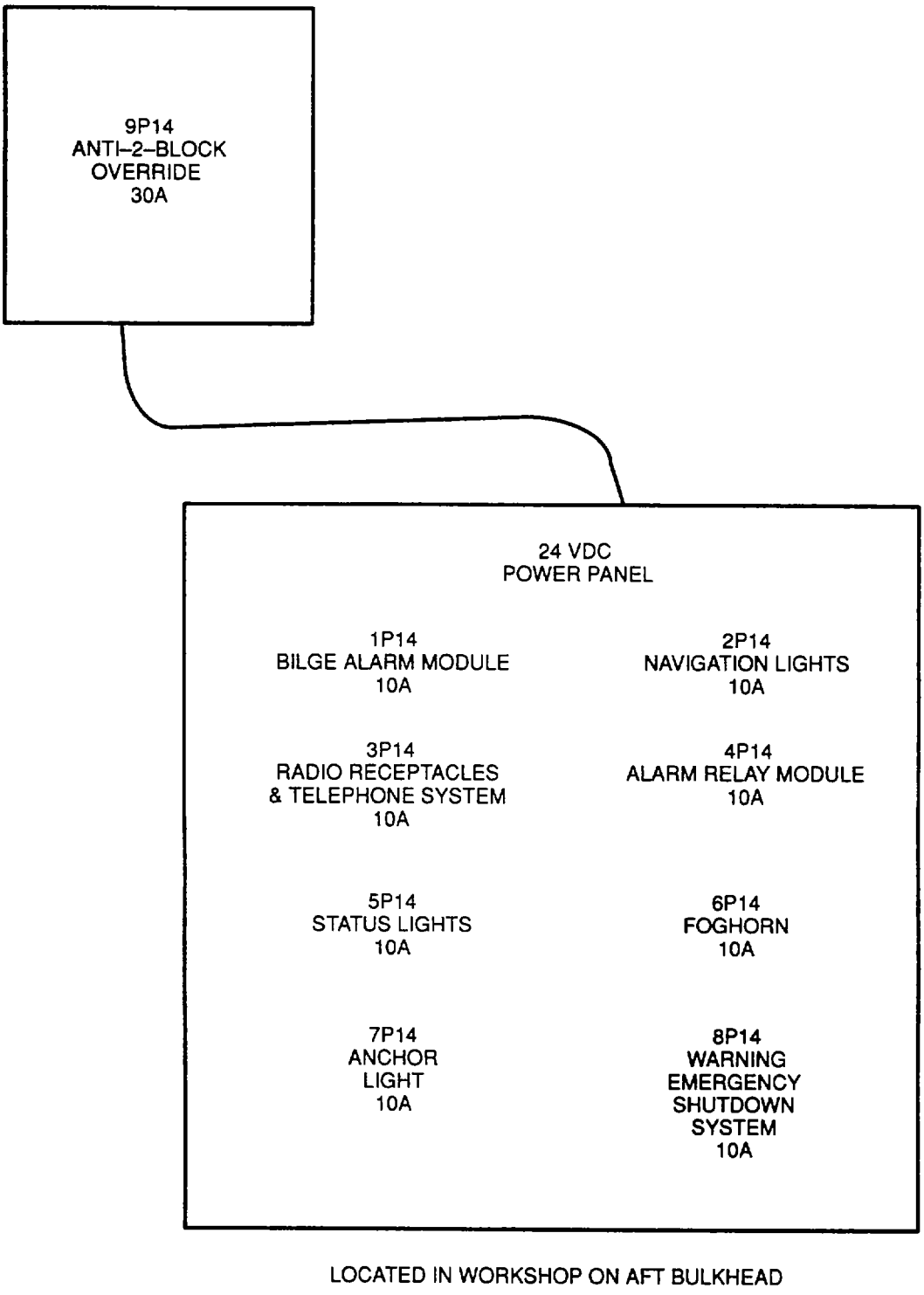


Figure 3-1. 24 VDC Power Panel

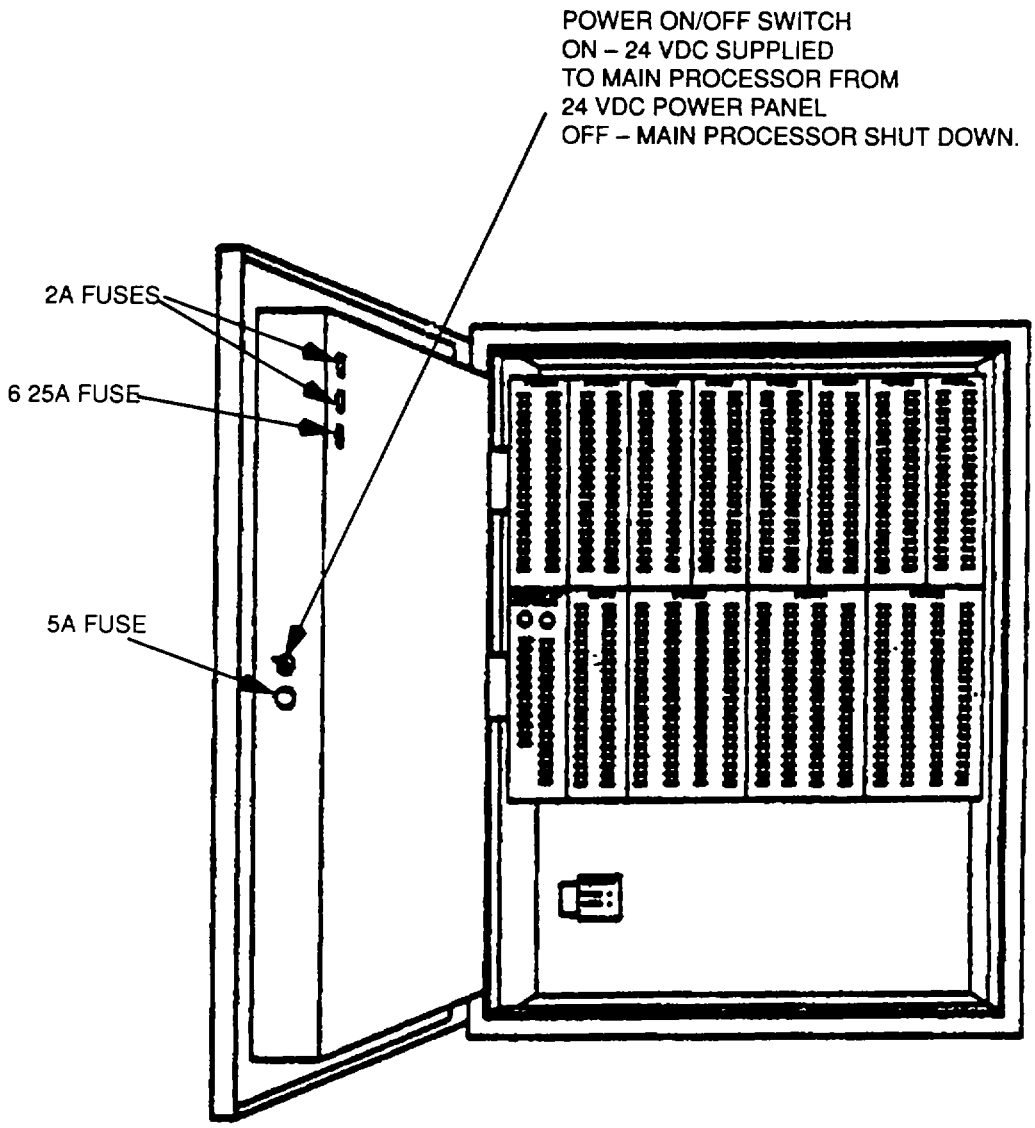


Figure 3-2. Equipment Monitoring System Main Processor

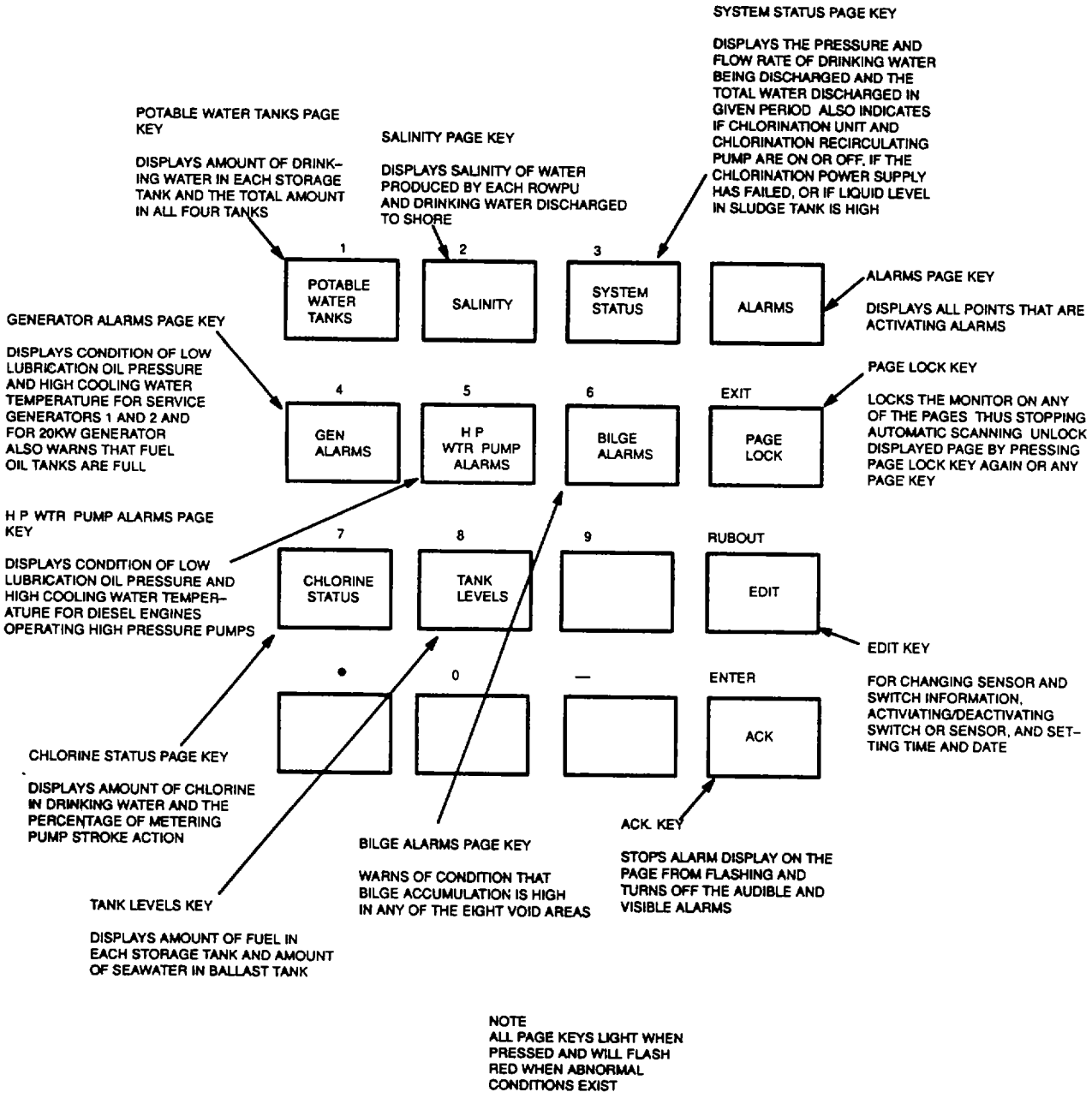


Figure 3-3. Equipment Monitoring System Keyboard

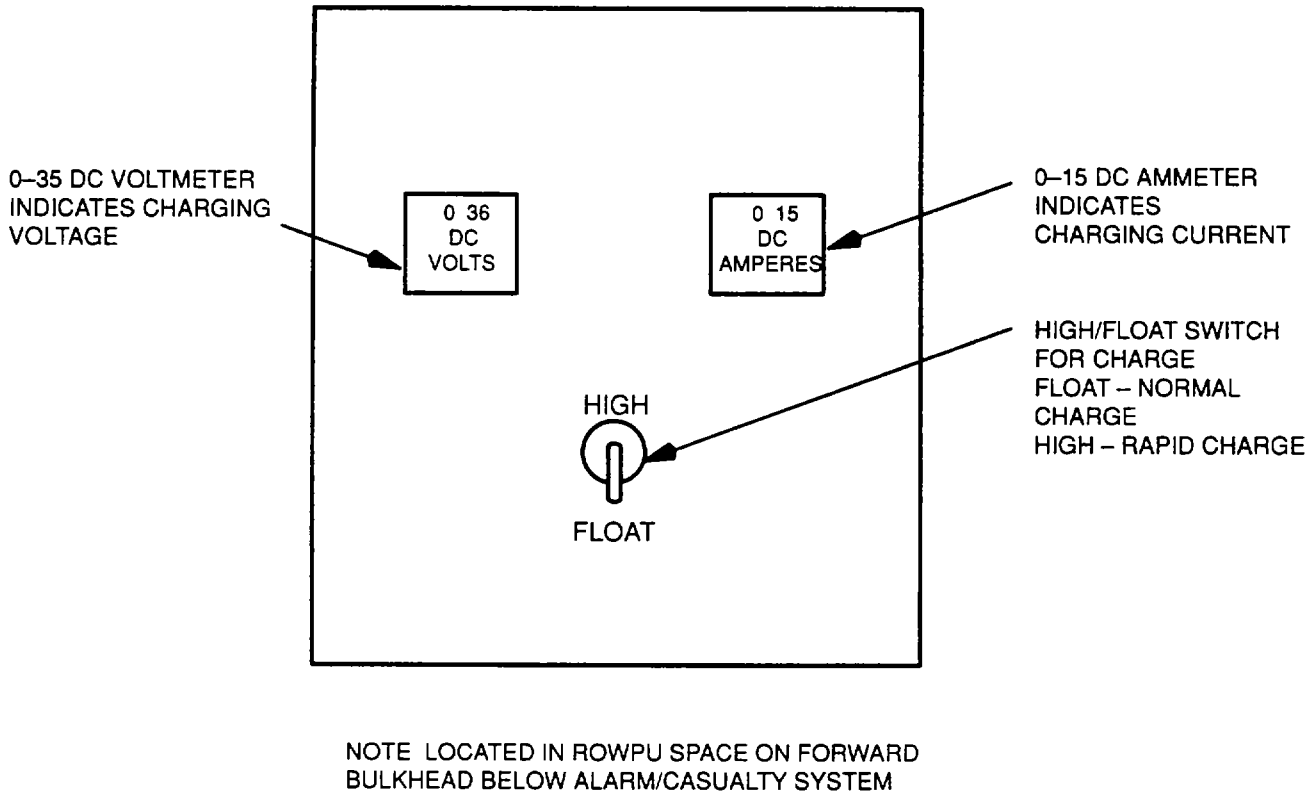


Figure 3-4. Main Processor Battery Charger

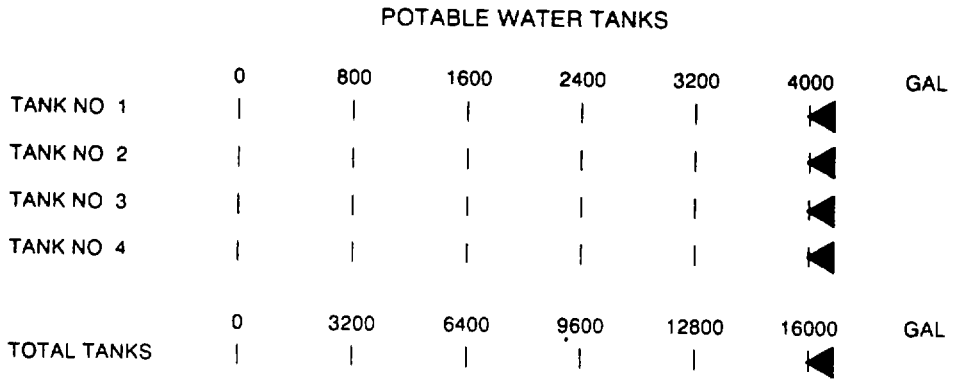


Figure 3-5. Potable Water Tanks Display Page

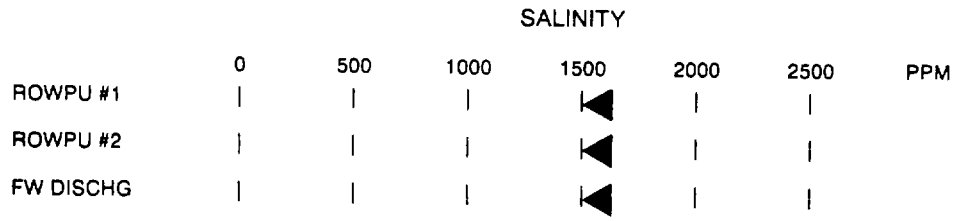


Figure 3-6. Salinity Display Page

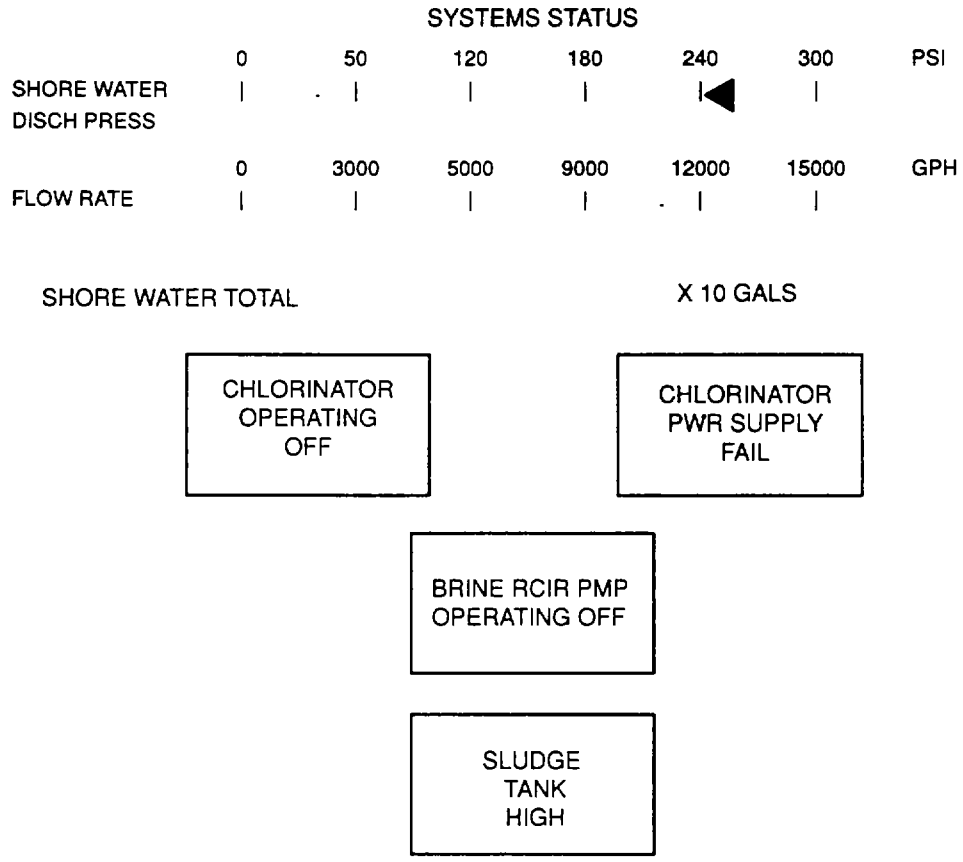


Figure 3-7. System Status Display Page

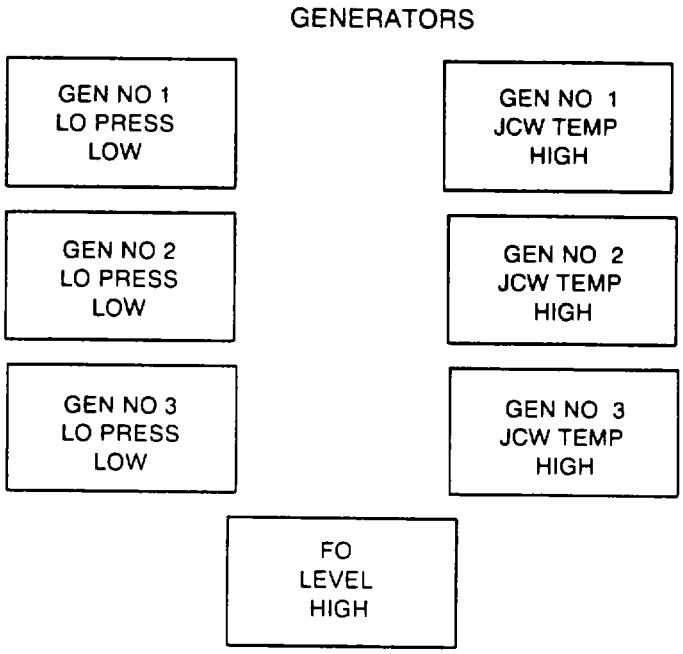


Figure 3-8. Generator Alarms Display Page

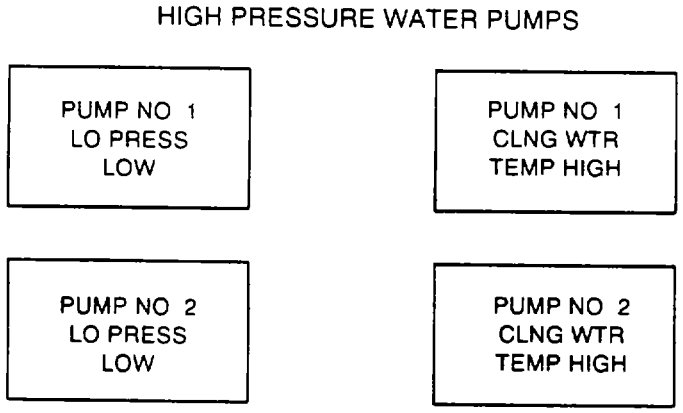


Figure 3-9. High Pressure Water Pumps Display Page

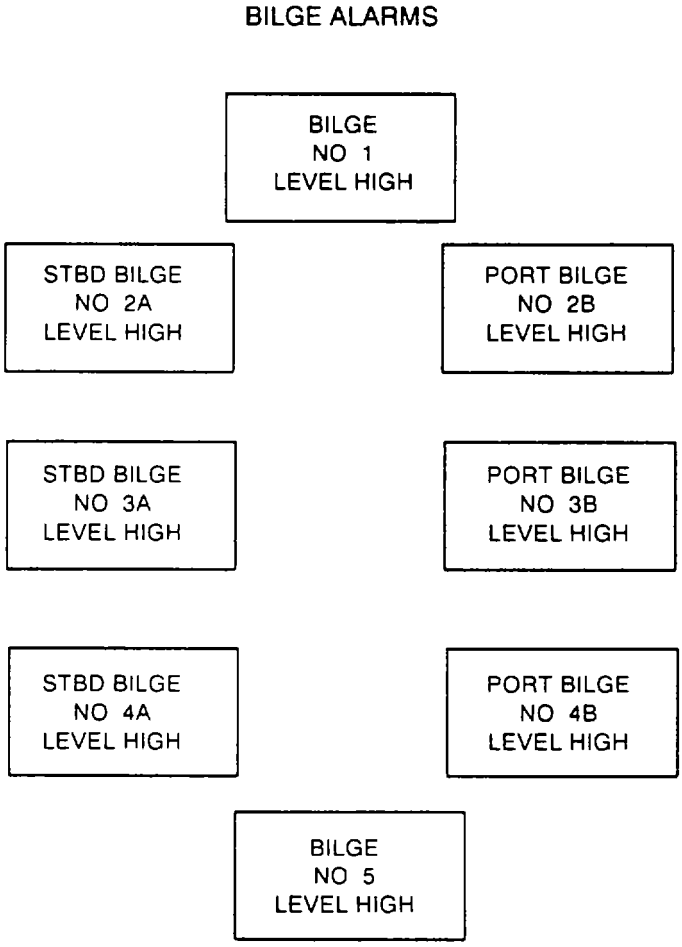


Figure 3-10. Bilge Alarms Display Page

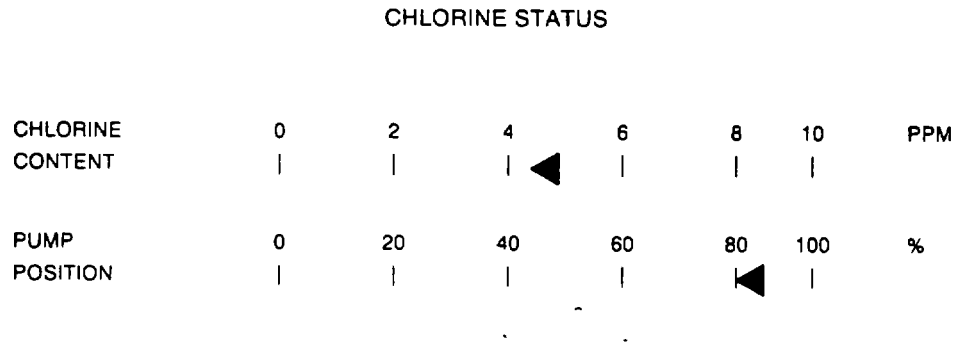


Figure 3-11. Chlorine Status Display Page

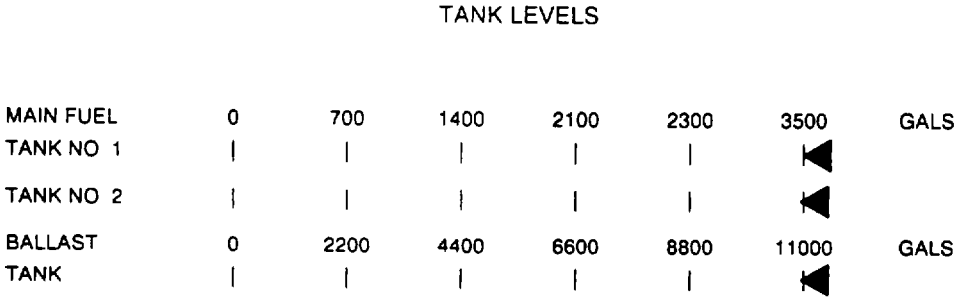


Figure 3-12. Tank Levels Display Page

3-5 Alarm acknowledgment. Anytime a sensor detects a value outside acceptable limits (abnormal situation), EMS activates alarms Indicating this requires immediate operator attention.

3-5.1 Abnormal conditions are indicated In four ways:

a. Horn and flashing strobe light are activated in ROWPU space and on mast on deckhouse top, buzzer sounds in dayroom and alarm sounds on keyboard.
b. Video monitor automatically switches to ALARMS SUMMARY display page, which displays all conditions causing alarms. Listing starts with condition most recently causing alarm. This condition is shown in bright (double intensity), flashing characters.
c. Keyboard key corresponding to display page where alarm point is located flashes red.
d. Bar or block display of the alarmed point on display page corresponding to red flashing key shows alarm condition in bright (double intensity), flashing characters. However, this is not immediately noticeable until flashing red key Is pressed

3-5.2 To acknowledge alarms sounded by EMS:

a. Press key that is flashing red. This makes video monitor change from ALARMS SUMMARY display page to display page showing alarm-causing sensor, which will be displayed as bright (double intensity), flashing characters
b. Press ACK (acknowledge) key. This silences keyboard and external alarms, providing there are no other alarm conditions to be acknowledged. The key for display page containing acknowledged alarm changes from flashing red to white, and bar or block display Indicator stops flashing, but remains at double intensity until condition is corrected
c. If there are other alarm conditions, repeat steps a and b until all have been acknowledged. Determine and correct condition that caused alarm

NOTE

Bar or block portion of display page, previously being displayed at double intensity, returns to normal intensity when alarm condition Is corrected.

3-6 System editing. Keyboard, with video monitor, sets time and date, activates or deactivates sensors and sets display page information, including alarm points These functions are performed when edit mode is selected by pressing EDIT key on keyboard EDIT key lights and changes keyboard functions to those shown In black above each key (Figure 3-3) Potable key now has a value of "1," SALINITY key a value of "2," etc., like a calculator keyboard These keys, now serving as numbers, change settings in EMS during edit mode

NOTE

During each step of edit mode, instructions in the form of a menu or prompts are shown on video monitor. Follow these menus or prompts and EMS will not be damaged. While editing, should alarms be activated, press EXIT key and then ACK key to acknowledge alarms. While editing, to return to normal monitoring, press EXIT key.

3-6.1 Accessing edit mode

a. Press EDIT keyboard key (Figure 3-3). Make sure key lights and following edit menu appears on video monitor

MENU
TO SELECT OPTION, PRESS KEY BELOW NUMBER
1 - PRINT LAST PAGE
2 - PRINT ALL PAGES
3 - PRINT ALARMS
4 - SYSTEMS STATUS PAGE
5 - SYSTEM EDIT
6 - KEYBOARD LAMP TEST

NOTE

The above menu, in these instructions, is called the "basic menu" to separate It from an "edit menu" and from "prompts."

b. Ignore options 1, 2 and 3 They do not apply to ROWPU barge application.
c. If temperature reading inside main processor is desired, push keyboard key 4 (GEN ALARMS) now functioning as a number 4 This selects option 4-SYSTEMS STATUS PAGE, which in ROWPU barge application of the EMS, selects procedures for obtaining internal EMS temperature. Follow procedures In paragraph 3-3h
d. To perform keyboard lamp test, push keyboard key 6 (BILGE ALARMS) now functioning as a number 6. This selects option 6 KEYBOARD LAMP TEST Follow procedures In paragraph 3-3g.
e. Push keyboard key 5 (H P WTR PUMP ALARMS) now functioning as number 5. This selects option 5-SYSTEM EDIT Make sure following Is displayed on video monitor.

ENTER EDIT ACCESS COMBINATION

NOTE

This combination prevents unauthorized entry Into EMS programs. Two levels of editing are available, level 1 and level 2. The bargemaster has access combination for each.

f. Contact bargemaster to obtain access combination or combinations for use. Proceed to paragraph 3-.2 if level 1 edit access is desired or paragraph 3-.3 if level 2 edit access is desired.

3-6.2 Level 1 editing. Select level 1 editing by entering access combination for level 1 edit. Following display appears:

EDIT MENU
TO SELECT OPTION, PRESS KEY BELOW NUMBER

1 - ACTIVATE/DEACTIVATE SENSORS
2 - ACTIVATE/DEACTIVATE SWITCHES
3 - ACTIVATE/DEACTIVATE/PRESET TOTALIZERS
4 - SET TIME/DATE
5 - EDIT SCHEDULE LOG

NOTE

In above display, SENSORS are bargraph displays such as SALINITY (Figure 3-6). SWITCHES apply to block displays such as GENERATORS (Figure 3-8). Option 3 applies only to TOTAL TANKS bargraph on Potable WATER TANKS display page (Figure 3-5). Option 4 sets time and date on EMS Internal clock which displays this information on bottom of display pages. Option 5, only for systems with a printer, Is not used on ROWPU barges.

3-6.2.1 Using EDIT MENU option 1 to activate/deactivate sensors

NOTE

Deactivating a sensor stops main processor from monitoring that particular sensor. Deactivation may be desirable when a sensor is malfunctioning and displaying Incorrect Information and activating alarms when no problem exists. When a sensor is deactivated, the word DEACTIVATED appears In place of the bargraph. After sensor is repaired or replaced, sensor Is reactivated. The word DEACTIVATED disappears and sensor readout again appears on video monitor.

a. Select EDIT MENU option 1 to activate/deactivate sensors by pushing keyboard key 1. Following prompt appears on screen SELECT PAGE TO EDIT BY PRESSING CORRESPONDING KEY OR PRESS EDIT KEY TO RETURN TO THE MENU NOTE If display page that shows a bargraph is pressed, highlighted Instructions called "prompts" show in the right corner or across top of video monitor and cursor highlights top bargraph. If a display page without a bargraph is selected, page will flash and monitor returns to menu shown above. Push either another display page key or EDIT key.
b. Push key of display page that shows a bargraph, such as POTABLE WATER TANKS (Figure 3-5) or CHLORINE STATUS (Figure 3-11). Make sure selected display page shows on video monitor.

c. If following prompts show on screen and cursor appears over first bargraph, go to step e

    1 - ADVANCE CURSOR
    2 - EDIT THIS ONE
    3 - SELECT NEW PAGE
    4 - RETURN TO EDIT MENU

d. If screen flashes, indicating display page does not have sensor readouts, either press another display page key or press EDIT key to return to edit menu.

NOTE

Cursor Is a bright bar that extends from left side to middle of screen and highlights an item to be edited. Pushing keyboard key 1 (prompt ADVANCE CURSOR) moves cursor one line down. Repeatedly pushing this key or holding It down, moves cursor to the last line that can be edited, and then cursor returns to top line.

e. Push keyboard key 1 (ADVANCE CURSOR) and move cursor to desired sensor bargraph.
f. Push keyboard key 2 (EDIT THIS ONE). Make sure video monitor displays desired sensor information with sensor label on top line and prompts in upper right corner. Also make sure that cursor is on the line with "SENSOR ACTIVE."
g. Push keyboard key 2 (EDIT THIS ONE) again. Make sure cursor extends all the way to the right.
h. To activate sensor, push keyboard key "0" and to deactivate sensor, push keyboard key 1.
i. Push ENTER keyboard key. Note that cursor will shorten.

NOTE

EXIT keyboard key provides means to Immediately leave edit mode at anytime. When EXIT key Is pressed, EDIT key goes out and EMS resumes scanning.

j. If editing is complete, push EDIT keyboard key to leave edit mode and return EMS video monitor to normal scanning If editing is not completed, push keyboard key 3 (prompt SELECT NEW BAR) to return to display page.
k. When display page appears on video monitor, take one of these three actions:
   (1) Push keyboard key 1 (prompt ADVANCE CURSOR) to move cursor to select new sensor,
   (2) Push keyboard key 3 (prompt SELECT NEW PAGE) to select a new page,
   (3) Push keyboard key 4 (prompt RETURN TO EDIT MENU) to return to EDIT MENU.
l. To change reference markers, go to paragraph 3-6.2.2.
m. If reference markers are not to be changed, and editing Is complete, push EXIT keyboard key to leave edit mode. Make sure EDIT key goes out and video monitor starts normal scanning of display pages.

3-6.2.2 Using EDIT MENU option 1 to change or set reference markers

a. Press keyboard key 1 (prompt ADVANCE CURSOR) to move cursor to line labeled "REFERENCE MARKER"
b. Press keyboard key 2 (prompt EDIT THIS ONE). Make sure prompt display appears on video monitor and reads as follows.

KEY IN NEW VALUE, THEN PRESS ENTER
RUBOUT ERASE LAST ENTRY

c. Using keyboard key, enter new position for reference marker.

NOTES

If mistake Is made, correct it before pressing ENTER keyboard key by using RUBOUT keyboard key. Pressing RUBOUT key causes EMS to backspace and erase last digit pressed. Further pressing RUBOUT key erases next digit and so on, until all digits are erased.

If mistake is discovered after ENTRY key has been pushed, mistake is treated like a normal setting and changed by following procedures in paragraph 3-6.2.3.

d. Correct mistake, if necessary, by using RUBOUT key

e. Push ENTER keyboard key. Make sure prompt information changes to the following:

1 - ADVANCE CURSOR
2 - EDIT THIS ONE
3 - SELECT NEW BAR

f. Repeat steps a through e for changing reference marks of additional sensors.
g. When desired reference marks are changed, press EXIT keyboard key to return video monitor to normal scanning and to leave Edit mode, or press '3" keyboard key (SELECT NEW BAR) to return to display page.
h. When display page appears on video monitor screen, take one of these actions:

(1) Push keyboard key 1 (prompt ADVANCE CURSOR) to move cursor to select a new sensor.
(2) Push keyboard key 3 (prompt SELECT NEW PAGE) to select a new page
(3) Push keyboard key 4 (prompt RETURN TO EDIT MENU) to return to EDIT MENU.

3-6.2.3 Using EDIT MENU option 2 to activate/deactivate switches

NOTE

Switches are activated/deactivated for the same reason and in a similar manner to activating/deactivating sensors in paragraph 3-6.2.1.

Deactivating a switch stops main processor from monitoring that particular switch. Deactivation may be necessary when a switch Is malfunctioning, is displaying false information on video monitor display page and Is activating alarms when no problem exists. When a switch is deactivated, the word DEACTIVATED appears in place of the switch emblem on video monitor display page. After switch is repaired or replaced, switch Is reactivated. The word DEACTIVATED disappears and switch emblem again appears on video monitor.

a. Push keyboard key 2 (EDIT MENU option ACTIVATE/DEACTIVATE SWITCHES). Make sure page select prompt In step 3-6.2 la appears on video monitor
b. Push keyboard key that shows switch data, such as GENERATORS display page (Figure 3-) or HIGH PRESSURE WATER PUMPS (Figure 3-9) display page.

(1) Make sure display page chosen shows on video monitor.
(2) If highlighted Instructions called "prompts," shown below, are displayed on screen and switch closest to top left side of the page is double intensity, go to step c.

1 - ADVANCE CURSOR
2 - EDIT THIS ONE
3 - SELECT NEW PAGE
4 - RETURN TO EDIT MENU

(3) If screen flashes, indicating display page has no switches, either press another display page key or press EDIT key to return to EDIT MENU.

c. Push keyboard key 1 (prompt ADVANCE CURSOR) and move cursor to switch to be activated/deactivated./deactivated

d. Push keyboard key 2 (prompt EDIT THIS ONE). Make sure video monitor displays switch information with switch label at top of page and prompts in upper right corner. Make sure cursor is on the line with 'SWITCH ACTIVE"
e. Push keyboard key 2 (prompt EDIT THIS ONE) again. Make sure cursor extends all the way to the right.

NOTE

When switch is deactivated, the word DEACTIVATED appears In place of switch emblem. After switch Is repaired or replaced, switch Is reactivated. The word DEACTIVATED disappears and switch emblem again appears on video monitor.

f. To activate switch, push keyboard key "0" and to deactivate switch, press keyboard key 1.
g. Push ENTER keyboard key. Note that cursor willshorten.
h. Push EDIT keyboard key to leave edit mode and return EMS video monitor to normal scanning or push keyboard key 3 (prompt SELECT NEW SWITCH) to return to display page.
i. When display page appears on video monitor, take one of these three actions.

(1) Push keyboard key 1 (prompt ADVANCE CURSOR) to move cursor to select new switch.
(2) Push keyboard key 3 (prompt SELECT NEW PAGE) to select a new display page.
(3) Push keyboard key 4 (prompt RETURN TO EDIT MENU) to return to EDIT MENU

3-6.2.4 Using EDIT MENU option 3 to activate/deactivate totalizers

NOTE

Totalizers are activated/deactivated for the same reason and in a similar manner to activating/deactivating sensors in paragraph 3-6.2.1. Deactivating a totalizer stops main processor from monitoring that particular switch. Deactivation may be necessary when a totalizer is malfunctioning, Is displaying false Information on video monitor screen display page and Is activating alarms when no problem exists. When a totalizer Is deactivated, the word DEACTIVATED appears In place of the totalizer emblem on video monitor. After totalizer has been repaired or replaced, totalizer Is reactivated. The word DEACTIVATED disappears and totalizer emblem again appears on video monitor.

a. Push keyboard key 3 (EDIT MENU option ACTIVATE/DEACTIVATE/PRESET TOTALIZERS). Make sure page select prompt in step 3-6.2.1 a appears on video monitor.
b. Push POTABLE WATER TANKS keyboard key that shows TOTAL TANKS totalizer data (Figure 3-7).

(1) Make sure display page chosen is shown on video monitor.
(2) If highlighted instructions called "prompts" shown below are displayed on the screen and totalizer is double intensity, go to step c.

1 - ADVANCE CURSOR
2 - EDIT THIS ONE
3 - SELECT NEW PAGE
4 - RETURN TO EDIT MENU

(3) If screen flashes, indicating display page has no totalizer, either press another display key or press EDIT key to return to EDIT MENU.

c. Push keyboard key 1 (prompt ADVANCE CURSOR) and move cursor to totalizer to be activated/ deactivated.
d. Push keyboard key 2 (prompt EDIT THIS ONE). Make sure video monitor displays totalizer information with totalizer label at top of page and prompts in upper right corner. Make sure cursor is on the line with 'TOTALIZER ACTIVATE."
e. Push keyboard key 2 (prompt EDIT THIS ONE) again. Make sure cursor extends all the way to the right.

NOTE

When totalizer Is deactivated, letter X replaces numbers to indicate totalizer is no longer counting. After totalizer is repaired or replaced, totalizer is reset to agree with flow meter reading and then is reactivated. Letter X is replaced with input figures.

f. To activate totalizer, push keyboard key '"0" and to deactivate totalizer, press keyboard key 1.
g. To set number for totalizer to begin counting from zero or number shown on flowmeter, do the following' (1) Press keyboard key 1 (ADVANCE CURSOR).

(2) Press keyboard key 2 (EDIT THIS ONE)
(3) Press keyboard number keys to set desired number.
(4) Push ENTER keyboard key to enter numbers. Note that cursor will shorten.

h. Push EDIT keyboard key to leave edit mode and return EMS video monitor to normal scanning or push keyboard key 3 (prompt SELECT NEW TOTALIZER) to return to display page.
i. When display page appears on video monitor, take one of these three actions.

(1) Push keyboard key 1 (prompt ADVANCE CURSOR) to move cursor to select new totalizer.
(2) Push keyboard key 3 (prompt SELECT NEW PAGE) to select a new display page.
(3) Push keyboard key 4 (prompt RETURN TO EDIT MENU) to return to EDIT MENU.

3-6.2.5 Using EDIT MENU option 4 to set time and date on EMS clock

NOTE

EMS maintains a 24 hour clock as well as displaying month, day and year at bottom of each video monitor display page. When main power is off, a battery inside main processor keeps clock operating so that next time EMS is turned on, correct time is shown on display pages.

a. Push keyboard key 4 (option SET TIME/DATE). Make sure video monitor displays the following and prompts are in upper right corner of screen.

	OLD	NEW
MONTH	JAN	
DAY	31	
YEAR	1986	
HOUR	16	
MINUTE	52	

*After editing, new information appears on screen.

NOTE
Cursor will be on "O" MONTH

b. Push keyboard key 1 (prompt ADVANCE CURSOR) to move cursor to item (MONTH, DAY, YEAR, etc.) to be changed.
c. Push keyboard key 2 (prompt EDIT THIS ONE). Make sure cursor extends through old value.

NOTE
By pushing keyboard number keys (as well as "-" and "."), keys act as calculator keys and write numbers on video monitor.

d. Use keyboard keys to enter new values.
e. Push ENTER keyboard key. Note that cursor will shorten.

NOTE
If video monitor shows message "MIN" or "MAX," allowable range has been exceeded.

f. If allowable range has been exceeded, repeat steps c and d, otherwise go to step g.
g. Repeat steps b through f until correct date and time is entered in NEW column.

NOTE
With time and date set, with seconds set to zero, clock starts when EXIT keyboard key is pushed to move video monitor to normal scanning of display pages.

h. Press EXIT keyboard key to leave edit mode and return EMS video monitor to normal scanning or push keyboard key 3 (prompt RETURN TO EDIT MENU).

3-6.3 Level 2 editing procedures. Select level 2 editing by entering access combination for level 2 edit obtained from bargemaster to change display page information Make sure following EDIT MENU display appears

EDIT MENU
TO SELECT OPTION, PRESS KEY BELOW NUMBER
1. EDIT BATR PARAMETERS
2. EDIT SWITCH PARAMETERS
3. EDIT TOTALIZERS
4. EDIT ALARM INHIBITS
5. SET TIME/DATE
6. EDIT SCHEDULE LOG

NOTES
High and low alarm points are typical data that can be set in level 2.

Video monitor displays many Items that pertain to general monitoring system capability and are not part of EMS as used onboard ROWPU barges. Items that are used onboard have data printed under OLD column; those that do not often have "N/A" (not applicable) in that column.

a. Follow procedure for editing level 2 data as used for level 1 in paragraph 36.2. First select an option and then follow steps in the prompt shown on video monitor.

NOTE
Time and date can be set either In level 1 or level 2 editing.

b. To leave edit mode at any time, press EXIT keyboard key.

3-7 Edit termination. When editing Is to be interrupted or Is completed, press EXIT key to return EMS to scanning video monitor display pages.

3-8 Shutdown procedures

NOTE
Main processor and video monitor are not turned off unless barge is to be out of operation for more than 7 days.

a. For normal shutdown, pull main power switch OFF.
b. Check for damage or corrosion Repair, clean or paint as necessary.

Section IV. Operation under extreme conditions

3-9 General. For EMS optimum operating conditions, main processor internal temperature must be maintained between 32 and 131 degrees F. When this temperature reaches 125 degrees F, take the following actions

a. Make sure all ROWPU space overhead fans are operating and hatches and doors are open.
b. If available, use additional portable fans blowing on the main processor.
c. In extreme cases, cover main processor with damp cloths and have portable fans blowing on main processor
d. If these methods can not keep internal temperature below 131 degrees F, turn off EMS during hottest part of the day and visually monitor tank level indicators, gauges, flowmeters, etc, to make sure systems are operating normally since alarm system will be shut down

CHAPTER 4 MAINTENANCE INSTRUCTIONS

4-1 Maintenance concept. Because EMS has solid-state electronic construction, system should remain trouble-free with reasonable care. However, EMS is essentially a microprocessor with various sensors and it may become unserviceable if any internal elements or sensing devices are damaged. If system requires maintenance beyond that specified in paragraphs 4-5 through 4-18, Intermediate Direct Support/Intermediate General Support (IDS/IGS) maintenance unit provides skilled electronics technicians to accomplish this work according to information provided in manufacturer's manual In Appendix B, their knowledge of electronic microprocessors and sensors and, if necessary, additional guidance received from manufacturer's technical representative.

41.1 Unit level maintenance on EMS equipment is performed onboard by barge crewmembers whenever possible.

4-1.2 IDS/IGS maintenance is provided by a shore-based area support maintenance unit. This unit also determines if depot support maintenance is required.

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

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

4-1.5 Maintenance Allocation Chart (MAC) is in Appendix C of TM 55-1930-209-14&P-18. For maintenance of other equipment onboard, consult appropriate manual 4-2 Maintenance Instructions. Maintenance instructions are presented in the following sections: Appendix C, Preventive maintenance; paragraph 4-4, Troubleshooting; and paragraphs 4-5 through 4-18, Maintenance procedures.

4-3 Preventive maintenance checks and services. See TM 55-1930-209-14&P-11, Appendix C for preventive maintenance checks and services for the equipment monitoring system. See TM 55-1930-20914&P-19 for complete preventive maintenance checks and services for all systems on the ROWPU Barge.

4-4 General

a. Unit level troubleshooting procedures are In Table 4-1
b. Additional troubleshooting procedures for use by IDS/IGS maintenance unit are in PMS II Maintenance Manual In Appendix B

Table 4-1. Troubleshooting Procedures

Problem	Possible Cause	Suggested Action
1. Electric Power not on	a. Batteries not charged	a. Connect batteries or replace 20A fuse in battery charger circuit 13P13 fuse box
	b. Main power switch off or malfunctioning	b. Turn switch ON or test and repair or replace switch (paragraph 4-11)
	c. Batteries dead	c. Replace batteries (paragraph 4-16)
	d. Battery charger malfunctioning	d. Test and repair or replace battery charger (paragraph 4-15)

Table 4-1. Troubleshooting Procedures (continued)

Problem	Possible Cause	Suggested Action
2. Video monitor does not come on	a. Switch behind panel off	a. Turn switch ON
	b. 5A fuse on main processor door blown	b. Replace fuse (paragraph 4-6.3.1)
	c 1 A and/or 3A fuse(s) on video monitor blown	c. Replace fuse(s) (paragraph 4-8.3)
	d. Monitor malfunctioning	d. Test and repair or replace (paragraph 4-7)
3. Keys do not light up on keyboard lamp test	a Bulb(s) burned out	a. Replace bulb(s) (paragraph 4-7.3.3)
	b. 3A fuse inside keyboard unit	b. Replace fuse (paragraph 4-7.3.1)
	c. Keyboard malfunctioning	c. Replace circuit board (paragraph 4-7.3.2) or test and repair or replace (4-7)
4. EMS will not respond to keyboard commands	Coaxial cable improperly connected	Inside main processor door panel, disconnect black coaxial cable from right hand connection and connect to left.
5. Keyboard alarm sounds but external horn and strobe light in ROWPU space and buzzer in dayroom not activated by alarm relay module	a. Alarm relay module not energized	a. Close (ON) 4P14 circuit breakers on 24 Vdc power panel
	b 1 OA fuse(s) Inside alarm relay module blown	b. Replace fuse(s) (paragraph 4-9.3)
	c. Alarm relay module horn, strobe light, or buzzer malfunctioning	c. Test and repair or replace alarm relay module (paragraph 4-9), horn (paragraph 4-12), strobe light (paragraph 4-13), or buzzer
6. Keyboard alarms sound, but horn and strobe light on top of deckhouse mast	a. Blidge alarm module not energized	a. Close (ON) 1 P14 circuit breaker on 24 Vdc power panel
	b 1 OA fuse(s) inside alarm relay blown	b. Replace fuse(s) (paragraph 4-10.3)

Table 4-1. Troubleshooting Procedures (continued)

Problem	Possible Cause	Suggested Action
	c. Bilge alarm module, horn or strobe light malfunctioning	c. Test and repair or replace bilge alarm module (paragraph 4-10), horn (paragraph 4-12) or strobe light (paragraph 4-13)
7. Random symbols appear on screen	Either 2A fuse(s) and/or fuse inside main processor door panel blown	Replace fuse(s) (paragraph 4-6.3.1)
8. EMS continues to malfunction	Unknown causes beyond unit level of maintenance	Notify IDS/IGS maintenance support unit to troubleshoot (Section IX in PMS II Maintenance Manual in Appendix B)

4-5 General

a. Preventive maintenance requirements are in paragraph 4-3.
b. Maintenance beyond that required in this section must be referred to IDS/IGS maintenance unit. That unit provides skilled electronic technicians to accomplish required maintenance according to manufacturer's manual in Appendix B, their knowledge of Electronic microprocessors and sensors and, if necessary, additional guidance from manufacturer's technical representative (tech rep).

WARNING

Turn off electrical power before performing any maintenance. Redtag appropriate switches and circuit: breakers with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MA[)E." Observe safety precautions listed in this manual and those in manufacturers' Instructions/manuals.

4-6 Main processor

WARNING

Make sure main power switch (Figure 1-3) is in OFF position when performing maintenance. Redtag switch with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-6.1 Cleaning and inspection

a. Wipe clean exterior of main processor with clean rag. Open door and vacuum clean or clean inside with electrician's brush. Avoid using unauthorized solvents for cleaning inside of main processor. Solvents leave a greasy film on components that may reduce electrical conductivity.
b. Visually inspect for indications of burns, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion from contacts and terminals, tighten loose connections, and replace damaged parts. Remove corrosion with silver polish, fine sandpaper, or burnishing tool. Do not use emery paper or emery cloth or steel wool. Vacuum to remove residue. Touch up paint according to TB 43-144. Do not paint threads or labels.

4-6.2 Test

a. If main processor is inoperative, move main power switch to on (Figure 1-3), check input line voltage to processor from battery. If reading is not between 25 arid 28 Vdc, check power source. If reading is between 25 and 28 Vdc go to step b.
b. Check output voltage to video monitor and keyboard. If reading is not between 25 and 28 Vdc, check fuse, replace fuse as given in paragraph 4-6.3.1 or replace faulty printed circuit board as given in paragraph 4-6.3.2. If main processor is not operative after repair, troubleshoot monitoring system as given In paragraphs 5 and 6 in Section IX of the PMS II Maintenance Manual. If main processor still not operative, replace main processor as given in paragraph 4-6.5.

4-6.3 Repair

4-6.3.1 Fuse replacement

a. 5A fuse (Figure 3-2). Unscrew fuse holder and replace fuse.
b. 2A fuses and 6.25A fuse (Figure 3-2). Remove and replace fuse(s) on printed circuit boards (power supply, input or process and display). See Section VII of the PMS II Maintenance Manual for additional fuse information.

4-6.3.2 Printed circuit board replacement

CAUTION

The printed circuit board contains some components that are sensitive to static electricity and therefore must be handled with caution.

a. Removal

(1) Hold board (power supply, input or process and -display) only by the edges and do not touch individual components or back of board when removing board
(2) If board Is to be repaired, place board inside of protective bag supplied with board.
(3) If board is to be reused, always lay board on a flat surface and on top of the protective bag supplied with board

b. Installation

NOTE

EPROM's may have to be replaced on process and display and input printed circuit boards. See Section IX paragraph 2.0 in PMS II Maintenance Manual In Appendix B.

(1) Hold board as given in Step a(1), when board is installed in main processor or being removed from protective bag.
(2) Always lay board on a flat surface and on top c)f the protective bag when board is out of bag.

4-6.4 Calibration. Calibrate PMS system as given in Section IV in PMS II Maintenance Manual in Appendix B.

4-6.5 Replacement

a. Removal

(1) Disconnect cable (C2) to keyboard.
(2) Disconnect cable (C1) to video monitor
(3) Disconnect cables (C5 and C6) to terminal boxes
(4) Disconnect cable (13P13F) to main power switch.

(5) Disconnect cables (C3, C4, and 1 P14A) from bilge alarm module.
(6) Disconnect cable (A8-1 and A8-2) to chlorination system metering pump control unit
(7) Remove mounting hardware and carefully remove main processor.

b. Installation

(1) Install main processor In reverse order of installation in step a. See also Section I in PMS II 6050D Installation Manual in Appendix B for additional installation information.
(2) Operate monitoring system and check main processor for normal operation. If main processor does not operate normally, troubleshoot as given in Section IX in PMS II Maintenance Manual in Appendix B.

4-7 Keyboard

WARNING

Make sure main power switch (Figure 1-3) Is In OFF position when performing maintenance. Redtag switch with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-7.1 Cleaning and Inspection

a. Wipe clean exterior of keyboard with clean rag Remove front plate and inner cover. Vacuum clean or clean inside with electrician's brush. Avoid using unauthorized solvents for cleaning inside of main processor. Solvents leave a greasy film on components that may reduce electrical conductivity.
b. Visually inspect for indications of burns, corrosion, loose connections, damaged parts, or chipped paint Clean corrosion, tighten loose connections, and replace damaged parts. Remove corrosion with silver polish, fine sandpaper, or burnishing tool. Do not use emery paper or emery cloth or steel wool. Vacuum to remove residue Touch up paint according to TB 43-144. Do not paint threads or labels.

4-7.2 Test

a. If keyboard is inoperative, move main power switch to ON (Figure 1-3). Check input voltage from main processor If Input voltage reading Is not between 25 and 28 Vdc, go to step b to check main processor and cable. If reading is between 25 and 28 Vdc, go to step c to check keyboard.
b. Check main processor output voltage to keyboard If output voltage reading is not between 25 and 28 Vdc, main processor is at fault Check main processor as given In paragraph 4-6. If output voltage reading is between 25 and 28 Vdc, check cable connections and continuity. Tighten cable connection or repair or replace bad cable between main processor and keyboard
c. Check keyboard output voltage to alarm relay module. If output vdtage reading is not 25 to 28 Vdc, replace fuse if bad as given In paragraph 4-7.3 or replace process and display board in main processor as given In paragraph 4-6.3. If after repair keyboard still does not operate, troubleshoot as given in Section IX in the PMS II Maintenance Manual. If after troubleshooting keyboard still does not operate normally, replace video monitor as given In paragraph 4-6.4.

4-7.3 Repair

4-7.3.1 Fuse replacement

CAUTION

When removing front of keyboard use care not to damage keyboard printed circuit board and connecting cables.

a. Remove front plate by loosening four screws on front of keyboard
b. Remove cover protecting keyboard Inner circuitry by removing six nuts holding cover in place.
c. Remove 3A fuse located on printed circuit board and replace.
d. Remove Inner circuitry cover and front page.

4-7.3.2 Printed circuit board replacement

CAUTION

When removing front of keyboard, use care not to damage keyboard circuit board and connecting cables.

a. Remove front plate by loosening four screws on front of keyboard.
b. Remove cover protecting keyboard Inner circuitry by removing six nuts holding cover in place.
c. Replace keyboard circuit.
d. Replace inner circuitry cover and front plate.

4-7.3.3 Keyboard key lights replacement

CAUTION

When removing front of keyboard, use care not to damage keyboard circuit board and connecting cables.

a. Remove cap from key containing burned out lamp.
b. Lift bulb hold-down plate to release lamp(s)
c. Replace lamp(s) and key cap

4-7.4 Replacement

a. Removal

(1) Disconnect cable (C2) to main processor.

(2) Disconnect cable (13P13J) to alarm relay module

(3) Disconnect cable (13P13H) to video monitor.

(4) Remove mounting hardware and carefully remove keyboard

b. Installation

(1) Install keyboard in reverse order of installation in step a. See also Section I in PMS II 6050D Installation Manual in Appendix B for additional installation information
(2) Operate monitoring system and check keyboard for normal operation. If keyboard does not operate normally, troubleshoot as given in Section IX In PMS II Maintenance Manual in Appendix B.

4-8 Video monitor

WARNING

Make sure main power switch (Figure 1-3) Is in OFF position when performing maintenance. Redtag switch with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-8.1 Cleaning and inspection

a. Wipe clean exterior of main processor with clean rag. Open back and vacuum clean.
b. Visually inspect for indications of burns, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion and tighten loose connections Touch up paint according to TB 43-0144. Do not paint threads and labels.

4-8.2 Test

a. If video monitor is inoperative, move main power switch to ON (Figure 1-3). Check input voltage from main processor. If input voltage reading is not between 25 and 28 Vdc go to step b to check main processor and cable. If reading is between 25 and 28 Vdc, go to step c to check video monitor.
b. Check main processor output voltage to video monitor. If output voltage reading is not between 25 and 28 Vdc, check main processor as given In paragraph 4-6. If output voltage reading is between 25 and 28 Vdc, check cable connections and continuity. Tighten cable connection or repair or replace bad cable between main processor and video monitor.
c. Check video monitor output voltage to keyboard. If output voltage reading is not 25 to 28 Vdc, replace fuse if bad as given in paragraph 4-8.3 or replace process and display board In main processor as given in paragraph 4-6.3. If after repair, video monitor does not operate, troubleshoot as given in Section IX in the PMS II Maintenance Manual If after troubleshooting video monitor still does not operate normally, replace video monitor as given in paragraph 4-6.4.

4-8.3 Repair. Repair Involves replacement of fuses

NOTE

Some video monitors have both a 1 A fuse on the back cover and a 3A fuse inside, while others have only a 3A fuse inside the back cover.

a. Unsecure video monitor from mounting bracket by removing two screws from each side of monitor.
b. Disconnect cables on back of monitor and remove monitor
c. Unscrew 1A fuse on back of monitor and replace. If required, remove back cover, use fuse puller to remove 3A fuse, replace fuse and back cover
d. Connect cables to video monitor and reattach to mounting-bracket.

4-8.4 Replacement

a. Removal

(1) Unsecure video monitor from mounting bracket by removing two screws from each side of monitor
(2) Disconnect cables (C1 and 13P13H) on back of monitor and remove monitor.

b. Installation

(1) Connect cables (C1 and 13P13H) to back of video monitor.
(2) Secure video monitor to each side of mounting bracket with two screws

4-8.5 Video board adjustment. Adjust video board as given In Section 9, paragraph 1.0 in PMS II Maintenance Manual in Appendix B

4-9 Alarm relay module

WARNING

Make sure main power switch (Figure 1-3) Is in OFF position and circuit breaker 4P14 or 24 Vdc power panel is open (OFF) when performing maintenance. Redtag switch with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-9.1 Cleaning and Inspection

a. Wipe clean exterior of alarm relay module with clean rag. Remove front plate and vacuum clean or clean inside with electrician's brush. Avoid using unauthorized solvents for cleaning inside of alarm relay module. Solvents leave a greasy film on components that may reduce electrical conductivity.
b. Visually inspect for indications of bums, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion from contacts and terminals, tighten loose connections, and replace damaged parts. Remove corrosion with silver polish, fine sandpaper, or burnishing tool. Do not use emery paper or emery cloth or steel wool. Vacuum to remove residue. Touch up paint according to TB 43-0144. Do not paint threads or labels.

4-9.2 Test

a. If alarm relay module is inoperative, move main power switch to ON (Figure 1-3) and close (ON) circuit breaker 4P14 or 24 Vdc power panel. Check input voltage from keyboard and 24 Vdc power panel. If input voltage reading from keyboard is not between 25 and 28 Vdc go to step b to check keyboard and cable. If input voltage from 24 Vdc power panel is not between 25 and 28 Vdc, go to step c to check power source. If both readings are between 25 and 28 Vdc, go to step d to check alarm relay module.
b. Check keyboard voltage to alarm relay module. If voltage reading is not between 25 and 28 Vdc, check keyboard as given in paragraph 4-7. If voltage reading is between 25 and 28 Vdc, check cable 13P13J connections and continuity Tighten cable connection or repair or replace bad cable between keyboard and alarm relay module.
c. Check 24 Vdc power panel circuit breaker 4P 14 output. If output reading Is not between 25 and 28 Vdc, power source is at fault Check power source. If output voltage is between 25 and 28 Vdc, check cable 4P14 connections and continuity. Tighten cable connection or repair or replace bad cable between alarm relay module and 24 Vdc power panel
d. Check alarm relay module voltage to horn, strobe light and buzzer. If output voltage reading is not 25 to 28 Vdc, replace fuse as given In paragraph 4-9.3. If after repair, alarm relay module still does not operate, replace module as given In paragraph 4-9.4. If output voltage is 25 to 28 Vdc, check horn, as given In paragraph 4-11, strobe light as given in paragraph 4-12, or buzzer as given in paragraph 4-13.

4-9.3 Repair. Repair Involves replacement of fuses.

a. Remove alarm relay module front plate by loosening four screws.
b. Remove and replace 1 OA fuse(s) located on center of left and right sides of circuit board c. Replace front plate.

4-9.4 Replacement

a. Removal

(1) Tag and disconnect cables (13P13J, 4P14, 4P14A, 4P14B, and 4P14C) from alarm relay module.
(2) Remove mounting hardware and remove module.

b. Installation

(1) Install module and secure with mounting hardware.
(2) Connect cables.

4-10 Bilge alarm module

WARNING

Make sure main power switch (Figure 1-3) Is in OFF position and circuit breaker 1P14 on 24 Vdc power panel is open (OFF) when performing maintenance. Redtag switch with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-10.1 Cleaning and Inspection

a. Wipe clean exterior of alarm relay module with clean rag. Remove front plate and vacuum clean or clean inside with electrician's brush. Avoid using unauthorized solvents for cleaning inside of alarm relay module. Solvents leave a greasy film on components that may reduce electrical conductivity.
b. Visually inspect for indications of burns, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion from contacts and terminals, tighten loose connections, and replace damaged parts. Remove corrosion with silver polish, fine sandpaper, or burnishing tool. Do not use emery paper or emery cloth or steel wool. Vacuum to remove residue. Touch up paint according to TB 43-0144. Do not paint threads or labels.

4-10.2 Test

a. If bilge alarm module is inoperative, move main power switch to ON (Figure 1-3) and close (ON) circuit breaker 1 P14 on 24 Vdc power panel Check input voltage from main processor and 24 Vdc power panel. If input voltage from main processor Is not between 25 and 28 Vdc go to step b. If input voltage from 24 Vdc power panel is not between 25 and 28 Vdc, go to step c to check power source. If both readings are between 25 and 28 Vdc, go to step d to check bilge alarm module
b. Check main processor output voltage to bilge alarm module. If voltage to bilge alarm module reading is not between 25 and 28 Vdc, check main processor as given in paragraph 4-6. If voltage reading is between 25 and 28 Vdc, check cable 1 P14A, C3 and C4 connections and continuity. Tighten cable connection or repair or replace bad cable between main processor and bilge alarm module.
c. Check 24 Vdc power panel circuit breaker 1 P14 output. If output reading is not between 25 and 28 Vdc, power source is at fault Check power source. If output voltage is between 25 and 28 Vdc, check cable 1 P14 connections and continuity. Tighten cable connections or repair or replace bad cable between bilge alarm module and 24 Vdc power panel
d. Check bilge alarm module output voltage to horn and strobe light on top of deckhouse. If voltage reading is not 25 to 28 Vdc, replace fuse as given In paragraph 4-10.3. If after repair, bilge alarm module still does not operate, replace module as given In paragraph 4-10.4. If voltage is 25 to 28 Vdc, check horn as given in paragraph 4-12 or strobe light as given in paragraph 4-13.

4-10.3 Repair. Repair involves replacement of fuses

a. Remove bilge alarm module front plate by loosening four screws.
b. Remove and replace 1OA fuse(s) located on center of left and right sides of circuit board.
c. Replace front plate.

4-10.4 Replacement

a. Removal

(1) Tag and disconnect cables (1P14, 1P14A, 1P14B, 1P14C, C3 and C4) from bilge alarm module.
(2) Remove mounting hardware and remove module.

b. Installation

(1) Install module and secure with mounting hardware.
(2) Connect cables.

4-11 Main power switch

WARNING

Make sure main power switch (Figure 1-3) Is In OFF position and batteries are disconnected when performing maintenance. Redtag switch with: "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-11.1 Cleaning and inspection

a. Wipe clean exterior of alarm relay module with clean cloth. Open door and vacuum clean or clean inside with electrician's brush. Avoid using unauthorized solvents for cleaning inside of main processor. Solvents leave a greasy film on components that may reduce electrical conductivity.
b. Visually inspect for indications of burns, corrosion, loose connections, damaged parts, or chipped paint. Clean corrosion from contacts and terminals, tighten loose connections, and replace damaged parts. Remove corrosion with silver polish, fine sandpaper, or burnishing tool. Do not use emery paper or emery cloth or steel wool. Vacuum to remove residue. Touch up paint according to TB 43-0144. Do not paint threads or labels.

4-11.2 Test

a. Check input voltage from battery. If Input voltage reading is not between 25 and 28 Vdc, go to step b to check power source and cable. If reading is between 25 and 28 Vdc, go to step c to check switch.
b. Check battery output voltage. If output voltage reading is not between 25 and 28 Vdc check batteries. If output voltage reading Is between 25 and 28 Vdc, check cable connections and continuity. Tighten cable connections or repair or replace bad cable between battery and switch

c. Check switch output voltage to main processor. If output voltage reading is not 25 to 28 Vdc, replace fuse if bad as given In paragraph 4-11.3. If after repair switch does not operate, replace switch as given in paragraph 4-8.4.

4-11.3 Repair. Repair involves replacement of fuses

a. Open switch door.
b. Use fuse puller to replace fuse
c. Close switch door

4-11.4 Replacement

a. Removal

(1) Tag and disconnect cables (13P13F and 13P13G) from switch.
(2) Remove mounting hardware and remove module

b. Installation

(1) Install switch and secure with mounting hardware
(2) Connect cables to switch.

4-12 Horn

WARNING

Make sure main power switch is off and circuit breaker 1 P14 or 4P14 is open (OFF) when performing maintenance. Redtag switch with "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-12.1 Cleaning and Inspection

a. Wipe exterior clean with clean cloth.
b. Visually inspect for loose wire connections, corrosion, or damage. Clean corrosion and tighten loose connections

4-12.2 Test. Check input voltage to horn located in ROWPU space or deckhouse mast. If input voltage is between 25 and 28 Vdc, replace horn as given in paragraph 4-12.3. If input voltage is not between 25 and 28 Vdc, check connections and continuity of input cable (4P14A to ROWPU space horn or 1 P14C to deckhouse mast horn). Tighten loose connections or repair or replace bad cable. If input cable to horn in ROWPU space is good, check alarm relay module as given in paragraph 4-9. If input cable to horn on deckhouse mast is good, check bilge alarm module as given in paragraph 4-10.

4-12.3 Replacement

4-12.3.1 Horn in ROWPU space on forward bulkhead (Barge 1) and on overhead (Barges 2 and 3)

a. Removal

(1) Tag and disconnect cable (4P14A)
(2) Remove mounting hardware and remove horn.

b. Installation

(1) Install horn and secure with mounting hardware.
(2) Connect cable to horn

4-12.3.2 Horn on deckhouse mast

a. Removal
(1) Remove 12 hex nuts and lock washers to free mast from foundation
(2) Lay mast on deck
(3) Tag and disconnect cable (1P14C)
(4) Remove mounting hardware and remove horn.

b. Installation
(1) Install horn and secure with mounting hardware.
(2) Connect cable to horn.
(3) Stand up mast, align holes and studs, and secure mast with 1 hex nuts and lock washers 4-13 Strobe light

WARNING

Make sure main power switch Is off and circuit breaker 1 P14 or 4P14 is open (OFF) when performing maintenance. Redtag switch with "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-13.1 Cleaning and inspection

a. Wipe exterior clean with clean cloth and glass cleaner.
b. Visually inspect for loose wire connections, corrosion, or damage. Clean corrosion and tighten loose connections.

4-13.2 Test

a. Check lamp. If bad, replace lamp as given in paragraph 4-13.3. If good, go to step b.
b. Check input voltage to strobe light located in ROWPU space or deckhouse mast. If input voltage is between 25 and 28 Vdc, replace strobe light as given in paragraph 4-13.4. If input voltage is not between 25 and 28 Vdc, check connections and continuity of input cable (4P14B to ROWPU space strobe light or 1 P14B to deckhouse mast strobe light). Tighten loose connections or repair or replace bad cable. If input cable to strobe light in ROWPU space is good, check alarm relay module as given in paragraph 4-9. If input cable to strobe light or deckhouse mast is good, check bilge alarm module as given in paragraph 4-10.

4-13.3 Repair. Repair involves replacement of the lamp.

a. Strobe light in ROWPU space on forward bulkhead (Barge 1) and on overhead (Barges 2 & 3).

(1) Remove glass cover on strobe light by loosening screw and releasing clamp at base.
(2) Pull out lamp and replace.
(3) Replace glass cover and clamp. Secure cover to base by tightening clamp screw.

b. Strobe light for bilge level switches on deckhouse mast.

(1) Remove 12 hex nuts and lockwashers to free mast from foundation.
(2) Lay mast on deck
(3) Remove glass cover on strobe light by loosening screw and releasing clamp at base
(4) Pull out lamp and replace.
(5) Replace glass cover and clamp. Secure cover to base by tightening clamp screw.
(6) Stand up mast, align holes and studs and replace 12 hex nuts and lockwashers at foundation.

4-13.4 Replacement

4-13.4.1 Strobe light In ROWPU space on forward bulkhead (Barge 1) and on overhead (Barges 2 and 3)

a. Removal

(1) Tag and disconnect cable (4P14B).
(2) Remove mounting hardware and remove strobe light.

b. Installation

(1) Install strobe light and secure with mounting hardware
(2) Connect cable to strobe light.

4-13.4.2 Strobe light for bilge level switches on deckhouse mast

a. Removal

(1) Remove 12 hex nuts and lockwashers to free mast from foundation.
(2) Lay mast on deck.
(3) Tag and disconnect cable (1P14B)
(4) Remove mounting hardware and remove strobe light.

b. Installation

(1) Install strobe light and secure with mounting hardware.
(2) Connect cable to strobe light.
(3) Stand up mast, align holes and studs, and secure mast with 12 hex nuts and lockwashers.

WARNING

Make sure main power switch is off and circuit breaker 1 P14 or 4P14 is open (OFF) when performing maintenance. Redtag switch with "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-14 Buzzer

4-14.1 Cleaning and Inspection

a. Wipe exterior clean with clean cloth.
b. Visually inspect for loose wire connections, corrosion, or damage. Clean corrosion and tighten loose connections.

4-14.2 Test. Check input voltage to buzzer located in dayroom on aft bulkhead. If input voltage Is between 25 and 28 Vdc, replace buzzer as given in paragraph 4-14.3. If input voltage is not between 25 and 28 Vdc, check connections and continuity of input cable 4P14C Tighten loose connections or repair or replace bad cable. If input cable is good, check alarm relay module as given in paragraph 4-9.

4-14.3 Replacement

a. Removal

(1) Tag and disconnect cable 4P14C from buzzer.
(2) Remove mounting hardware and remove buzzer.

b. Installation

(1) Install buzzer and secure with mounting hardware.
(2) Connect cable to buzzer

4-15 Inverter/Battery Charger

WARNING

Make sure circuit breaker 13P13 on power panel 3 is open (OFF) position when performing maintenance. Redtag circuit breaker with "WARNING DO NOT ACTIVATE. REPAIRS BEIN(; MADE."

4-15.1 Cleaning and Inspection

a. Wipe clean exterior of charger with clean cloth. 'Vacuum clean interior of charger.
b. Visually inspect for indications of burns, corrosion, loose connections, or damaged parts. Clean corrosion and tighten loose connections. Touch up paint according to TB 43-0144. Do not paint threads or labels.

4-15.2 Test. See manufacturer's service manual in Appendix B for additional information.

a. If charger Is inoperative or not charging battery, close (ON) circuit breaker 1 3P1 3 on power panel 3. Check ac input and dc output fuses. If fuses are good, go to step b. If fuses are bad, replace fuse.
b. Check Input voltage from circuit breaker 13P13. If input voltage reading is not 120 Vac, go to step c to check power source. If reading is 120 Vac, go to step d to check output cable

c. Check circuit breaker 13P13 fuses. Replace fuses if bad as given in paragraph 4-15.3. If fuses are good, check connections and continuity of cable 13P13C. Tighten loose connections or repair or replace bad cables.
d. Check Vdc output voltage from charger. If output voltage is not obtained, troubleshoot charger as given in the manufacturer's service manual in Appendix B. If troubleshooting does not eliminate the problem, replace charger as given in paragraph 4-15.4.

4-15.3 Repair

a. Fuses. Replace fuses as follows:

(1) Open battery charger by loosening screw on right side of door.

NOTE
There are 2 fuses on circuit board: a 35A dc fuse on left and an 18A ac fuse on right.

(2) Unscrew blown fuse(s) and replace.
(3) Close door and tighten screw on right side of door

b. Diodes. Troubleshoot and replace silicone diodes as given on page 8 of the manufacturer's service manual in Appendix B

4-15.4 Replacement

a. Removal

(1) Tag and disconnect cables 13P13C and 13P13C£.
(2) Remove mounting hardware and remove charger.

b. Installation

(1) Install battery charger and secure with mounting hardware
(2) Connect cables.
(3) Operate as given in the INSTALLATION paragraph on page 11 in the manufacturer's service manual in Appendix B.

4-16 Battery

WARNINIG
Make sure battery charger Is not operating by securing circuit breaker 13P13 on power panel 3. Redtag circuit breaker with "WARNING DO NOT ACTIVATE. REPAIRS BEING MADE."

4-16.1 Cleaning and Inspection

a. Wipe clean exterior and interior of battery box and batteries with clean cloth.
b. Visually inspect for corrosion, loose connections, or darnage. Clean corrosion and tighten loose connections. Touch up paint according to TB 43-0144. Do not paint threads or labels.

4-16.2 Test

a. With battery charger off, check charge on battery. If charge is not between 25 and 28 Vdc, replace batteries if battery charger is operating normally. If charge is between 25 and 28 Vdc, go to step b.
b. Check battery charger as given in paragraph 4-15.

4-16.3 Replacement

a. Removal

(1) Remove battery cover
(2) Observe how + or battery terminals are connected. Draw sketch of arrangement to be sure that new batteries are connected in the same way.
(3) Disconnect cable 13P1 3E from negative (-) battery terminal and then from positive (+) battery terminal. Then disconnect cable between battery terminals.
(4) Clean and wrap with dry cloth and place so cable 13P 13E ends do not touch any metal part of battery box or other barge components
(5) Remove oil batteries

b. Installation

(1) Install new batteries In same positions as old batteries.
(2) Connect cables to batteries as sketched In step 3-2. Connect cable to positive (+) terminal first and then to negative (-) terminal
(3) Make sure cable ends are tight Coat terminals with anticorrosive grease.
(4) Install battery cover.

4-17 Electrical wiring and cables

4-17.1 Inspection. Inspect wiring and cables for chafed or burned insulation. Look for causes of chafing and burns. Inspect terminal connectors for corrosion and loose connectors and broken parts. Clean corrosion and replace damaged connector pins or wires, replace damaged connectors, or replace harness assemblies. Check mounting hardware, hangers, and receptacles for tightness. Tighten if necessary.

4-17.2 Repair or replacement When replacing wires or repairing cables, lay wires alongside wire or cable and cut new wire at least 1 1/2 inches longer than wire being replaced

4-18 Terminal box

4-18.1 Cleaning and inspection

a. Wipe clean exterior of terminal box with clean cloth. Vacuum clean interior of box.
b. Visually inspect for indications of burns, corrosion, loose connections or damage. Clean corrosion and tighten loose connections Touch up paint according to TB 43-0144. Do not paint threads or labels.

4-18.2 Test

4-18.2.1 40-terminal box

a. Check connections and continuity of cable C6 between main processor and terminal box. Tighten cable connections, or repair or replace bad wires or cable. If cable is good, go to step b.
b. Check connections and continuity of the following cables between terminal box and sensors/switches. Tighten cable connections, or repair or replace bad wires or cable. If cable is good, notify general support.

Cable	Main Processor to Sensor/Switch
A7-1	Water Storage Tank No. 1 Liquid Level
A7-2	Water Storage Tank No. 2 Liquid Level
A7-3	Water Storage Tank No. 3 Liquid Level
A74	Water Storage Tank No. 4 Liquid Level
A7-6	R/O Block No. 1 Salinity

A7-7	R/O Block No. 2 Salinity
A8-3	Fuel Tank No. 1 (Starboard)
A8-4	Fuel Tank No. 2 (Port)
S1-1	Bilge Void No. 1
S1-2	Bilge Void No. 2 Starboard
S1-3	Bilge Void No. 3 Port
S2-2	Power Failure (Chlorination Unit)
S2-3	Low Salinity (Chlorination Unit)
S2-4	Recirculating Pump Failure (Chlorination Unit)
S2-5	Sludge Tank Level

4-18.2.2 20-terminal box

a. Check connections and continuity of cable C-5 between main processor and terminal box. Tighten cable connections, or repair or replace bad wires or cable. If cable is good, go to step b.
b. Check connections and continuity of the following cables between terminal box and sensor/switches. Tighten cable connections or repair or replace bad wires or cable. If cable is good, notify intermediate general support.

Cable	Main Processor to Sensor/Switch
A7-5	Discharge Pressure (Shore Discharge Line)
A7-8	Salinity (Shore Discharge Line)
R-1	Flow Rate (Shore Discharge Line)
S1-4	Bilge Void No 3 Starboard
S1-5	Bilge Void No. 3 Port
S1-6	Bilge Void No. 4 Starboard
S1-7	Bilge Void No. 4 Port
S1-8	Bilge Void No. 5
S1-11/S1-12	155 kW Generator Set No 1
S1-13/S1-14	155 kW Generator Set No. 2
S1-15/S1-16	20 kW Generator Set
S2-8/S2-9	ROWPU High-Pressure Pump Diesel Engine No. 1
S2-10/S2-11	ROWPU High-Pressure Pump Diesel Engine No. 2

4-18.2.3 Replacement

a. Removal

(1) Tag and disconnect all cables to terminal box.
(2) Remove mounting hardware and remove terminal box.

b. Installation

(1) Install terminal box and secure with mounting hardware.
(2) Connect cables.

CHAPTER 5 STORAGE

5-1 Short-term storage. If barge is taken out of service for more than 7 days but less than 30 days, follow shutdown procedures In paragraph 3-8 Inspect for damage, corrosion, or pilferage

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

5-2.1 Administrative storage procedures. If not used In administrative storage, EMS Is processed as specified In steps below and Inspected as specified In paragraph 5-2.2

a. Turn main power switch OFF
b. On Inside of front panel, turn main processor switch off
c. Behind panel under the screen, turn video monitor switch off
d. Open 24 Vdc power panel circuit breakers 1P14 and 4P14
e. Make sure batteries are fully charged
f. Disconnect positive and negative leads from battery terminals, wrap In clean, dry cloth and locate so they do not touch battery box or any other metal part of barge Be sure to reinstall battery cover
g. Thoroughly clean all external surfaces to remove any corrosion or other foreign matter Clean all surfaces with cloth dampened In soapy water, then wipe clean with cloth dampened In soapy water, then wipe clean with cloth dampened In clean water Clean electrical components with a clean cloth moistened with silicone spray lubricant
h. Touch up paint as necessary to match surrounding areas In accordance with TB 43-0144

5-2.2 Administrative storage inspection. The EMS, if not used during storage, will be Inspected at least once every 30 days Check for corrosion, damage or pilferage Correct as necessary

5-3 Long-term storage. If barge Is to be taken out of service for 6 months or more, turn It In to depot for preparation and placement Into long-term storage If barge is In administrative storage and Is to be taken out of service and placed In depot long-term storage (6 months or more), process EMS for normal operation before releasing to depot

CHAPTER 6 MANUFACTURERS' SERVICE MANUALS/INSTRUCTIONS

6-1 General These references provide additional Information on EMS components A ready reference copy 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 volume.

Component	Document title	Manufacturer
PMS II monitoring system	1. PMS II Operator's Manual 2 PMS II 6050D Installation Manual 3 PMS II Maintenance Manual	Tracor Marcon, Inc 13433 N E 20th Street Bellevue, WA 98005 (206) 643-0912
Battery charger	Model A46 Engine Generator Set Float Charger Troubleshooting Manual for all series Battery Chargers, including Models All1, A11P, A33, A12, A12B, A46, A40, A28, A29	LaMarche Manufacturing Co 106 Bradrock Drive Des Plaines, IL 60018 (312) 299-1188

CHAPTER 7 MANUFACTURERS' WARRANTIES/GUARANTEES

7-1 General Information on EMS component warranties/guarantees Is listed below

Component	Manufacturer	Duration	Coverage
PMS II monitoring system	Tracor Marcon, Inc 13433 N.E 20th St. Bellevue, WA 98005 (206) 643-0912	1 year from date of acceptance	Material and workmanship
Battery charger	LaMarche Manufacturing Co. 106 Bradrock Drive Des Plaines, IL 60018 (312) 299-1188	1 year from date of purchase	Material 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
13226E1914	Miscellaneous Foundations
13226E1928	Alarm/Casualty Monitoring System
13226E1932	Electrical Power Schematic Diagram
13226E1935	Electrical Power System Layout

A-2 Demolition to Prevent Enemy Use

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

A-3 Cleaning

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

A-4 Maintenance

DA PAM 738-750	The Army Maintenance Management System (TAMMS)
TB 43-0144	Painting of Vessels

APPENDIX B

MANUFACTURERS' SERVICE MANUALS/INSTRUCTIONS

Component	Document title	Manufacturer
PMS II monitoring system	1. PMS II Operator's Manual 2. PMS II Maintenance Manual	Traor Maroon, Inc. 13433 N.E. 20th Street Bellevue, WA 98005 (206) 643-0912
Battery charger	Troubleshooting Manual for all series Battery Chargers, including: Models All, A11 P, A33, A12, Al2B, A46, A40, A28, A29	LaMarche Manufacturing Co. 106 Dradrock Drive Des Plaines, IL 60018 (312) 299-1188

TRACOR MARCON

PMS II

OPERATOR'S MANUAL

TABLE OF CONTENTS

Section I. Introduction

I. Introduction

The PMS II Is a compact, effective, and easy to use monitoring system displaying and logging critical operating parameters while automatically alarming out-of-range readings. The system is composed of a Main Collector/ Processor Unit and up to 2 Operator's stations. All of the information collected by the PMS II Is displayed on a compact video monitor, replacing large annunciator panels. This manual will tell you, the operator # how to use the PMS II.

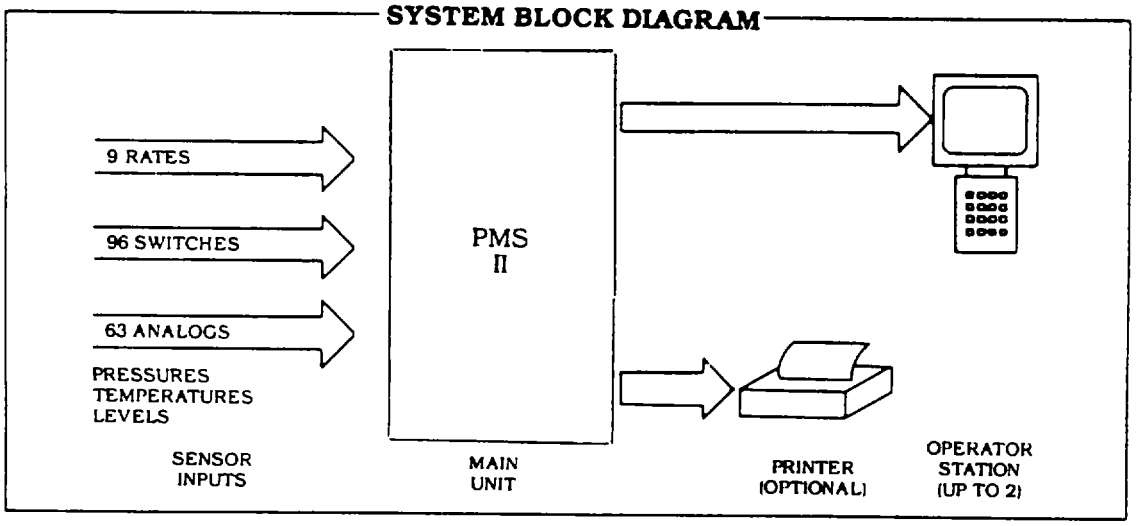


Fig. 1

Section II. Detailed System Description

II. Detailed System Description

This paragraph will provide a working description and explanation of the system and Its components.

A. Main Collector/Processor Unit (Fig. 2)

The Main Collector/Processor Unit Is the primary component of the system. It Is directly connected to the sensors and switches monitoring the equipment. All the Information Is then processed, formatted, and sent to the Operator's Stations for display.

B. Operator's Station

The operator's station Is where the PMS II meets the operator. Here the system takes In commands from the operator, and displays measurements and alarm Information. The Operator's Station has two parts, a video monitor and a keyboard. (Fig. 3) The monitor displays measurement and alarm Information. The keyboard (Fig. 4) controls the video information displays, and also acknowledges alarms. Keyboards are equipped with an audible alarm, which provides a local annunciating function.

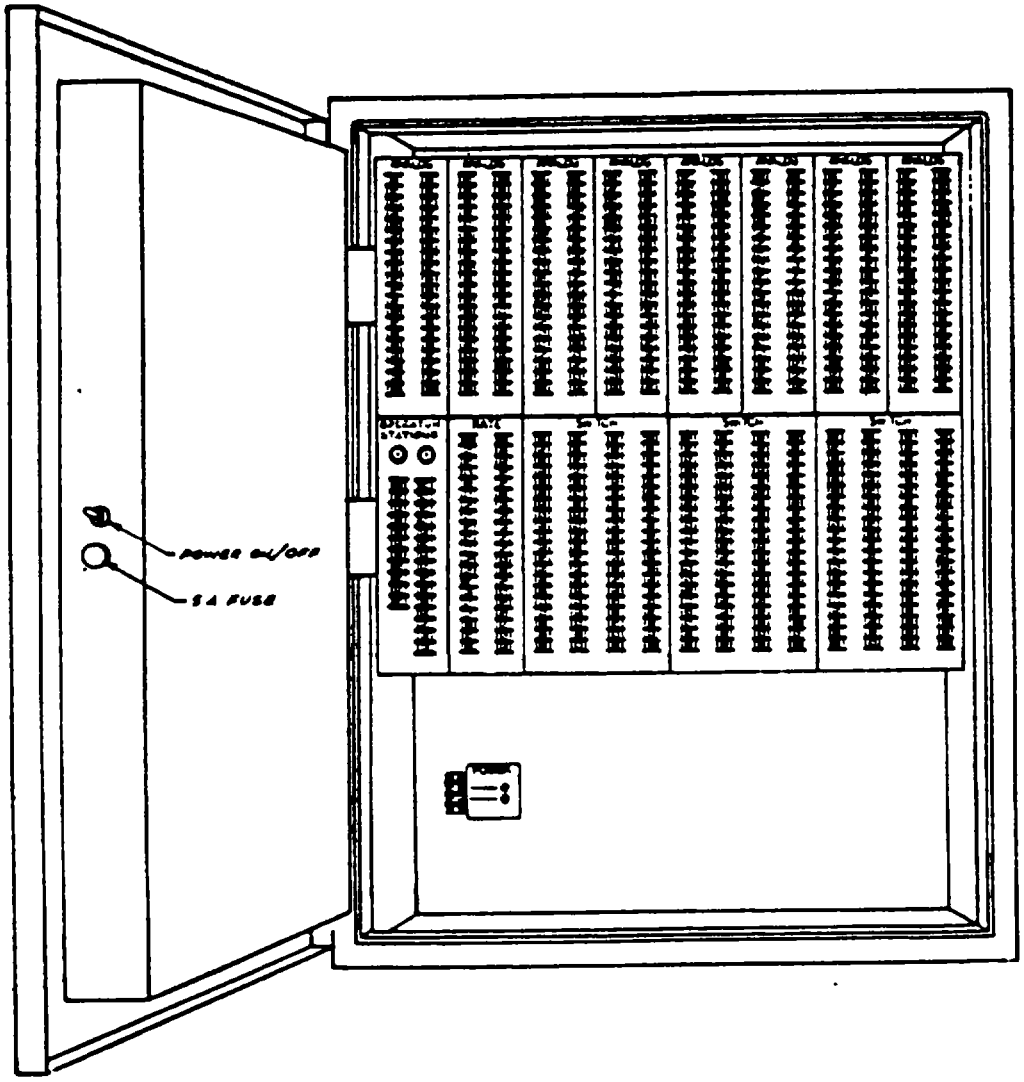
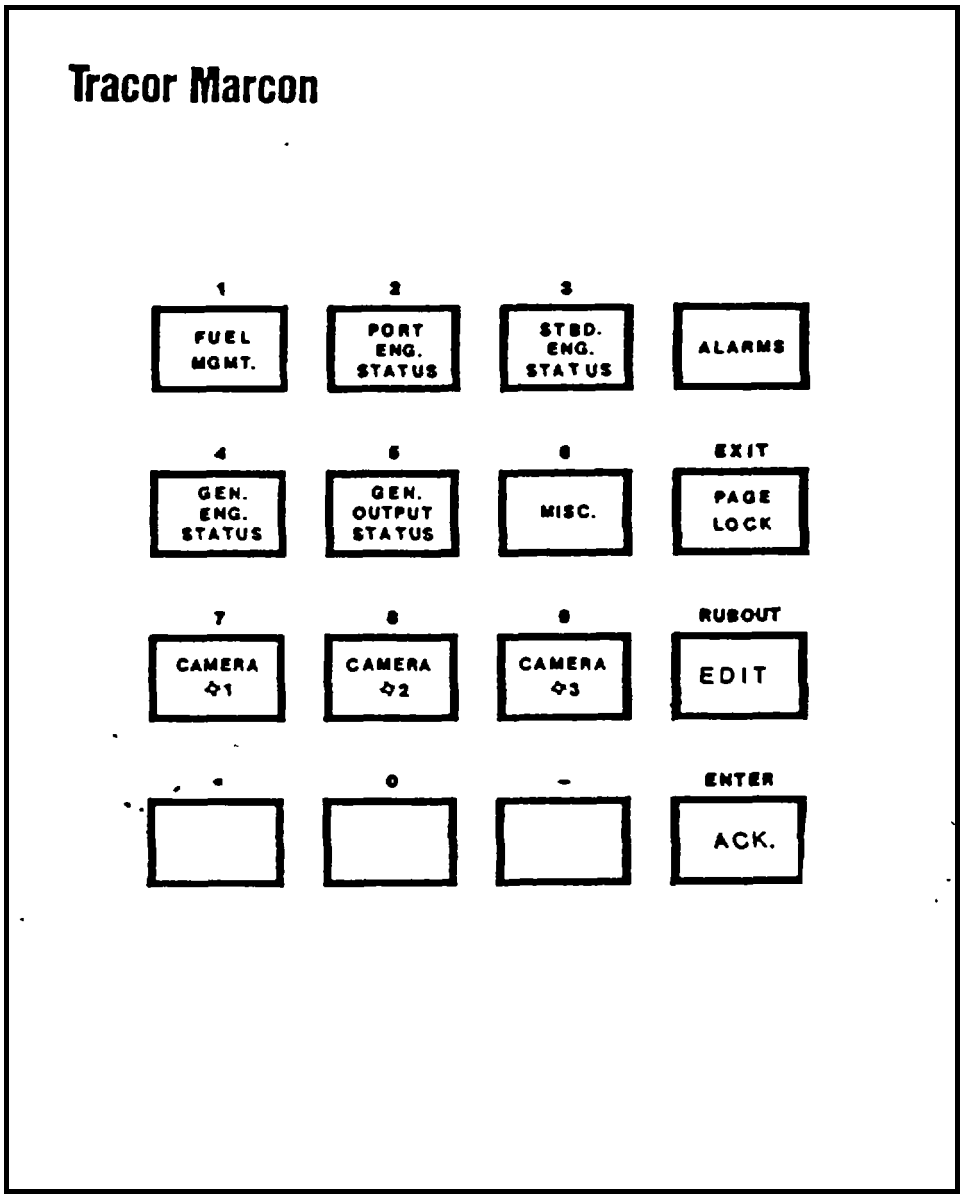


Fig. 2 MAIN COLLECTOR/PROCESSOR UNIT



OPERATOR'S KEYBOARD

FIG. 3

III. System Power-up and Initialization

The Main Collector/Processor power switch is inside the enclosure on the edge of the door mounted component chassis. (Fig. 2) Each operator's station monitor has a power switch and a system main power switch and fuse panel is located in the vicinity of the remotely mounted power source. To power up the PMS II, turn on the main system power first, then the Main Collector/Processor and each operator's station monitor. After turning on power to the Main Unit there will be a delay of about 2 seconds and monitoring will begin.

IV. Monitor Display

A. Measurements

1. Bargraph Format (Fig. 5)

Measurements are displayed on the screen, one per line, with the label or identifier on the left side of the screen, a scale with a bar representing the magnitude of the data in the middle of the screen, and a digital readout on the right. Marcon's format for displaying information has many advantages over other types of formats. The labeling to the left of the bar will clearly identify what that measurement is. The bar format, which can be read by comparing the length of the bar with the scaling above it, can be scanned quickly, and makes it easy to compare readings. The numbers to the right of the bar gives exact measurement readings.

2. Bar Symbols

There are two symbols types which may be displayed on the bar, setpoint markers and reference markers. Setpoint markers are represented by large white triangles pointing to the left or right. Markers pointing to the right are low level alarm setpoints, and markers pointing to the left are high level alarm setpoints. Measurements crossing these markers are alarms, and will be annunciated. The other marker, a small, white, inverted triangle, is a reference marker. it may be used by the operator to mark normal operating levels or to check for changing readings. Setting of the reference marker is covered in paragraph VI. D. 6. b. of this manual.

3. Bar Messages

There are a number of messages which may be displayed in place of the bar. These messages, which indicate special situations, are;

DEACTIVATED
This message indicates that the sensor has been deactivated, or 'turned off'.

OVERRANGE
This message is displayed when the data received from that sensor is of greater value than the scale displayed on the page. it is the equivalent of the needle on a gauge being pegged at the top end.

UNDERRANGE
This message is displayed for rate measurements, and some level measurements. it means that the reading is too low to measure accurately.

UNIT NOT OPERATING
This message is displayed to inform the operator that the alarm setpoint on this bar is not active because the unit being monitored is not on, and the alarm would not be meaningful. This message may still be displayed

after the unit has been turned on for a set period to allow the readings time to come up to their operating level.

ALARM DISABLED
This message is similar to UNIT NOT OPERATING, except that the unit being monitored is now on, but that the alarm is not yet armed. Digital information is displayed on the right margin during this time. An example of how these messages would appear follows; the engine is off, and the message on the lube oil pressure bar shows UNIT NOT OPERATING. When the engine is started, the messages changes to ALARM DISABLED, and the critical pressure measurements are displayed digitally on the right margin. This message will be replaced by the bar when the arming delay has expired, and the alarm setpoints will be active.

ALARM DISABLED - OVER RANGE
ALARM DISABLED - UNDER RANGE
These messages show the alarm disabled status with the correct over range/underrange indications.

INPUT BOARD FAILURE
This message is displayed when the PMS II detects that the Input Board has stopped sending information to the Process and Display Card. This message will always be displayed as an alarm on the bar of every sensor, and will stay until the Input Board has righted itself or has been repaired. Since it is a monitoring system alarm as opposed to an out of tolerance indication from a monitored point, it will not appear as a blinking display, and does not require acknowledgment.

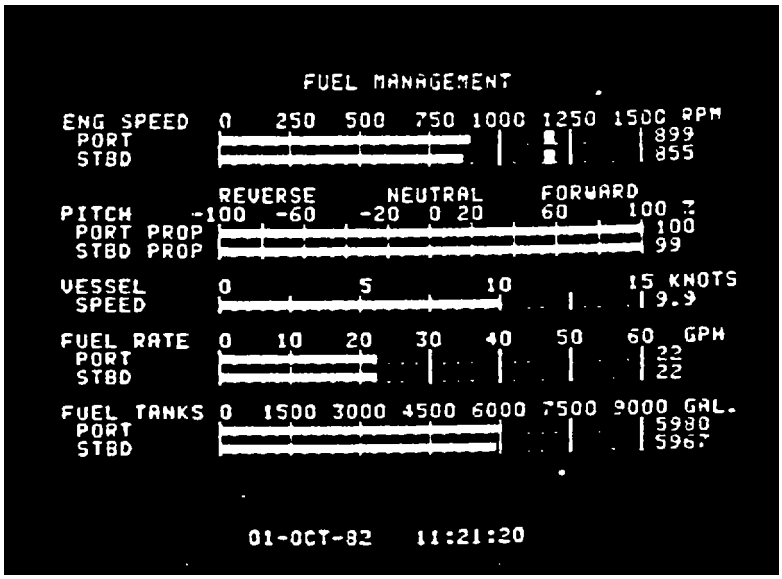
THERMOCOUPLE OPEN
This message is displayed when the input board has detected an open thermocouple. This is a monitoring system alarm, and will be displayed the same as an Input Board failure.

B. Totalizers

Totalizers are quantitative measurement displays without the bar format. These displays can be from 1 to 8 digits (up to 99,999,999) with leading zeroes suppressed. Several can be displayed on one line. A totalizer is an accumulated count of events. The kinds of data that typically would be displayed as a totalizer are gallons of fuel consumed or hours of engine operation. Totalizers can be deactivated (turned off) by the operator using the Edit Mode (see VI.D.2.c.). When a totalizer has been deactivated, the number field will be replaced by IX's to signify that the totalizer is no longer counting.

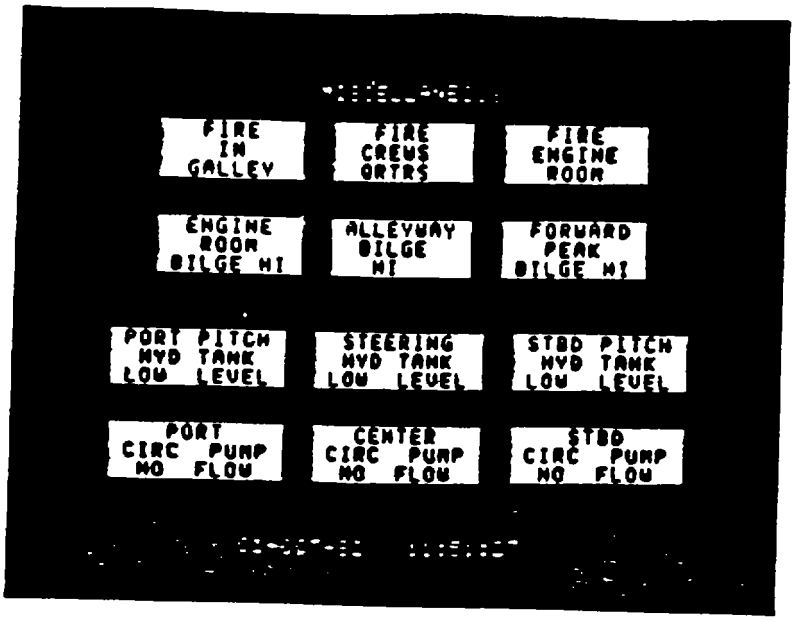
C. Switches

1. Switch Formats (Fig. 6)



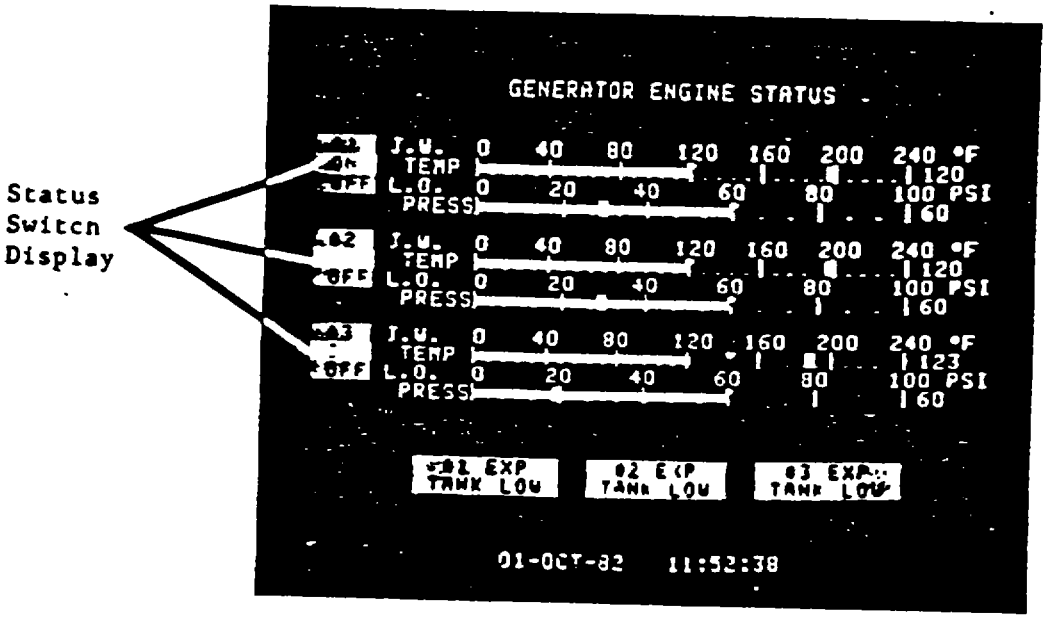
Monitor page display with bargraph formats

FIG. 5



Monitor page display with switch formats

FIG. 6



Monitor page display with status switch formats

FIG. 7

Switches are displayed on the screen as white rectangles with labels inside. The size of switch displays can vary. The primary active switch information is alarm annunciation, which is discussed in paragraphs V.B and C. When a switch has been deactivated, or when the Input Board has failed, the switch is displayed as the switch label with no borders. This format is to make it clear to the operator that this switch is not active, and will neither alarm nor show status.

2. Status Switches (Fig. 7)

The most commonly used switches are those that cause alarm annunciation, however the PMS II also supports switches which show status instead of alarm. This is done by bracketing one of the bottom lines of the switch with the same symbols as high/low setpoint markers to indicate the status.

D. Alarm Summary Page

The Alarm Summary Page provides the operator with the capability of viewing all alarming points on a single page. Alarms are displayed with the label of the point on the left side of the page, and, if the alarming point is a bargraph, the digital value on the right side of the page. Alarm status and digital information is updated every three seconds. Unacknowledged alarms appear first, and are displayed in double-intensity blinking format. Acknowledged alarms follow, and are displayed in normal intensity. Further, if alarm group priority is specified, the alarms will be arranged in their respective alarm groups in descending priority, labeled with the group heading. The Alarm Summary Page will be displayed automatically whenever a new alarm is annunciated, or can be selected manually by the operator by pressing the Alarm Summary key on the Operator's Station keyboard. if there are too many alarms to be displayed on one page, pressing the Alarm Summary key again will display the next page of alarms, and so on until all the alarms have been displayed. Pressing the Alarm Summary key once more will return the display back to the first page.

E. Auto-Scan

The PMS II provides for 'hands-off' scanning of all the pages that can be displayed on the Operator's Station. Scanning will automatically start after an interval of time has elapsed since the last page was manually selected. This time interval is usually set at 15 minutes. Optional manual capability to start Auto-Scan is indicated by the presence of a key labeled, 'AUTO-SCAN', on the keyboard. Pressing this key will immediately place the Operator's Station into the Auto-Scan mode, and will also light the key as a mode status indicator. Once in the Auto-Scan mode, the video

monitor will scan through the displays, pausing on each page for a preselected interval. Auto-Scan can be stopped by pressing any page key, causing that page to be immediately displayed. if the optional AUTO-SCAN key is present, an alternate method of stopping Auto-Scan is to press this key a second time. The Auto-Scan key light will be extinguished, and the page being displayed will remain unchanged.

F. Page Lock

Page Lock provides the operator with the capability to lock the monitor on the page presently being displayed, thus disabling automatically reverting to Auto-Scan. First, select the page to be continuously displayed, then press the key labeled 'PAGE LOCK'. The Page Lock key will light as a status mode indicator. The display can be unlocked by pressing the Page Lock key a second time or by pressing any page key, extinguishing the Page Lock key light and causing that page to be immediately displayed. The operator's station will now be subject to automatic starting of Auto-Scan as discussed previously. if the 'AUTO-SCAN' key is present, an alternate way to unlock the display is to press this key, putting the operator's station into Auto-Scan immediately.

V. Alarms

A. Definition

Alarms are annunciated anytime something occurs that requires immediate operator attention. This could be a sensor reading outside of its normal operating range, or a switch changing from its normal position. The PMS II will first detect the situation, then monitor it for a pre-determined period of time to see if it is momentary, and alarm if it persists.

B. Unacknowledged Alarms

Unacknowledged alarms are annunciated in four ways; (1) The monitor will automatically display an alarm summary page with the parameter in alarm being displayed in bright (double intensity) characters and flashing, (2) the bar or switch block on the normal page display is made bright (double-intensity) and starts to flash, (3) the key for the page on which the alarm is located starts flashing red, and (4) the keyboard audible alarm and the main system alarm relay are turned on. An unacknowledged alarm display (double-intensity and flashing) will remain until the alarm is acknowledged, even if the point returns to normal in the meantime. This ensures the cause for the alarm will be observed.

C. Acknowledged Alarms

An Acknowledged Alarm is indicated by a display which is double-intensity, but not flashing. The operator' can acknowledge an unacknowledged alarm displayed on the screen by pressing the ACK (acknowledge) key. This will cause all the unacknowledged alarm displays on the page to stop flashing (become acknowledged alarm displays) and turn off the main system alarm relay and the audible alarms on all the Operator's Stations. Should there be other alarms on other pages (as indicated by other flashing keys), the operator should press the flashing key to cause the alarming indication to be displayed, notice which displays are flashing, and press the ACK (acknowledge) key. Acknowledged alarms will remain double-intensity until the condition that caused them returns to normal. The PMS II guards against repeated alarms from a sensor reading near a setpoint by requiring that readings return well within the normal range before cancelling the alarm. For this reason, it is sometimes possible to see bars near a setpoint which are within the normal range, yet still double-intensity.

D. Silenced Alarms

Operator's Stations may be configured with a SILENCE key in place of an ACK key. These stations are to be installed in the workstations of personnel meant to be informed of alarms, but not responsible for acknowledging or correcting them. When an unacknowledged alarm is annunciated, the audible alarms of all stations and the main alarm relay are turned on. The operator may silence his individual station audible alarm by pressing the SILENCE key. The main system alarm relay, the audible alarms at

the other Operator's Stations, and the unacknowledged alarm displays on the screen will be unaffected.

VI. Extended Capabilities

The Operator's Station can be used to access extended capabilities of the PMS II, such as logging information on the printer, reading PMS status, deactivating sensors, and setting time and date for the PMS clock. These are all available by using the Edit mode. The following paragraphs will explain the extended capabilities, and how to use them, in detail.

A. Edit Mode Operation

To use the Edit mode, start by pressing the EDIT key. The EDIT keys on both Operator's Stations will light, locking all other users out of the Edit mode (pressing the EDIT key when someone at the other operator's station is in the Edit mode will have no effect), and instructions will be displayed on the video monitor. During each step of using the Edit mode, instructions, in the form of a menu of options, will be displayed on the screen. Using the Edit mode means simply following the instructions. There is nothing you can do that will cause any harm. The first thing to realize about the Operator's Station is that once the EDIT key is pressed, the keys on the keyboard have new functions. These functions are printed in black on the keyboard panel above the key. Therefore, the top left key has the value '1', Just like a calculator key. These secondary functions of the keys are used to perform the operations described below.

Note: The system will -continue its monitoring functions even while the operator is using the edit mode. Should an alarm, or any other reason to return to the monitoring display occur, pressing the EXIT key will cancel all Edit mode operations and resume display of monitored points on the Operator's Station.

1. Option Selection

As mentioned earlier, a menu of options is presented at each step in the Edit mode. Each option is numbered. Select the option by pressing the key with the same number as the chosen option. The PMS II will ignore any key not on the menu except EXIT.

B. Logging

The PMS II has the capability of logging information on a printer. This information includes the time and date, sensor and switch labels, alarm status, and sensor readings. One type of logging, Event logging, is automatic. The other two types of logging, Demand and Schedule logging, are controlled through the Edit mode.

1. Event Logging

Event logging takes place every time an alarm is annunciated, acknowledged, or returns to normal. On the printer, each line will be tagged with either 'ALARM', 'ACK', or 'NORM' as appropriate to identify the event.

2. Demand Logging
   Demand logging provides a printer listing of sensor readings and their alarm status, status switches, and alarming annunciator switches. The operator may choose to log all the points monitored by the PMS II, only those points displayed on a single page, or only those points in alarm.

   a) Single Page Demand Log

   1. Press the key for the page to be logged so that it is displayed on the screen
   2. Press the EDIT key
   3. Press ‘1' for ‘PRINT LAST PAGE'. The system will immediately resume normal display monitoring, and will simultaneously print the data from the points from the selected page.

   b) All Pages Demand Log
   1. Press the EDIT key
   2. Press '2' for "PRINT ALL PAGES". Once again, the system will resume display monitoring and will print the data from all the points monitored by the PMS II.

   c) Alarms Demand Log
   1. Press the EDIT key
   2. Press '3' for "PRINT ALARMS". The system will resume display monitoring and will print the data from all points currently in alarm.

3. Schedule Logging
   Schedule logging provides the capability to log, on the printer, a summary of all the points monitored by the PMS II and to do so automatically on a preset schedule. For instructions on how to enter a logging schedule, refer to paragraph VI.D.6.e Edit Schedule Log.

C. System Status

The PMS II displays the status of it's printer on a status page selected by the Edit mode. The following paragraphs describe the possible status messages and their meanings.

1. Blinking EDIT Key
   The PMS II has the feature that events requiring operator's attention will blink the EDIT key. This occurs when a system error is detected. The operator should press the key, and the System Status page will be displayed automatically. The message or messages that caused the EDIT key to blink or are new since the last status display will be highlighted in blinking double intensity. An alternate way to view the Status Page when the EDIT key is not blinking, is to press the EDIT key, and press '4' (SYSTEM STATUS). A menu in the upper

right corner will prompt the operator options. Pressing the '1' key will update the information on the status page. Pressing the '2' key will return to the EDIT menu. (For further information, refer to paragraph VI. C. 5) Pressing EXIT will return the system display to the monitoring pages. The possible errors are discussed in the following paragraphs.

2. Printer
   A status message for the printer will be displayed only when there is an error. The message indicates that the printer is either not turned on, off-line, disconnected from power, disconnected from the Main Unit, or in need of repair. Refer to the PMS II Maintenance Manual if printer service is required.

3. Main Unit Temperature
   The temperature inside the Main Unit enclosure is displayed on the System Status Page. This temperature is the value used in temperature compensation of thermocouple data.

D. System Edit

These paragraphs will describe the Edit mode as it relates to changing sensor and switch information and setting time and date.

1. Access Combination
   The Edit mode is protected against unauthorized use by requiring a 3 digit entry access combination. The operator must enter the correct combination out of a possible 1000 combinations, or the PMS II will exit and re-display the page that was on the monitor before the attempt to enter the Edit mode was made. Perform the following steps to enter the Edit mode;

   1. Press the EDIT key

   2. Press '5' (SYSTEM EDIT)

   3. Screen will prompt "ENTER EDIT ACCESS COMBINATION"

   4. Enter your system's 3 digit combination

   5. Screen will display Edit Menu

2. Cursor Movement
   Moving the cursor is the method the operator uses to select the line, sensor, or switch to be changed. For lines and sensors, the cursor is a bright bar extending from the left side of the screen to mid-screen. To move the cursor, press the appropriate key as indicated on the menu (usually '1'), and notice that the cursor moves one line down. Repeatedly pressing the key (or holding it down), will make the cursor move all the way down to the last editable line, and then start again at the top. To select the line or sensor to edit, stop the

cursor on the desired line or sensor display and press the key for the menu option 'EDIT THIS ONE', usually '2'. The process is much the same for switches and totalizers, except that the cursor position is indicated by making the switch or totalizer display double intensity. Also, since there may be more than one switch or totalizer per line, the cursor moves from left to right to the last display on the line, then moves down to the next line.

3. Entering numbers

   Changing numbers (like setting time and date) involves choosing a line to edit and entering a new value. The format of the on-screen information is labels on the left and a column of numbers near the middle of the screen. The labels are a description of a set of parameters, and the column is the present value of those parameters. The preceding paragraph described making a line selection by moving the cursor and pressing the key to 'EDIT THIS ONE'. When this key is pressed, the cursor will extend through the column of numbers. Now, pressing the numbers keys (as well as '-' and '.') will act like calculator keys and write those numbers on the screen. When the number to be entered is on the screen, press the key marked 'ENTER'. This will shorten the cursor and accept the numbers entered. if the numbers are not acceptable because they are outside the allowable range (like trying to set time for 26 o'clock), the PMS II will print the max or min allowable value on the screen next to the number entered. That entry will be ignored. You can try again by pressing the key for 'EDIT THIS ONE' again, and starting over.

4. Rubout

   When entering numbers, before the ENTER key is pressed, mistakes can be corrected by using the RUBOUT key. The RUBOUT key will cause the PMS II to backspace and erase the last digit pressed. Successively pressing the RUBOUT key will erase the next digit, and so, on until no digits are left.

5. Exit

   The key marked EXIT provides a method for immediately leaving the Edit mode, at any time. On pressing the EXIT key, the EDIT key will go out, and the system will resume monitoring display. The EXIT key should not be pressed when the cursor is extended and numbers are being entered, since those numbers will not be accepted by the system. The ENTER key must be pressed first for those numbers to be accepted.

6. Edit Capabilities

   The capabilities of the Edit mode are displayed on the Edit menu for the operator to make his choice. The following paragraphs describe the options and their use.

   a) Activate/deactivate sensors

Section VI. Extended Capabilities

Sensors may be activated and deactivated from the Edit mode. Deactivating a sensor means to make the PMS II stop monitoring that point. Reasons this might be done are if the wire from the sensor to the Data Remote Unit is broken, or the sensor has failed. in this case, the sensor would give an erroneous reading, and possibly trip a setpoint alarm when in fact no alarm exists. Rather than allow the PMS II to display misleading measurements and bogus alarms, the sensor can be deactivated. When this is done, the alarm is canceled and the reading is replaced by the bar message, 'DEACTIVATED'. When the wire or sensor has been repaired or replaced, the sensor could be reactivated. Perform the following steps to activate or deactivate sensors;

1. Press the '1' key (ACTIVATE/DEACTIVATE SENSORS)

2. The screen will display a prompt to select the page to Edit. Press the key corresponding to the page where the sensor you wish to Edit is located.

3. The screen will display the monitoring page with prompts in the upper right corner and the cursor on the first bargraph. Use the '1' (ADVANCE CURSOR) key to position the cursor to the desired sensor. (Note: if the page flashes, and returns to the page select prompt, there are no sensors on that page. Either select another page, or press the EDIT key to return to the Edit menu.)

4. Press '2' (EDIT THIS ONE)

5. The screen will display the sensor information, with the sensor label on the top line, and prompts in the upper right corner. if the sensor is an analog sensor, the sensor number will be displayed as 2 digits separated by a dash (-): the first being the analog module number, and the second being the position of that sensor on the analog module. if the sensor is a rate sensor, the sensor number will be displayed as "R-", followed by a number representing the position of that sensor on the rate module. (NOTE: Some rate sensor numbers will not correspond to positions on the rate module. These cases apply to multiple readings being generated from one signal, as in fuel flow rate and fuel consumed being provided by one sensor.) The cursor will be on the line with 'SENSOR ACTIVE".

6. Press '2' (EDIT THIS ONE)

7. The cursor will extend, press 'O' to activate

the sensor or Ill to deactivate the sensor, and then press ENTER. The cursor will shorten.

8. Press EXIT to leave the Edit mode, or press '3' (SELECT NEW BAR) to return to the page display.

9. Use the ‘1' key to move the cursor to select a new sensor, the 13' key to select a new page, or the '4' key to return to the Edit menu.

b) Set Reference Markers

The operator may set the position of reference markers through the Edit Mode. To set the position of a reference marker, perform the following steps;

1. Repeat steps Yl.d.6.a.1 through 5.

2. Press the '1’ key (ADVANCE CURSOR) to move the cursor to the line labeled "REFERENCE MARKER".

3. Press the t2' key (EDIT THIS ONE).

4. Enter the new position for the reference marker, making sure that the value is within the MAX/MIN values displayed at the top of the page. Entering a ‘00’ will remove the reference marker from the bar display.

5. Press the ENTER key.

6. Press EXIT to leave the Edit mode, or press '3' (SELECT NEW BAR) to return to the page display.

7. Use the ‘1' key to move the cursor to select a new sensor, the '3' key to select a new page, or the '4' key to return to the Edit menu.

c) Activate/deactivate Switches

Switches may be activated and deactivated for the same reasons as sensors. Once deactivated, a switch will be displayed as the switch label with no borders. To activate or deactivate switches, perform the following steps;

1. Press 12' (ACTIVATE/DEACTIVATE SWITCHES)

2. The screen will display the page select prompt. Press the key corresponding to the page where the switch is located.

3. The page will be displayed with prompts on the top 2 lines, and the switch closest to the top left side of the page will be double intensity. Use the '1' key to illuminate the switch you wish to activate/deactivate. (Note: if the screen flashes and returns to the page select prompt, there are no switches on the selected page. Either press another page key, or press EDIT to return to the Edit menu.)

4. Press '2' (EDIT THIS ONE)

5. The screen will displayed switch information with the switch label at the top of the pages and prompts in the upper right corner. The switch number will be displayed as 2 digits: the first being the switch module number, and the second being the position of that switch on the switch module. The cursor will be on the line 'SWITCH ACTIVE'.

6. Press '2' (EDIT THIS ONE)

7. The cursor will extend. Enter '1' to deactivate the switch, or '0' to activate it. Then press the ENTER key.

8. Press the EXIT key to leave the Edit mode, or press '3' (SELECT NEW SWITCH) to return to the page display.

9. Use the '1' key to select a new switch, the '3' key to select a new page, or the '4' key to return to the Edit menu.

d) Activate/Deactivate/Preset Totalizers

Totalizers are counters (like the odometers on a car) that display up to 8 digits. They are used to monitor fuel consumed, engine hours, and other similar functions. Totalizers can be activated, deactivated, or preset to a number to start counting from, by using the Edit mode. To set a totalizer, perform the following steps;

1. Press '3' (ACTIVATE/DEACTIVATE/PRESET TOTALIZERS)

2. The screen will display a page select prompt. Press the key corresponding to the page where the totalizer is located.

3. The screen will display the monitoring page with prompts on the top 2 lines and the totalizer display closest to the top and the left side illuminated. Use the '1' key (ADVANCE CURSOR) to illuminate the totalizer you wish to set. (Note: If the page flashes, and returns to the page select prompt, there are no totalizers on the selected page. Either select a new page, or press the EDIT key to return to the Edit menu.)

4. The screen will display the totalizer information, with the totalizer label at the top and prompts in the upper right corner. The cursor will be on the line with 'TOTALIZER ACTIVE'.

5. To activate or deactivate the totalizers press 12', (EDIT THIS ONE), then enter a '0' to activate the totalizer, or a '1' to deactivate.

6. To set the number for the totalizer to begin counting from, press '1' (ADVANCE CURSOR), then press 12' (EDIT THIS ONE), enter up to 8 digits, and press ENTER.

7. Press the EXIT key to leave the Edit mode, or press '3' to return to the page display.

8. From the page display press '1' to move the cursor to the next totalizer, press 131 to select a new page, or '4' to return to the Edit menu.

e) Set time and date

The PMS II maintains a 24 hour clock, as well as month, day, and year displayed at the bottom of each page. The time is used to tag logged values on the printer. The clock must be set to the right time and date if the PMS II is turned off long enough (approx. two months) for its data protect battery to go dead. To set the time and date, perform the following steps;

1. Press '4' (SET TIME AND DATE)

2. The screen will display date and time on the page in a column with the month represented by a number (1 = Jan, 12 = Dec), and with prompts in the upper right corner. The cursor will be on MONTH. Use the '1' key (ADVANCE CURSOR) to move the cursor to the value to be changed.

3. When the cursor is located there, press '2' (EDIT THIS ONE). The cursor will extend through the old value.

4. Enter the new value, and press ENTER. if the screen shows a message 'MIN =' or 'MAX =', the allowable range has been exceeded. Press the '2' key and enter the correct value.

5. Repeat steps 3. and 4. until the correct date and time is in the column marked "NEW" to the right.

6. The time and date set, with seconds set to zero, will take effect on leaving the Edit Time page. Press EXIT to leave the Edit mode, or press '3' (RETURN TO EDIT MENU).

f) Edit Schedule Log

As mentioned previously in paragraph VI.B.3, the operator is capable of initiating printer logging on independent schedules. The schedule setting

operations were made part of the Edit Mode to prevent unauthorized interference with the logging schedules. To enter a logging schedule, perform the following steps;

1. Press '5' (EDIT SCHEDULE LOG).

2. If the system has been configured without a logging printer, the screen will continue to display the Edit Menu. Otherwise, the screen will display the Schedule Log Selection page, with the cursor on LOG INTERVAL. To change the log interval, press '2t (EDIT THIS ONE). This will extend the cursor. Then, enter a digit from 0 to 9 corresponding to the desired interval from the prompts displayed above (0 =OFF, 1 = 15 MIN, etc.), and press ENTER.

3. To change the start time, press '1' (ADVANCE CURSOR). The start time can only be edited if the log interval is something other than '0' (OFF). if the cursor will not go to the Start Time line, it will be necessary to first set the log interval to from 1 to 9. The 4 digits displayed for the start time is the last start time set for schedule logging, or 0000 if schedule logging was off. Press '2' (EDIT THIS ONE) to extend the cursor, enter 4 digits (24 hour time format), and press ENTER. For example, 0900 for 9:00 a.m., 2100 for 9:00 p.m. Entering the wrong number of digits will result in the time being rejected, and the message, "? IMPROPER TIME", being displayed.

4. Changing either the log interval or the start time will cause a new log schedule to be set. Press '3' (RETURN TO LOG EDIT MENU) to return to the System Edit Menu, or press EXIT to resume monitoring display.

E. Keyboard Lamp Test

The Keyboard Lamp Test may be run at each Operator's Station at any time the Edit Mode is not otherwise in use, without affecting the current monitoring capabilities. To execute the Keyboard Lamp test, perform the following steps;

1. Press the EDIT key

2. Press the '6' key (KEYBOARD LAMP TEST)

3. All keys but the ACK key should light, and the keyboard audible alarm should sound. Verify that this is so.

4. Press the EXIT key to complete the test and resume monitoring.

TRACOR MARCON, INC.

PMS II MAINTENANCE MANUAL

CONTENTS

SECTION I

INTRODUCTION

This manual contains system technical information above the Installation Manual level, and in fact builds on that information. Therefore, it will be to your advantage to familiarize yourself with both the Operators Manual and the Installation Manual for your particular system before proceeding. it is expected further, that the reader is a technician with a working knowledge of electrical circuits, the ability to use a digital volt ohm meter, and some basic electrical/electronics troubleshooting experience.

The following paragraphs give brief descriptions of the additional sections in this manual.

Section II is intended to provide you with a better understanding of the internal system components, their functions and locations. This will aid your troubleshooting and repair of the system which is generally performed by replacing the defective sensor, PC board or module.

The Complete Edit Mode operating definitions and instructions are given in Section III. Use of this mode (as opposed to the Limited Edit Mode whose instructions are in the PMS II Operators Manual) will enable you to change the system's Data Base, thereby editing the individual sensor calibration, operating parameters, alarm set points-,-etc.

Section IV contains the Calibration Procedures used to calculate new values for a sensor's Data Base. These values are then entered into the system memory via the Complete Edit Mode.

To make repairs adequately, it is necessary that you have access to a complete set of spare modules. A representative list of these is in Section V. in those systems having multiple keyboards, monitors, etc. , it may be possible to make an emergency repair by substituting certain sub-assemblies.

The PMS II system must be electrically isolated from the vessel's hull. Section VI describes the conditions and testing procedures required to ensure proper operation.

System circuit fuses are listed and described in Section VII. Section VIII outlines the sensor simulator test box whose use is covered in the following section.

A complete system troubleshooting guide is presented in Section IX.

Manufacturers' manuals for the printer and video monitor (as required) are found in Section X. These may be referred to for adjustment and/or repair of these units.

SECTION II

SYSTEM COMPONENTS

NOTE: MAIN UNIT POWER MUST BE TURNED OFF WHEN REMOVING/REPLACING MODULES AND CIRCUIT CARDS, REPLACING FUSES OR DISCONNECTING/CONNECTING ANY INTERNAL CABLES.

1.0 Main Unit

The Main Unit (Fig. 1) performs all multiplexing, data processing, display formatting, alarm detection, and keyboard processing. it consists of the following major internal circuit cards/modules: (Refer to Dwg. 23705 for the physical locations of these sub-assemblies.)

NOTE: THE PRINTED CIRCUIT BOARDS CONTAIN SOME COMPONENTS THAT ARE SENSITIVE TO STATIC ELECTRICITY AND THEREFORE MUST BE HANDLED WITH THE PROPER PRECAUTIONS:

1. Hold board only by the edges and do not touch the individual components or back plane.
2. When storing a board, always place inside the protective bag supplied with it.
3. Lay boards only on a flat surface and on top of the protective bag.

1.1 Process and Display Circuit Board, (bottom board on Main Unit Door).

This contains the central processor unit which controls the overall system operation, the memory which holds the software program and data base parameters, the video display processing and the communication link between the Input Board and itself.

Program execution starts when power is turned on. it will be restarted automatically if a system reset, caused by the deadman switch, occurs.

The video section provides the link between up to two (2) operators stations (keyboard and monitor) and the CPU. it converts data from the CPU section into a composite video signal for display and contains the ports through which the CPU section communicates with the keyboards. The system clock, deadman switch, and alarm output control are also in this section.

The two potentiometers located on the bottom right of the board are monitor video gain adjustments. Refer to Paragraph 6.0 for adjustment procedures.

1.2 Input Circuit Board (top board on Main Unit Door)

The input Board, an intelligent circuit card, is the data collecting unit of the system. it reads signal inputs from the Rate, Switch, and Analog Modules, converts these signals to digital information and transmits the data to the Process and Display Board.

1.3 Power Supply Circuit Board (small board on Main Unit Door)

This is the power supply which furnishes +15 VDC, -15 VDC and +5 VDC for PMS II operation. Required input voltage is either 12 VDC or 24 VDC depending upon your system. Refer to system's installation Manual for this information.

1.4 Rate Input Module

Accepts rate (frequency pulses) inputs and couples these signals through a ribbon cable to the input board.

1.5 Switch Input Module(s)

Accepts switch closure [normally closed (NC) or normally open (NO)] inputs and couples these signals through a ribbon cable to the input board.

1.6 Analog Input Module(s)

Accepts analog signal inputs from various type analog sensors and couples these signals through a ribbon cable to the Input Board. These sensors are interfaced to the input PC Board through sensor headers which are plugged into sockets on the Analog Module PC board. Due to the different headers required for different sensor types, these modules are not interchangeable unless the headers for each channel are changed to remain with the original sensor. Also located on the Analog Module PC board is a -10vdc regulated power source used for excitation of some sensors.

2.0 Operator Station(s)

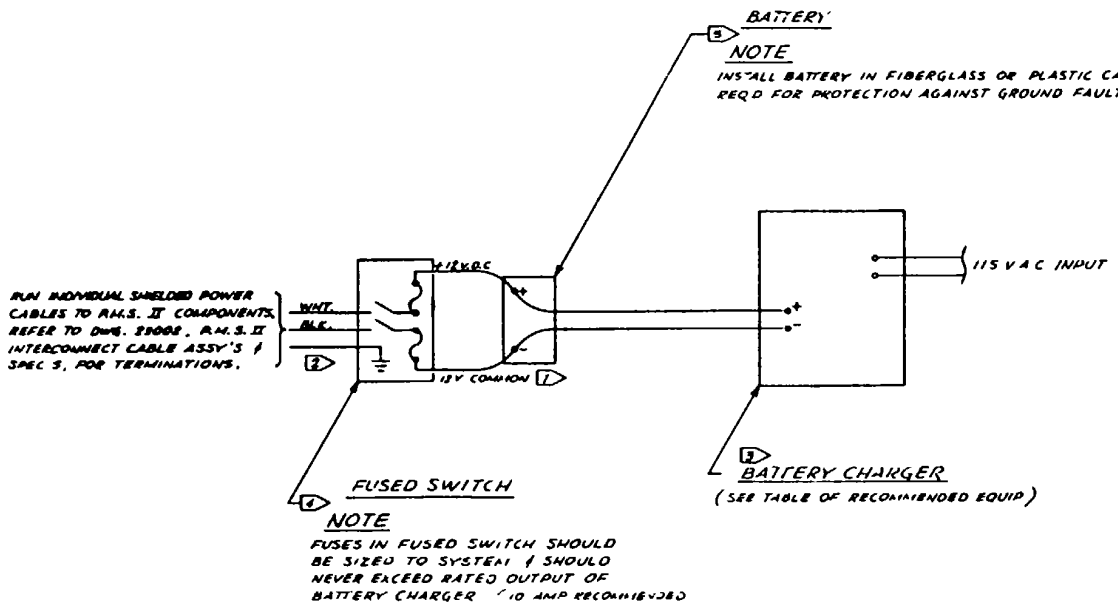
An Operator Station is composed of a video monitor for data display and a keyboard of 16 backlighted keys for operator commands and alarm status notification. it is the terminal through which the user can, to some extent, edit or alter the system operation. The PMS II may have two (2) fully independent operator stations.

3.0 Sensors

The system's sensors are the physical link between the function being monitored and the Main Unit. There are three (3) basic electrical input type sensors connected to the system. These are rate (variable pulse output), switch (closed or open dry contacts), and analog (variable voltage, current or resistance output) sensors. These sensors are terminated inside the Main Unit at their respective modules.

4.0 System Power Source

The system requires an isolated, uninterruptable and dedicated 12 VDC or 24 VDC power source for operation. (Refer to the Installation Manual to determine which applies for your system.) This consists of one or two commercial-duty twelve (12) volt storage batteries in. series, supplied from a consta-volt charger with sufficient amperage output to satisfy the individual system requirements. A fused switch box is also required at the source for completely turning off system power. Refer to Dwg. 23008 (12VDC) or 23096 (24VDC) for details.



INSTALLATION NOTES:

7. DO NOT ADD ANY CONNECTION FROM 12 V COMMON TO HULL, CHASSIS, OR ANY OTHER POWER SOURCE.
2. TERMINATE SHIELDS OF SYSTEM POWER CABLES AT FUSED SWITCH.

RECOMMENDED EQUIPMENT —

3. BATTERY CHARGER: LAMARCHE MODEL NO. A46-10-12 V (10 AMP)
4. FUSED SWITCH: (10 AMP MINIMUM REQUIRED) GE TG-3221. (OR EQUIV)
5. BATTERY: ONE 12 V D C, 60 AMP HR MIN LEAD ACID BATTERY, MOUNTED IN FIBERGLASS OR PLASTIC ENCLOSURE

ITEM PART NUMBER QTY DESCRIPTION

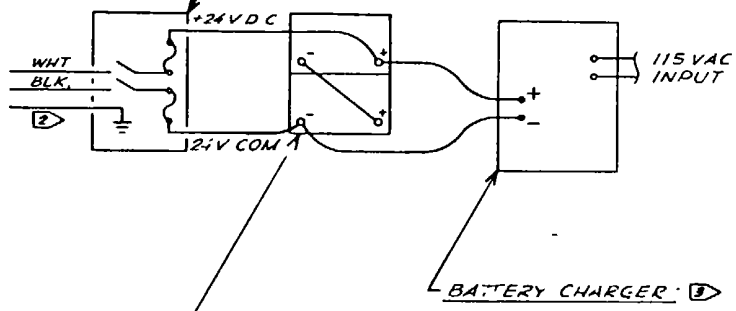
MATERIAL LIST

Tracor Marcon

12 V D C
R.M.S. II D C POWER
RECOMMENDATIONS

23009

A		PMS SYSTEM WAS 6050 SYS			



RUN INDIVIDUAL SHIELDED POWER CABLES TO PMS SYS COMPONENTS REFER TO DWG #23091, PMS SYS INTERCONNECT CABLE ASSEMBLIES & SPEC.S FOR TERMINATIONS

INSTALLATION NOTES:

1. ISOLATED 24 VDC POWER SUPPLY — DO NOT CONNECT TO HULL, CHASSIS, OR ANY OTHER POWER SOURCE.
2. TERMINATE SHIELDS OF SYSTEM POWER CABLES AT FUSED SWITCH

RECOMMENDED EQUIPMENT:

3. BATTERY CHARGER LAMARCHE MODEL NO: A46-10-24V (10 AM
4. FUSED SWITCH: 10 AMP MIN REQ'D.) GE TG-5221 (OR EQUIV.)
5. BATTERIES: 2-12 VDC 60 AMP HR MIN LEAD ACID BATTERIES, MOUNTED IN FIBERGLASS OR PLASTIC ENCLOSURES

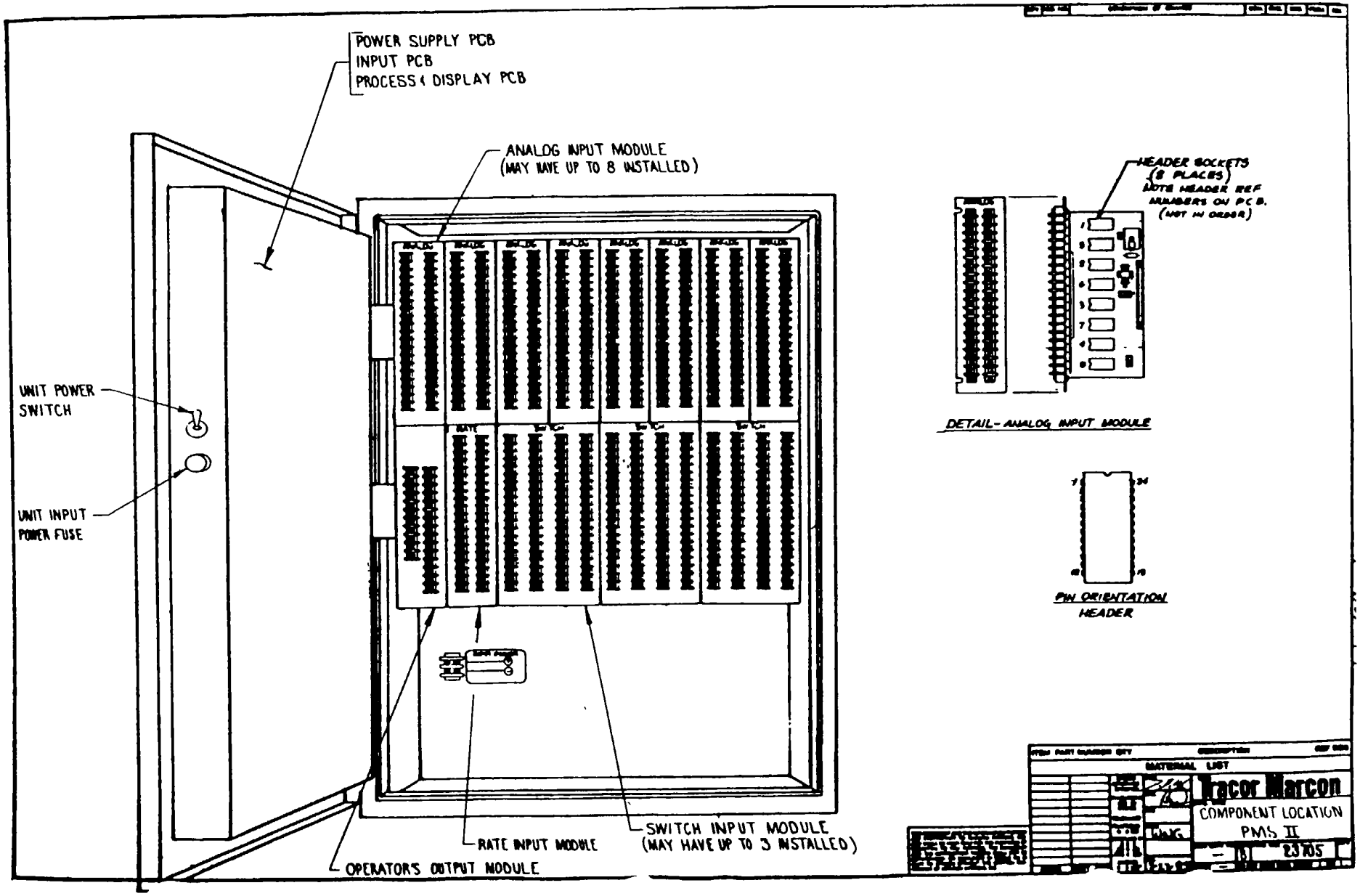
ITEM PART NUMBER QTY DESCRIPTION

MATERIAL LIST

Tracor Marcor

PMS SYSTEM DC POWE
RECOMMENDATIONS
24 VDC SYS

D 23096


POWER SUPPLY PCB
INPUT PCB
PROCESS & DISPLAY PCB
ANALOG INPUT MODULE
(MAY HAVE UP TO 8 INSTALLED)
UNIT POWER SWITCH
UNIT INPUT POWER FUSE
RATE INPUT MODULE
SWITCH INPUT MODULE
(MAY HAVE UP TO 3 INSTALLED)
OPERATOR'S OUTPUT MODULE
HEADER SOCKETS
(8 PLACES)
NOTE HEADER REF NUMBERS ON PCB.
(NOT IN ORDER)
DETAIL - ANALOG INPUT MODULE
PIN ORIENTATION
HEADER
MATERIAL LIST
Tracor Marcon
COMPONENT LOCATION
PMS II
23705

SECTION III

COMPLETE EDIT MODE OPERATING PROCEDURE

NOTE: EXERCISE CARE WHEN USING THE COMPLETE EDIT MODE AS IMPROPER ENTRIES CAN CAUSE THE SENSOR READING TO BECOME ERRATIC, INACCURATE OR INOPERATIVE.

1.0 Introduction

Section VI of the PMS II Operator's Manual deals with the Extended Capabilities provided to the operator through the Limited Edit Mode. Its purpose is to allow the operator to activate and deactivate monitored points, set time and date, and set logging schedules on the PMS II. These capabilities are made available to the operator when he enters a three (3) digit combination.

A second Edit mode is available which contains all the functions of the Limited Edit mode, plus adjusting alarm setpoints, and changing alarm delay times. This Edit Mode, intended for use only by the Chief or Port Engineer, is accessed by using a different three (3) digit combination than the one which selected the first Edit Mode. it is used primarily for changing alarm setpoints and alarm delay times. in addition, it can be used for sensor calibration during system installation or sensor replacement. Care must be taken when using this Edit mode, as accidental altering of the calibration of a sensor could render that sensor inaccurate or inoperative. The technician who is entrusted with the combination and access to these capabilities should ensure that unauthorized persons do not learn the combination.

The purpose of this section will be to describe the operating parameters which can be changed. it is assumed that the technician has already read and understands the Limited Edit Mode Section of the Operator's Manual (Section VI. Extended Capabilities). A brief explanation of the commands will be repeated here for convenience. However, the technician should refer to the Operator's Manual for an explanation of selecting sensors, switches and totalizers.

2.0 Edit Mode Operation

To use the Edit mode, start by pressing the EDIT key. The EDIT keys on both Operator's stations will light, locking all other users out of the Edit mode (pressing the EDIT key when someone at the other operation's station is in the Edit mode will have no effect), and instructions will be displayed on the video monitor. During each step of the Edit mode, instructions in the form of a menu of options will be displayed on the screen. Using the Edit mode requires simply following these displayed instructions.

Important: when the EDIT key is pressed, the keys on the keyboard have new functions. These functions are printed in black on the keyboard panel above the key. Therefore, the top left key has the value '1', Just like a calculator key. These secondary key functions are used to perform the various operations described below.

2.1 Option Selection

As mentioned earlier, a menu of options is presented at each step in the Edit mode with each option numbered. Select the option by pressing the key with the same number as the chosen option. The PMS II will ignore all unlabeled keys, and any key not on the menu.

2.2 System Edit Menu

The system edit menu will be displayed on the screen after the correct three (3) digit combination has been entered.

The following paragraphs will describe the changes which can be made for each of these choices. The method used to make these changes is described in paragraph 2.3.

2.2.1 Edit Bar Parameters

Two types of sensors are the sources of bargraph displays: analog input sensors, and rate input sensors. Because the significance of some of the calibration information is different for the two sensor types, they will be discussed separately. it should be noted here that prior to changing any of the sensor calibration parameters (offset, span, calibration, and range), the operator should consult the calibration section of the sensor drawings in the installation manual.

a. Analog Input Sensors

Sensor Active This parameter governs whether the sensor will be monitored by the PMS II. Entering a "1" will deactivate the sensor, the system will stop monitoring this point, and the bar will be replaced by a "DEACTIVATED" message. Entering a "O" will reactivate the sensor.

Reference Marker The reference marker is an inverted white triangle on the bar grid, and it may be used to mark any point on the grid important to the operator. Enter the numerical scale point where you desire this marker to appear. This parameter has no operational significance to the PMS II.

Low Limit Setpoint Right pointing triangle. Any time the sensor reading falls below this setpoint, an alarm sequence will begin. Enter the numerical scale point (if any) where you desire this to take place.

High Limit Setpoint Left pointing triangle. Any time the sensor reading rises above this setpoint, an alarm sequence will begin. Enter the numerical scale point (if any) where you desire this to take place.

Schedule Log Enable Each sensor can be individually enabled or disabled from being logged on the Printer during a Schedule log.

Alarm Delay The alarm delay is set and counted down after the sensor display crosses an alarm setpoint. if the sensor does not return to a normal reading by the time the alarm delay times out, an alarm will be annunciated. Alarm delays are adjustable from one second to 127 seconds.

Bar Filter The System maintains a running average (digital filter) of all analog data. The bar filter is the number of previous readings averaged to obtain the current data value. it can be adjusted from 1 to 15. Scan Rate This selects how often the sensor will be read by the System. The scan rate is used only to multiply the bar filter on non-Rate analog channels.

Offset The offset is the number of voltage counts the System uses to zero the analog signal, so that 0 count indicates the lower limit of the display range. Range is from -3840 to +3840. NOTE: The magnitude of the negative offset can never be greater than the span.

Span This is the gain for the sensor. it and the calibration voltage determine the weight of a count. Range is from 0 to 3840.

Type When equal to 1, it is used to indicate a thermocouple type sensor to be temperature compensated.

Range Voltage multiplier used by the System. Values can be 0, 1, or 2 to indicate a multiplier of 1, 10, or 100, respectively.

Calibration Ranging from 2 to 6, selects any one of 5 precision reference voltages used by the System for digitization of analog signals. Misc. Used to supply the number of the linearization table to be used, if any.

Alarm Lockout number The number of the alarm enabling condition, if any.

b. Rate Input Sensors

Most parameters are the same as for voltage input sensors. Only those that differ are discussed below: Scan Rate Must be 1.

Offset The offset is the time interval in 20ths of a second increments that the System will wait between pulses before setting an UNDERRANGE status. Span The conversion factor from the interval of time between pulses to a 12 bit answer. The equation used is SPAN/INTERVAL.

Type This instruction is used to determine whether the pulse input is to be interpreted as a totalizer or a rate input.

Range Used as a multiplier in the SPAN/INTERNAL calculation.

Calibration 2nd Co-channel.

Misc. Co-channel number. if the current channel is used for rate input, the co-channel will be used to totalize the pulses.

2.2 Edit Switch Parameters

Switches have only four (4) parameters that are editable. These are:

Switch Active - When set to "0", the switch is active. When set to "1", the switch has been deactivated, and the switch is displayed as a borderless label.

Alarm Delay - same as sensors.

Normal open/closed - Each switch can be edited to set the normal state, the state in which it will not alarm. (0 = closed, 1 = open).

Alarm Lockout - same as sensors.

2.3 Edit Totalizers

A totalizer is a display of up to eight digits with no bar. it is an accumulation of pulses or hours of operation.

Totalizer Active When set to "o", the totalizer is active and will count. When set to "1", the totalizer will be deactivated, and the display will be replaced by "X"'s.

Schedule Log Entry A totalizer can be individually enabled to be logged on the Printer during a schedule log.

Counts/Units Used to set the number of pulses to be counted as 1 unit. For example, a counts/unit value of 4 would mean that every 4th pulse would be totalized.

Preset A preset total of up to 8 digits may be entered as a starting point.

Type indicates whether the channel is a direct totalizer, a co-channel of a rate channel, or an engine timer. Do not edit. Value is assigned at factory before installation.

Range Unused Calibration Unused

2nd Totalizer Totalization will simultaneously occur on this co-channel. An example of such an application would be total fuel consumed and trip fuel consumed.

Misc. - Number of the switch or rate channel that enables or disables totalization - used for conditional totalization.

1 to 63 - Channel number of switch, when closed, which enables totalization.

129 to 191 - This number, minus 128, is the channel number of the switch, which allows totalization when the switch is open.

65 to 73 - This number, minus 64, is the channel number of the rate sensor which allows totalization of engine time when the sensor reading is not underrange.

2.3 Edit Operational Commands

2.3.1 Cursor Movement

Moving the cursor is the method of selecting the line, sensor, or switch to be changed. For lines and sensors, the cursor is a bright bar extending from the left side of the screen to mid-screen. For totalizers and switches, the cursor position is indicated by making the switch or totallzer display double intensity. Movement is from left to right to the last display on the line, then down to the next line. To move the cursor, press the appropriate key as indicated on the menu (usually a "1"), and notice that the cursor moves one line down, or to the next switch block. Repeatedly pressing the key (or holding it down), will make the cursor move all the way down to the last editable line or sensor, and then start again at the top. To select the line or sensor to edit, stop the cursor on the desired line or sensor display and press the key for the menu option "EDIT THIS ONE".

2.3.2 Entering Numbers

Editing numbers (for example, setting time and date) involves choosing a line to edit and entering a new value. The format of the on-screen information places labels on the left and a column of numbers near the middle of the screen. The labels are descriptions of parameters, and the column is the present value of those parameters. The preceding paragraph described making a line selection by moving the cursor and pressing the key to "EDIT THIS ONE". When this key is pressed, the cursor will extend through the present value column. Now, pressing the number keys (as well as "-" and ". ") will, like a calculator, write those numbers on the screen. When the number to be entered is displayed, press the key marked ENTER. This will accept the numbers entered and shorten the cursor.

If the numbers are not acceptable because they are outside the allowable range (e.g. trying to set time for 26 o'clock), the PMS II will print the maximum or minimum allowable value on the screen next to the number entered. That entry will be ignored. You can try again by pressing the key for "EDIT THIS ONE" and starting over.

2.3.3 Rubout

When entering numbers, mistakes can be corrected before the ENTER key is pressed, by using the RUBOUT key. The RUBOUT key will cause the display to backspace and erase the last digit displayed. Successively pressing the RUBOUT key will erase the next digit, and so on until no digits are left.

2.3.4 Exit

The key marked EXIT provides a method for immediately leaving the Edit mode, at any time. On pressing the EXIT key, the EDIT key will go out, and the system will resume the monitoring display. The EXIT key should not be pressed when the cursor is extended and numbers are being entered, since those numbers will not be accepted by the system. The ENTER key must be pressed before those numbers are accepted.

SECTION IV

CALIBRATION PROCEDURE

All calibration In the PMS II system Is accomplished by changing values In the software data base. This may be done In the field by entering the complete edit mode with the proper access combination, selecting the edit page for the corresponding sensor and following normal edit procedures to change the values of the Offset, Span, Sensor Type, and Calibration readings. Refer to the second page of the appropriate Sensor Specification Drawing for these values.

NOTE: EXERCISE CARE WHEN USING THE COMPLETE EDIT MODE AS IMPROPER ENTRIES CAN CAUSE THE SENSOR READING TO BECOME ERRATIC, INACCURATE OR INOPERATIVE.

Notice on these drawings that certain sensors require field calibration while others do not. If the sensor In question does not require field calibration and its readings are Incorrect, then the sensor must be replaced. If, however, the specification drawing Indicates that field calibration Is required, use the following procedure:

A. Refer to the Individual Sensor Specification Drawing calibration section for special notes. Refer to the Sensor Specification Drawing Data Base section to verify that the correct data base values are entered for Sensor Type, Range and Calibration. Next, Insure the scale being calibrated Is linear; If so, continue. However, if the scale Is from a non-linear lookup table, proceed to section D.

B. Obtain two sets of upscale and downscale readings, one set from a reference gauge or measurement and the other set from the PMS II system. Make sure that both high readings and both low readings are taken together (at the same time) to ensure accuracy. These readings should be taken at points as far apart as possible on the bar graph scale.

C. Calculate the new span and offset values using the following formulas.

1. $$\text{New Span} = \left(\frac{\text{Actual Upscale - Actual Downscale}}{\text{Displayed Upscale - Displayed Downscale}}\right) \text{ X Old Span}$$

2. $$\text{New Offset} = \left(\frac{\text{(Actual Upscale - Min. Scale) X 3840}}{\text{Maximum Scale - Minimum Scale}}\right) -$$

$$\left\{\left[\left(\frac{\text{Displayed Upscale - Min. Scale X 3840}}{\text{Maximum Scale - Minimum Scale}}\right) - \left(\text{Old Offset}\right)\right] \text{ X } \left(\frac{\text{New Span}}{\text{Old Span}}\right)\right\}$$

NOTES:
1. Offset value may be a positive or negative number.
2. Zero sensor readings (no bar) cannot be used for calibration since they may be below scale. When this situation occurs, raise the offset value until a small onscale (bar present) reading Is displayed before beginning calibration.

D. If the sensor uses a non-linear look-up table (noted In data base section of Sensor Spec. Dwg.) there are three possible situations.
   1. The sensor has a fixed span value requiring only offset calibration.
   2. The sensor has a given offset value, requiring only span calculation and offset adjustment.
   3. Both span and offset must be calibrated.

   The appropriate situation will be noted In the Sensor Spec. Dwg. data base section.

   For the above situations, the following corresponding calibration procedure must be followed:

   Situation 1:

   Using a repetitive technique, calculate the new offset (refer Section C) repeatedly until the screen Is within +/- 1% of the desired reading. This may take several calculations to achieve, but Is required for proper results.

Situation 2:

Using a repetitive technique, calculate the new span (refer Section C) repeatedly, followed with a recalculation of new offset value using the formula.

$$\text{New Offset} = \left(\frac{\text{New Span}}{\text{Old Span}}\right) \times \text{Old Offset}$$

Do this until the screen is within +/- 1% of the desired reading. This may take several calculations to achieve, but is required for proper results.

Situation 3:

You must use a linear gauge which displays the linear values from which the look-up table was derived. Access the complete edit mode page for the sensor requiring calibration and record the Misc Data Value. Then set Misc Data value to zero (0). The sensor scale on the display page now no longer represents the scale Indicated, but Instead, a linear scale directly proportional (from zero to full scale) to the linear gauge you are using. Now use the linear calibration procedure (section b and c) and calibrate as any linear sensor. Upon completion of this, set the Misc Data back to Its original value.

SECTION V

SPARE MODULE LISTING

Main Unit Spares

1. Power Supply
2. Process and Display Circuit Card
3. Input Circuit Card
4. Analog Module
5. Fuses

Keyboard Spares

1. Keyboard Circuit Card
2. Light Bulbs
3. Fuse

Module Spares

1. Sensors
2. Fuses
3. Sensor Simulator Test Box

SECTION VI

PMS II GROUND FAULT TESTING

Conditions Which Must Be Met

1. There should be Infinite resistance between the Main Unit ground and the hull, and the Main Unit Ground and 24v common.

2. No solid voltage should exist between Main Unit ground and the hull.

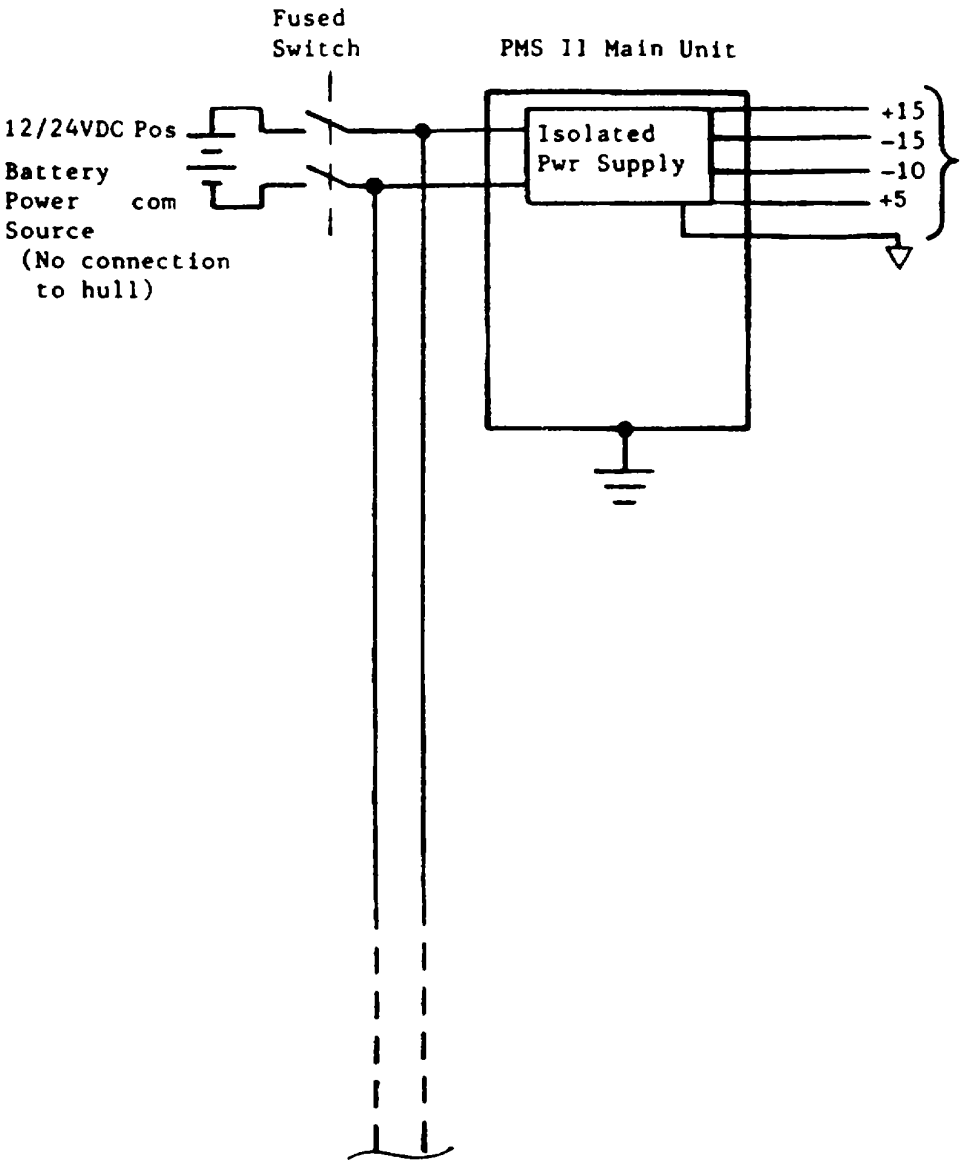
Testing Procedures

1. Measure resistance with system power turned off at the battery fused switch.

2. Measure voltages with system operating.

3. To Isolate Sensor ground faults to specific modules, disconnect the ribbon cables connected to the Input PC Board one at a time. Use a rate module GND terminal or a switch module ground (- OR GND) terminal (all switch -(NEG) Inputs are system ground) for this test. Ensure that the module (rate or switch) you are using for the ground terminal Is plugged Into the Input PC board.

PMS II SYSTEM GROUNDING DIAGRAM
TO BE USED IN GROUND FAULT CHECKING



GROUNDING :

= Ships Hull Gnd

= System Logic Gnd
(Not connected to ships hull)

MARCON SYSTEMS, INC

PMS II
GROUNDING

B FTB 103

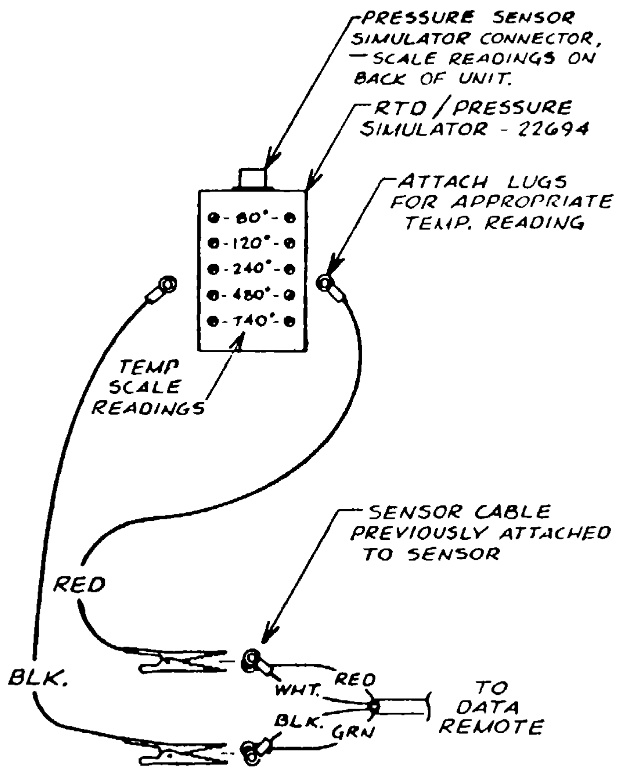
SECTION VII

PMS II MAIN UNIT FUSE APPLICATION LISTING

Fuse Label	Sub-Assembly Controlled
+24 or +12v	All
-15v	Input Board and Analog Modules
+15v	Input Board and Analog Modules
+5v	All

NOTE: If any fuse continues to blow, disconnect all sub-assemblies controlled by that fuse and apply power. If fuse remains good, the problem must be In the disconnected assembly(s). Reconnect one at a time to verify and Isolate problem. If fuse still blows, with all sub-assemblies disconnected, Inspect chassis wiring.

REV.	ECO. NO.	DESCRIPTION OF CHANGE	DRN.	CHK.	DES.	PROJ.	REL.



ITEM	PART NUMBER	QTY	DESCRIPTION	REF DES

MATERIAL LIST

MODEL	NEXT ASSY
	22694

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCE FRACTIONS = ± 1/4 DECIMALS = X ± .1 XX ± .03 XXX ± .010 ANGLES = ± 1/2°

DRN. 10/83 CVZ
CHK.
DES.
PROJ. WJC
REL. 12-5-83 BO

MARCON SYSTEMS, INC.
BELLEVUE, WASH 98005

DWG. TITLE: SENSOR TESTING: TEMPERATURE (RTD) PRESSURE SENSOR

CODE IDENT. NO.	SIZE	DWG. NO.	REV.
—	B	22701	—

SCALE — | DO NOT SCALE DWG | SHEET 1 OF 1

DWG. NO
REV

SECTION IX

TROUBLESHOOTING GUIDE

To use this guide, you need only to recognize the symptoms and follow the troubleshooting procedure until the problem Is discovered. The method of troubleshooting requires the replacement of modules within the system. The first step Is to determine which symptom listed best describes the problems encountered. Next, follow the troubleshooting procedure until an error Is found. After each error Is corrected, assume a working system, return to the beginning and continue until all errors are corrected and the system Is operational (no symptoms apply).

NOTE: INDIVIDUAL UNIT POWER MUST BE TURNED OFF WHEN REMOVING/REPLACING MODULES AND CIRCUIT CARDS, REPLACING FUSES OR DISCONNECTING/CONNECTING ANY INTERNAL CABLES.

NOTE: THE PRINTED CIRCUIT BOARDS CONTAIN SOME COMPONENTS THAT ARE SENSITIVE TO STATIC ELECTRICITY AND THEREFORE MUST BE HANDLED WITH THE PROPER PRECAUTIONS:

1. Hold board only by the edges and do not touch the Individual components or back plane.

2. When storing a board, always place Inside the protective bag supplied with It.

3. Lay boards only on a flat surface and on top of the protective bag.

SERVICE NOTES

1.0 Video Board Adjustment Procedures

1.1 Component Location

Two video gain potentiometers are located on the process and display PCB at the lower right corner of the board. They are mounted with the screw adjustments facing outward and may be adjusted without removing the cover plate if the door is fully opened. The lower pot is for Station 1 and the upper one for Station 2.

1.2 Conditions Required for Adjusting

System on

Monitor on

Program operating

Coax cable from video panel monitor output to monitor Input connected

Monitor's video Input switch In 75S position

1.3 Procedure

a. Select a page and turn monitor brightness and contrast controls C.W.

b. Turn video gain pot until picture appears.

c. Adjust brightness and contrast controls along with video gain pot for best picture.

d. If both video outputs are used, adjust both gain pots for equal output levels.

2.0 EPROM Replacement Procedure

2.1 EPROM Usage

System PC Boards (Process and Display and Input) have one or more EPROM's plugged into sockets Installed on the board. When replacing these boards, It may be necessary to change the EPROM(s) from the old board to the new board. If this Is required [replacement boards are generally shipped without EPROM(s) Installed] or If a new replacement EPROM must be Installed, observe the following.

2.2 EPROM Replacement

a. CAUTION - EPROM's are sensitive to static electricity. They are supplied Inside a plastic conductive tube or Inserted In conductive foam. Do not remove them from this tube or foam until they are to be Installed. Never lay them on any surface except Inside this tube or on the foam.

b. Remove an EPROM by prying It out of the socket with a small screwdriver or I/C extractor tool. WARNING: Do not pry socket out of board.

c. Insert EPROM In the socket with the notch on the end of the EPROM corresponding to the outline drawn on the PC Board. (Do not use stick-on labels for orientation reference).

d. Check that all pins are In the socket. None bent under.

e. Recheck EPROM orientation before applying power.

TROUBLESHOOTING SYMPTOMS

1.0 - - - - - - - - Blank Screen on Video Monitor.

2.0 - - - - - - - - Printer Inoperative.

3.0 - - - - - - - - Keyboard Inoperative.

4.0 - - - - - - - - Keyboard key lights inoperative.

5.0 - - - - - - - - Bar graph displays "OVER RANGE", "UNDER RANGE", "0" or reading Is frozen, erratic or inaccurate.

6.0 - - - - - - - - Bar graph displays "Input Board Failure"

7.0 - - - - - - - - Switch alarm or status display Inoperative.

TROUBLESHOOTING PROCEDURES

1.0 Blank Screen on Video Monitor

1. Check Input power to PMS II.
2. Check all PMS II fuses. Refer to PMS II Fuse Application Listing, Section VII.
3. Check power supply output voltages at Rate Input Module or Test Points.
4. Check monitor power and fuse, (power Indicator on monitor front panel should light when power Is on).
5. Check monitor brightness on front panel. (Lit screen with brightness fully clockwise).
6. Check monitor to PMS II coax cable and connections. Check Process and Display Video Gain Adjust.
7. Replace monitor. Refer to Monitor Mfg. Manual, Section X.
8. Replace Process and Display Board.

2.0 Printer Inoperative

1. Check Printer switches (power and on-line), fuse and Input power.
2. Check printer PMS II cable and connections.
3. Replace Process and Display Card.
4. Repair or replace printer. Refer to Printer Mfg. Manual, Section X.

3.0 Keyboard Inoperative

Note: Use caution when removing the front of keyboard, so as not to damage keyboard circuit card and connection cables. Disconnect keyboard power before removing front panel.

1. Check Keyboard cable, connections, and power.

2. Replace Process and Display Card.

3. Remove front of keyboard and replace keyboard circuit card.

4.0 Keyboard Key Lights Inoperative

Note: Use caution when removing front of keyboard, so as not to damage circuit card and connecting cables. Disconnect keyboard power before removing front panel.

1. If all lights are out, remove front of keyboard and check fuse on keyboard card.

2. If only certain lights are out:

   a. Check bulbs Inside button.

   b. Check connections on back of button Inside keyboard.

   c. Replace keyboard circuit card.

5.0 Bar graph displays "Overrange", "Underrange" or "O" when you know the parameter being measured Is not one of those. Display seems frozen, erratic or Inaccurate.

1. Check PMS II power supply outputs on MPU Rate Input Module screw terminals or Test Points. If a voltage(s) Is Incorrect, replace power supply.

2. Enter the Edit mode and determine at which Input Channel the sensor Is terminated.

3. Check Sensor cable and connections.

4. Check for system ground fault. Refer to Section VI.

5. When power supply voltages are correct and no ground fault exists, and the sensor In question Is a temperature sensor (4 wire RTD type) or a pressure sensor (4 wire 50,100,300,500 or 1000 PSI), refer to Section VIII to use Sensor Simulator Test box. Replace sensor If simulator displays a correct reading. Substitute sensor In the event text box Is not applicable. If Improper reading still exists, proceed to Item 8.

6. Use this step only for onscale and stable but Inaccurate sensor readings.

   Refer to your System Drawings to determine the sensor part number, then to that sensor's Specification Drawing, Data Base section, for sensor's data base values (Offset, Span, Sensor Type, Range and Calibration). Enter the complete edit mode with your proper access combination, select the edit page for the corresponding sensor and Insure that the Offset, Span, Sensor Type, Range and Calibration values are correct.

   Determine from the Sensor Spec. Dwg. If the sensor requires field calibration. Where field calibration is required, perform this by referring to Section IV for proper calibration procedure. If this falls to correct the problem or If sensor has fixed data base, not requiring field calibration, replace sensor.

   Note: Sensors that require field calibration as noted in the Sensor Spec. Dwg. Calibration section, will have Offset and Span values only approximately equal to those given in the data base section. They may also have a different value for Sensor Type, Range and Calibration. Refer to Calibration Procedure, Section IV.

   If these readings do not appear to be proper, change them, following normal edit procedures, to agree with the Sensor Spec. Dwg. data base values.

NOTE: EXERCISE CARE WHEN USING THE COMPLETE EDIT MODE AS IMPROPER ENTRIES CAN CAUSE THE SENSOR READING TO BECOME ERRATIC, INACCURATE OR INOPERATIVE.

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7. Replace Input Board.

8. Replace Analog Module Header. (Note header channel number printed on PCB card).

9. Replace Analog Module. (Transfer headers to same channel and sensor terminations to same screw terminals).

6.0 Bar Graph Displays "INPUT BOARD FAILURE"

1. Check PMS II fuses.

2. Check Main Unit power supply outputs on Rate Input Module screw terminals or at Test Points. If a voltage(s) Is Incorrect, replace power supply.

3. Check cabling and connections between the Input Circuit Board and the Process and Display Circuit Board.

4. Replace Input Board.

7.0 Switch Alarm or Status Display Inoperative.

1. Enter the Edit mode and determine at which Input Channel the switch is terminated. Also note whether the switch operates as normally closed (NC) or normally open (NO) during non-alarm condition.

2. Check switch sensor, sensor cable and connections.

3. Disconnect switch terminations at Input Board Switch Module screw terminals. Short "IN" and "GND" (+ and -) terminals together. Display should now be In non-alarm status (after delay time) if switch operates NC or In alarm status If operation is NO. Remove jumper and status should reverse. If Indications are Improper, replace Input Board.

LA MARCHE MFG. CO.

TROUBLE SHOOTING MANUAL

FOR All SERIES BATTERY CHARGERS, INCLUDING:

MODELS A11, A11P, A33,

A12, A12B, A46

***A40. **A28, **A29**

***Single charging rate**

****Single rate used as a power supply (no battery)**

PRELIMINARY CHECKS

1. CHECK NAMEPLATE SPECIFICATIONS WITH CUSTOMER'S ORDER, AND THE UNIT IN ACCORDANCE WITH THE NAMEPLATE.
2. CHECK INPUT AND OUTPUT VOLAGES.
3. CHECK INPUT AND OUTPUT FUSES.
4. CHECK FOR GROUNDS.
5. CHECK TAP SETTINGS (DUAL VOLTAGE UNITS ONLY).

INFORMATION YOU SHOULD HAVE WHEN CALLING IN FOR TROUBLE SHOOTING ASSISTANCE

1. MODEL NUMBER AND SERIAL NUMBER
2. MEASURE THE ACTUAL AC INPUT VOLTAGE.
3. MEASURE THE DC OUTPUT VOLTAGE WITH AND WITHOUT THE BATTERY.
4. CHECK THE FUSES.
5. RECORD THE DC OUTPUT AMPS WHEN MEASURING THE DC OUTPUT VOLTAGE WITH THE BATTERY ON.
6. NOTE WHAT THE TAPS ARE SET ON (DUAL VOLTAGE UNITS ONLY).
7. COUNT THE NUMBER OF CELLS BEING USED, AND NOTE THE TYPES OF CELLS (LEAD ACID, NICKEL CADMIUM, NICKEL IRON).
8. IF TRANSISTORS ARE USED, RECORD THE TRANSISTOR(S) NUMBER.

TROUBLE SHOOTING FOR MODEL A-11 SERIES

This trouble shooting guide should be used by trained service personnel or experienced electricians The guide is a step by step procedure which can be followed in servicing the LaMarche model A-11 series of chargers

EQUIPMENT:

The only instrument required is a multi-scale volt-ohm meter, such as Simpson 260 or Triplette 630 Miscellaneous electrical tools will also be required.

I. GENERAL:

On servicing new equipment, before setting up any complicated testing or lumping to any conclusions, give the unit a general inspection. Check the following

A. Check DC output cables, connections, battery type, and number of cells m battery with nameplate rating

B. Check nameplate specifications with customer's order, and the unit in accordance with the nameplate

C. Check input connections, input voltage, and line breaker size in accordance with nameplate

D. Loose connections, poor solder connections, broken wires, etc.

II. GROUND OR SHORT CIRCUIT TEST:

A simple ohmmeter check can be performed to check the unit for a short to ground, primary to secondary breakdown, AC-DC short, or DC ground Upon installation of a new unit, the above checks can be made before installing If a short of this type is suspected on a unit in service, check as follows

A. Disconnect AC input power to the unit Disconnect the DC battery from the charger

B. Set ohmmeter scale on ohms scale RX100.

C. Measure from one terminal of the input to one terminal of the output. Meter should not indicate If themeter reads full scale deflection, this indicates an AC-DC short

Wires beneath terminal board may be shorting. On high DC output units, the DC terminals heat to a high degree if the terminals are loose. AC wires should not be near the DC terminals. If an AC wire is lying hard against the DC terminal, it is possible for the insulation on the AC wire to heat, melt, and to short against the DC terminal. On shipping, an AC wire may rub against the DC lugs, terminals, etc., and cause a short. These problems may be eliminated by very carefully inspecting the wiring to make certain the AC wires are not touching the DC wiring If no wires are touching, then it is possible that the primary and secondary of the transformer or reactor is shorted. Disconnect the secondary of the transformer from the diodes. Measure with ohmmeter from input terminal to one of the isolated secondary leads. If there Is an ohmmeter indication, there is a insulation breakdown between primary and secondary windings. The transformer should be replaced.

D. Check the input terminals to ground, and check the output terminals to ground If the meter indicates full scale deflection, a wire is touching

a metal part of the charger. Look for wires that are near any metal part and inspect for possible breakdown caused by shipping The heatsink of the diodes and the transistor control unit are insulated from ground through the mounting legs. (NOTE On units with ground detector lights or relays, the ohmmeter will read a high resistance to ground on the DC to ground check. The bulbs can be removed for the ground check and the reset switch can be used to disconnect the ground detector relays.)

III. CHARGER IN SERVICE BUT NOT CHARGING BATIERY:

A. Check the AC input and DC output fuses. Fuses can be checked by pulling the fuse out of the charger and checking with an ohmmeter or measuring the voltage across the fuse with the unit operating. If no voltage is indicated across the fuse, the fuse is good. A voltage check should also be made at the input terminals and on the unit side of the fuse.

B. Measure the DC output voltage at the output terminals, the unit side of the fuse, and at the battery terminals. The voltage should be essentially the same for all three measurements.

C. AC or DC fuses are blown. An AC fuse blown on 30 units could indicate a blown diode A blown DC fuse could indicate a defective diode on 10 units. Check diodes in accordance with diode trouble shooting sheet. Shorts or grounds indicated in II could blow AC or DC fuses Check for short in load circuit - remove outside leads

D. Remove battery and check DC output voltage. If there LS no output voltage, check the following:

1. Check secondary AC voltage by measuring the voltage on 10 center tapped units from the DC negative terminal to the pigtail end of the one diode, then to the pigtail end of the other diode The AC reading should be approximately nominal DC voltage Measure from pigtail end of one diode to the other, reading should be twice the DC nominal. On 10 bridge units, measure voltage across 2 sets of pigtail ends of diodes for voltage reading. On 30 units with forward and reverse polarity diodes, the AC reading should be taken between diode heatsink 1 and 2, 2 and 3, and 1 and 3, for nominal reading. If there is no reading on 10 units, or very low voltage indicated on 30 units, check for broken primary wire.

2. Check DC voltage. On center tapped units, check voltage from negative terminal (NOTE: Inspect CT wire from transformer to negative terminal including wire crimp beneath terminal board) to heatsink. Follow the connecting positive lead making voltage measurements through to positive output terminal. On bridge units, DC reading may be taken across the heatsinks. Follow connecting wires taking readings through to both output terminals. On 30 units, two heavy DC leads connect to the jumpered ends of the pigtail ends of the diodes. Make reading at these points up through to output terminals.

E. If charger has DC output voltage, (check without battery connected) but will not charge the battery, make the following checks with AC "ON" and the battery connected.

1. Adjust potentiometer, high float switch, or timer If no change in output proceed to 2.

2. Jumper contacts of the power failure relay at the relay with jumper, or remove wires from relay and jumper together

3. The transistor control has a terminal block mounted on the heat- sink with three terminals Remove the two wires on terminal #1 from the control. Connect the two wires from #1 together. This isolates the control from the reactor. The reactors then must saturate and shift a high voltage to the transformers to increase the output. If the output increases to a high rate charge, without the control, this indicates the charger is working properly and the control is defective The control should be replaced. If it is more convenient, check parts for shorted transistor, shorted zener, or open RVI resistor.

4. If the charger does not go into a high rate charge

    a. Check RC resistor for heat. This resistor is the largest resistor in the unit and runs quite hot

    b. Check voltage across reactor center coil and RC resistor Both voltages should total battery voltage. If RC resistor is cold or proper voltages are not indicated, look for broken wires, defective RC resistor, or reactor center coil.

IV. IF THE CHARGER IS CHARGING AT A HIGH CHARGE RATE, AND WILL NOT SHUT DOWN TO THE REQUIRED FLOAT OF EQUALIZNG VOLTAGE:

A. Adjust potentiometer, high float switch, or timer. If no change in output proceed to B.

B. With the high float switch in the float position, jumper red slider on RV1 resistor to the positive output terminal (On older units using PNP transistor, jumper to negative) If the charger shuts down, check.

    1. Red slider connected to slider wires on resistor.

    2 Potentiometer for open.

    3 RVI resistor or positive lead for open

C. Check zener resistor mounted on the control panel, connected in series with terminal #2. Check by jumpering across resistor.

D. Check zener diode for open diode. Also zener must be insulated from heatsink

E. Check for open transistor.

F. Check for broken wires or cold solder connections from the slider through terminal #2 to transistor. Also check transistor socket.

V. WHEN INSTAILNG A NEW CONTROL. THE RED AND GREEN SLIDERS ON RVI OR RV3 MUST BE RESET TO THE PROPER OPERATING POSITION.

PARALLELING PROCEDURE INSTRUCTIONS

I. HIGH FLOAT SWITCH IN FLOAT POSITION

1. Chargers to be paralleled .must be of the same voltage rating

2. Turn one charger on. Charge the battery to full charge. Set the voltage control potentiometer so the desired float voltage is maintained at a trickle charge rate.

3. Apply the DC load. The charger should maintain the voltage constant while carrying the load providing the load does not exceed the charger current rating

4. Turn charger #1 off and turn on charger #2. Set the voltage control potentiometer to float charge as per (2). Apply load as per (3)

5. Turn both chargers on and applyload

6. Adjust the potentiometers of both units until the load is shared equally at the desired float voltage.

7. After a short period of time, one unit may assume more of the load Readjust the lower output charger so that the current is less than half the load Adjusting for exactly hall the load may over compensate and after a period time, assume more than half the load.

8. Once properly set, the charger should load share when the load is varied, from no load to full load.

9. Since there is no inter-connecting circuitry, and the units are completely isolated, both units regulate by sensing buss voltage. At the no load and trickle charge rate, one charger may assume all of the trickle current rate, with the other charger at zero current When loads are applied, the lower output unit will share the load

10. When two chargers of the same rating are paralleled, one unit may have more capacity than the other, and thus carry a greater percentage of the load When the chargers are operating in current limiting, one charger may be supplying more current than the other since the current limit between chargers may vary between 110% and 130% of rated capacity.

II. HIGH FLOAT IN EQUALIZE OR HIGH POSITION

1. When units are required to parallel in the equalize or high position, the chargers should be equipped with dual float and equalize potentiometers.

2. Follow the same procedure for setting the potentiometer as described in "float position." NOTE: Set potentiometer for the required equalize voltage.

3. If dual pots are not furnished, the balancing adjustment must be made by adjusting the green slider on voltage control resistor RVI with the unit. NOTE Be certain when making this adjustment that special care is taken not to break or damage the slide wires of the RVI Resistor

PARALLELING PROCEDURE

(With Load Sharing Circuitry)

Chargers with load sharing circuitry will force both units to share equally. When this circuit is used, each charger control senses the buss voltage. If the setting on one control has a slightly lower voltage setting, the charger will attempt to put out more current The sharing circuitry, however, forces the same current through both reactor control coils, forcing both units to put out the same current. One control can therefore, assume the control of both units. This has the advantage of both units operating even though one control circuit is open circuited or shorted Connect terminals 1W of each unit together.

Paralleling procedure is as follows:

1. Parallel the chargers in accordance with the paralleling procedure instruction sheet without the paralleling circuit.

2. Connect the paralleling circuit by turning the paralleling switch of both chargers "on."

3. When the paralleling circuit is used, the units should be checked periodically to make certain both units are operating and paralleling without the paralleling circuit To check simply turn the paralleling switch to "off" to disconnect the circuit.

TROUBLE SHOOTING AND REPLACING SILICON DIODES

The silicon diode may be a source of trouble. The function of the diode is to allow the flow of current through it in one direction only If the polarity of the conducting current is reversed, the diode will block the current flow. Thus, the diode has a low resistance to current flow in one direction, and a high resistance to current flow in the other direction. Therefore, a simple ohmmeter may be used to test the diode. The procedure for checking the silicon diode is as follows:

1. Isolate one end of the diode by disconnecting the wires attached to the nipple (or pig-tail) end of the diode (only one end of the 'diode must be disconnected).

2. Clip one lead of the ohmmeter to the nipple (or pig-tail) lead of the diode Clip the other ohmmeter lead to the aluminum heat sink. (If a portable multimeter is used, set the switches on ohms, DC and scale RX100).

3. Note the ohmmeter reading. Then reverse the leads to the diode Again, note the ohmmeter reading If the diode is good, the meter will indicate a high resistance m one direction, and a low resistance with the leads reversed. If the diode is shorted, the meter will read full scale, or "O" resistance with the leads in either direction. If the diode is "open," the ohmmeter needle will not indicate or show infinite resistance, indicating an open circuit with the ohmmeter leads in either direction.

4. All diodes must be checked in the event that more than one diode is defective.

5. If the diode is defective, remove the defective diode from the heat sink and replace with a new diode When installing a new diode, be sure to note if the old diode was insulated from the heat sink. If the diode should be insulated from the heat sink, care should be taken so that the mica insulating washer is placed properly on each side of the heat sink with the insulating bushing between the diode mounting stud and the aluminum heat sink.

WHEN ORDERING REPLACEMENT PARTS, DRAWINGS OR SCHEMATICS OR REQUESTING SERVICE INFORMATION, ALWAYS GIVE MODEL NUMBER, SERIAL NUMBER, AND AC INPUT VOLTAGE.

INSTALLATION AND OPERATING INSTRUCTIONS
FOR MODELS A-11 AND A-12

The Constavolt Float Rectifier is designed to operate on a specific number of cells. The name-plate on the charger indicates the type and the number of cells required Once properly installed and adjusted, the rectifier should maintain the battery m a fully charged condition. Install the rectifier so that the flow of air through the ventilators is not obstructed. Binding posts with wire lug connectors are provided on a terminal board within the unit. When hooking up the DC cables to the battery, be certain the positive terminal of the charger is connected to the positive battery terminal and the negative terminal is connected to the negative of the battery. Terminals are also provided for connection of the remote alarm system.

After the rectifier has been installed, give the battery a freshening charge to make certain it is fully charged by putting the High Float Switch on the front of the rectifier m the equalize or high position. The battery should be given an equalizing charge for at least 24 hours When the battery is in a fully charged condition, return the switch to thefloat position. With the switch m this position the voltage should average 2.17 volts per cell for lead acid, 1 4 volts per cell for nickel-cadmium and 1 5 volts per cell for nickel-iron (Edison) cells.

A potentiometer is provided to adjust the DC output so that the desired level may be maintained The range of the potentiometer adjustment Ls a minimum of plus or minus 08 volts per cell On model A12B units, dual potentiometers are provided so that both the float and equalizing positions may be independently adjusted

In normal operation the Constavolt Float Charger maintains a constant battery voltage from no load to loads up to its rated load capacity as indicated by the name-plate If the external loads exceed name-plate capacity the charger will attempt to carry the excess load up to its current limiting capacity Beyond this point, the battery will carry the excessive loads If the battery is discharged, the charger will re-charge the battery on a taper curve from its current limiting capacity to full charge

The High-Float Switch is used to raise the rectifier output voltage to 2 33 volts per cell for lead acid cells, 1 6 volts per cell for nickel-cadmium cells, 1.6 volts per cell for nickel-iron (Edison) cells so that the battery can be given an equalizing charge. To give an equalizing charge, it is only necessary to throw the switch to the high position and leave it there for 24 hours The rectifier will automatically hold the cell voltage at equalizing voltage when the switch is in high position and will drop back to float voltage when the switch is put back into the normal or float position.

If a 24 hour equalizing timer is provided, the timer switch replaces the manual high float switch To operate the timer, it is only necessary to turn the timer knob to the desired equalizing time setting. The time switch transfers the charger from the float to the equalizing charge rate. The timer times out to automatically return the charger to the float charge position.

The inherent design of the transformer-reactor combination provides compensation for line voltage variations of ± 10% The DC output is regulated to ± 1% from no load to full load with AC line variations of ± 10%

The DC output current is limited to provide for complete protection The current limiting feature allows for the unit to carry overloads and limits the output to a miximum of 140% of the rated output.

Power failure contacts are provided for remote power failure indication. One normally open and one normally closed contact are connected to three terminals on the terminal board for connection to the remote alarm system.

The charger is factory tested and preset so that no field adjustments are necessary. Potentiometer(s) are provided for adjusting the float and equalizing voltages to the required levels. Should further field adjustments be necessary the float voltage may be adjusted by moving the red slider band on the voltage divided resistor RV1. Moving the slider toward the green slider or toward RV2 raises the taper and shutdown point and moving the slider in the opposite direction lowers the point of shutdown. The green slider band is the equalizing voltage adjustment and may be adjusted in the same manner as the float slider. On A11B and A12B units the red and green adjustment slider bands are on different resistors (RV1, RV3).

TECHNICAL OPERATION OF THE LA MARCHE
SELF REGULATED AUTOMATIC
AC LINE COMPENSATED FLOAT BATTERY CHARGER

INSTALLATION:

To operate the charger it is only necessary to connect the AC power to the charger and the DC output cables to the battery. Before connecting the power or battery leads to the charger be certain the nomenclature on the name plate of the charger agrees with the incoming power and the battery type and number of cells.

When a battery is discharged or standing idle its terminal voltage will be less than its on charge float or equalize voltage Therefore, when the charger is put into operation it will immediately begin to charge the battery. The charger will charge the battery at its rated output to a pre-determined voltage. When this voltage Ls reached the charge rate will begin to taper to a trickle charge of a magnitude necessary to maintain the battery voltage at its pre-determined setting It is necessary to trickle charge the battery at a very low rate in order to keep the battery fully charged Therefore, after the charger has brought the battery to full charge it shuts down to a small continuous charge preserving charge.

CHARGER COMPONENTS:

The charger has four (4) basic components, a Transformer, Saturable Reactor, Silicon Rectifier Stacks, and Control Unit The basic operation of these units is as follows:

> The Transformer transforms the incoming AC voltage to the required level to charge the battery The transformer also isolates the incoming power from the output The Saturable Reactor regulates the power output of the transformer continuously over the charge cycle The Rectifier Stacks are made up of silicon diodes connected in a full wave center tap or full wave bridge configuration. These silicon diodes rectify the secondary AC power to DC power. The control senses the condition of the battery and controls the reactor which in turn regulates the power output of the transformer.

The standard float charger is provided with a potentiometer for adjusting the float and equalizing voltage level and a float/equalize switch for transferring the output of the charger from float charge to equalize charge. Dual pots for independently adjusting the float and equalizing points are provided as an additional option. A 24 hour equalizing timer may be provided in place of the manual float/equalize switch as an additional option. The time switch is set at a pre-determined setting (usually 24 hours) and when the timer times out, the charger is automatically returned to the float position.

BATTERY CELL TYPES AND VOLTAGES:

The LaMarche Float Chargers are designed specifically to charge lead acid, nickel cadmium or nickel iron batteries These chargers float the batteries at 2.17 volts per cell (lead acid), 1.4 volts per cell (nickel cadmium), or 1.5 volts per cell (nickel iron or Edison). The equalizing charge setting for the batteries are 2.33 volts per cell (lead acid), 1.55 volts per cell (nickel cadmium), or 1.6 volts per cell (nickel iron). The potentiometer adjustment allows for a ± 5% adjustment from the nominal float/equalize voltages. The charger name plate

indicates the type of battery and the number of cells the charger is designed to charge.

OPERATION:

Upon installation the charger will charge at its maximum rate and taper to a trickle charge at the battery float voltage. The desired float voltage may be obtained by adjusting the potentiometer. The battery should then be given a 24 hour freshening charge by putting the float/equalize switch in the equalizing position to make certain the battery is fully charged. The unit should then be returned to the float position for normal operation.

AUTOMATIC CHARGE CONTROIS:

The charge rate is completely controlled by the saturable reactor and sensing control. The battery voltage is sensed by a zener diode. The zener diode conducts into the base of a transistor and the transistor operates to shunt the saturating coil of the reactor. When the battery is discharged the battery voltage is low and the reactor saturating coil saturates the reactor The impedance change of the reactor due to the core saturating shifts more voltage to the primary of the transformer which in turn increases the induced voltage in the secondary of the transformer, thus increasing the charge rate to maximum rated output. When the battery voltage reaches its float voltage the control begins to operate to reduce the charge rate. The zener diode begins to conduct into the transistor regulator and begins to shunt the current from the starting coil of the reactor The reactor begins to de-saturate increasing the impedance, and the voltage to the transformer primary begins to drop, thus decreasing the output.

A voltage divided across the output terminals of the charger provides the battery reference voltage to the zener diode. On single potentiometer units a voltage divider is provided with two reference slider-band adjustments. Dual potentiometer units have separate voltage dividers with one slider band adjustment on the float divider and the other on the equalizing divider. If the potentiometer does not give the required float or equalizing points the slider bands may be adjusted to give the required operating voltage.

AC LINE COMPENSATION:

The float charger has a specially designed transformer-reactor combination which inherently compensates for variations in the incoming AC power. The impedance balance of the transformer-reactor combination compensates for a line voltage variation of ± 10% of the nominal AC voltage specified on the name plate.

AUTOMATIC CURRENT LIMITING:

The float charger will charge to its maximum current capacity and begin to current limit if overloaded. The automatic current limiting feature limits the output of the charger to a maximum of 140% rated load. The saturating current resistor is pre-set and factory adjusted to the required current limiting. The current limiting is accomplished by limiting the saturating current to the reactor, thus controlling the output of the unit.

AC POWER FAILUIE:

A power failure relay is provided to disconnect the automatic control from the

battery and therefore eliminate any drain on the battery. One normally open and one normally closed contact are connected to three terminals on the terminal board for connection to the remote alarm system. The charger will automatically resume charging upon return of AC power.

MAINTEANCE:

It should not be necessary to make any adjustments to the LaMarche Float Charger except for adjusting the potentiometer to the desired float or equalizing points Should any further adjustment be necessary extreme care should be taken in making the adjustment Because of the stable, rugged, and static design of this unit very little maintenance Is required. Occasional blowing out of dust and tightening of connections are the only maintenance requirements.

A11 SERIES TROUBLE ANALYSIS

SYMPTOM	POSSIBLE CAUSE	CHECK	CORRECTIVE ACTION	REMARKS
1 OPEN PRIMARY (AC) FUSE(S)	Shorted component(s)	(1) Timer motor (2) Power trans (3) Saturable reactor (4) Shorted lugs on fuse board (5) Shorted diode (bridge 6 30 units) (6) Incorrect AC line voltage	Replace as required	See paragraphs I, II & III in Trouble Shooting Guide See diode Trouble Shooting Guide
2 OPEN SECONDARY (DC) FUSE(S)	Shorted component(s)	(1) Battery connector (2) Output leads (3) Shorted diode (center tap rectifiers (4)	Repair/replace as required	See paragraph I & III in Trouble Shooting Guide See also diode Trouble Shooting Guide
3 CHARGER OPERATES BUT WILL NOT CHARGE BATTERY	Open AC fuse(s) Open DC fuse(s) AC contactor control XFMR (480 VAC units) Low DC output voltage	(1) Check AC supply (2) Check fuses (3) Check fuses (4) Check coil and contacts (5) Check for open PRI/SEC (6) DC contact on relay (7) Open diode (8) Transistor control panel (9) Open RC resistor	Repair/replace as required	See paragraph Ill in Trouble Shooting Guide See also diode Trouble Shooting Guide See paragraph III E in Trouble Shooting Guide
4 CHARGER NOT TAPERING TO REQUIRED FINISH RATE	Control panel or associated circuit	Check control panel or circuit		See paragraph IV & V in Trouble Shooting Guide
5 CHARGER TAPERING BUT FINISH RATE TOO HIGH	(1) RV1 not set for correct finish rate (2) Control panel	 Shunt transistor not conducting properly		See Adjustments Replace with good transistor
6 TIMER RUNS (1) BACKWARDS OR (2) CONTINUOUSLY	Replace timer (1) Defective timer (2) Timer wired incorrectly	 Trace timer wiring		 See Drawing WA1-1-1 & schematic for charger
7 CHARGER OPERATES CORRECTLY BUT TIMER DOES NOT TIME OUT	(1) Defective timer (2) Timer wired incorrectly	Wiring error		Replace timer See schematic
8 FLOAT/EOUALIZE VOLTAGE TOO HIGH/LOW	(1) Improper number of cells (2) Front panel potentiometer(s) set too high/low (3) RV1-RV3 set incorrectly	(3) Set potentiometer(s) half scale, set float/ equalize voltages with RV1/RV3		

FIELD TEST PROCEDURES
FOR A11 SERIES CHARGERS

Connect the AC input and DC output cables in accordance with the Installation and Operating Instructions. Be sure to note proper polarity when connecting the battery cables, positive of the charger to the positive of the battery and the negative of the charger to the negative of the battery.

TEST AS FOLLOWS:
With the high float switch in the float position, energize the charger. If the battery is discharged, the charger should charge at a high rate - up to its current limiting point. When the battery comes up to the float voltage setting of the charger, the voltage will be held constant and the current rate will taper off to a trickle charge

Transfer the high float switch to the high or equalize position. The output current rate of the charger should increase and when the battery voltage rises to the equalize voltage setting, the current will taper to a trickle charge.

A load can be applied to the battery and charger. The charger should maintain the output voltage setting within m 1%* from no load to the load rating of the charger If the applied load exceeds the rating of the charger, the output current will be limited and the voltage will begin to drop.

ADJUSTMENTS:
One potentiometer is provided for adjusting the constant potential output of the charger The float setting for lead acid batteries is 2.17 V/C for antimony and 2.2 V/C for calcium The equalize setting is 2.33 volts per cell. The settings for nickel cadmium batteries is 1.4 V/C for float and 1.55 V/C for equalize or high rate

If further adjustment is necessary, an adjustable resistor (RVI) within the unit can be adjusted Two slider bands, red for float and green for equalizing, are provided on this resistor

Two potentiometers can be provided as an additional option for independent adjustment of the float and equalize voltages

*A40-A46-A28 + or - 5%.

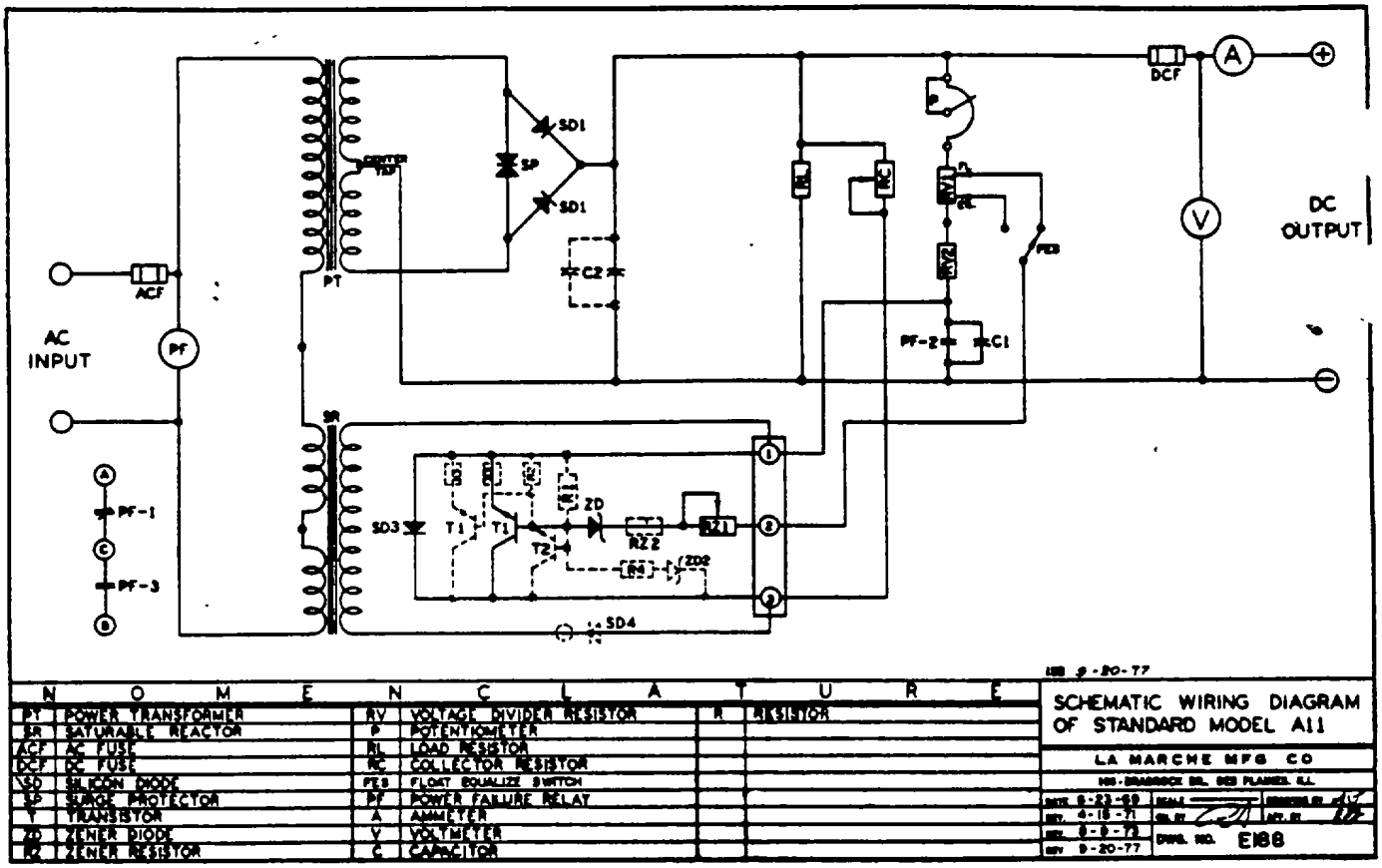
CHARGER ACCESSORY
A11 SERIES CHARGER
CHARGE DIVIDER

Chargers may be provided with charge dividers for battery isolation.

The charger output is fed through two or more diodes (one diode per circuit or battery). The output current of the charger is fed through these diodes to charge the batteries.

One battery may be completely discharged with the other battery remaining charged. The charge divider diodes isolate the loads from each battery. On re-charge, the charger supplies a charge to all batteries. The major portion of the charge will go to the more discharged battery.

When the batteries become fully charged, the charger will maintain all the batteries at full charge.

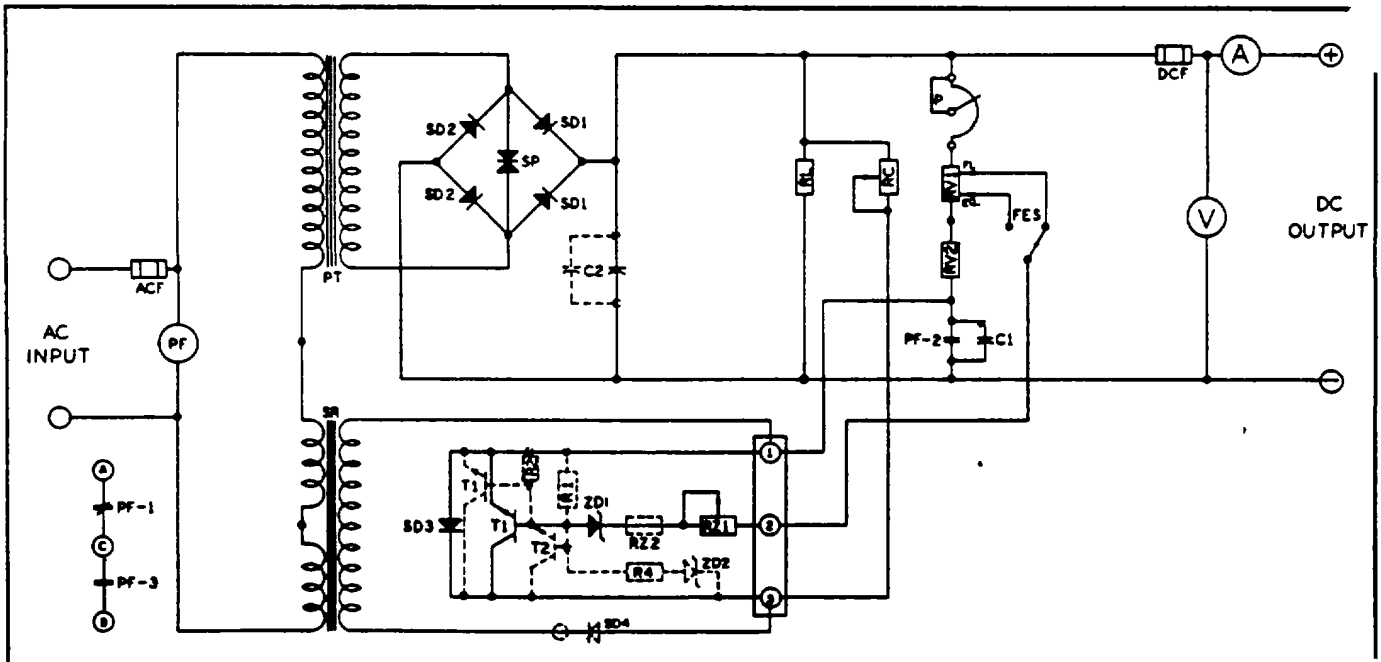


NOMENCLATURE					
PT	POWER TRANSFORMER	RV	VOLTAGE DIVIDER RESISTOR	R	RESISTOR
SR	SATURABLE REACTOR	P	POTENTIOMETER		
ACF	AC FUSE	RL	LOAD RESISTOR		
DCF	DC FUSE	RC	COLLECTOR RESISTOR		
SD	SILICON DIODE	FES	FLOAT EQUALIZE SWITCH		
SP	SURGE PROTECTOR	PF	POWER FAILURE RELAY		
T	TRANSISTOR	A	AMMETER		
ZD	ZENER DIODE	V	VOLTMETER		
RZ	ZENER RESISTOR	C	CAPACITOR		

SCHEMATIC WIRING DIAGRAM OF STANDARD MODEL A11

LA MARCHE MFG CO

DATE	8-23-69
REV.	4-15-71
REV.	8-8-73
REV.	9-20-77
DWG. NO.	E188

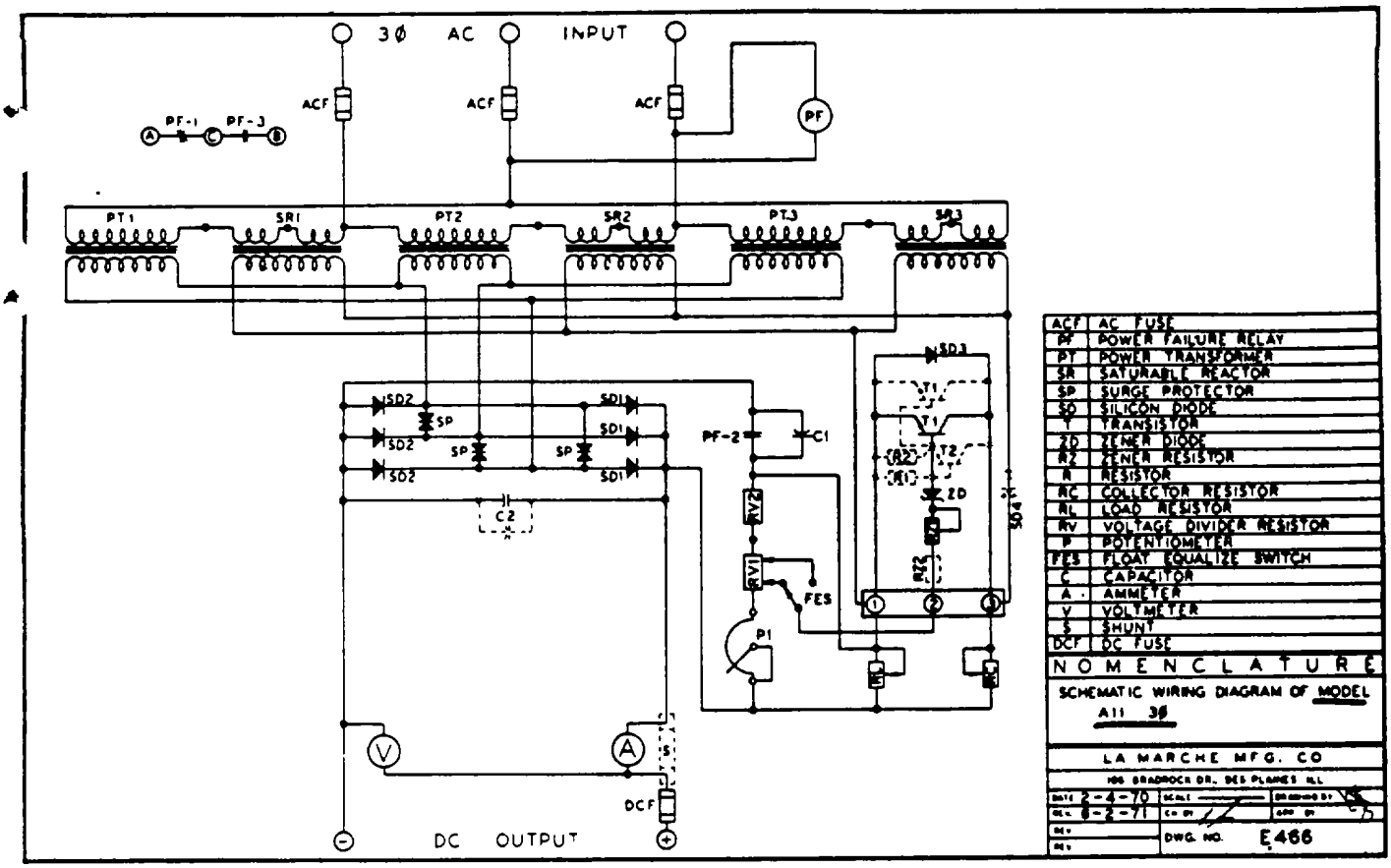


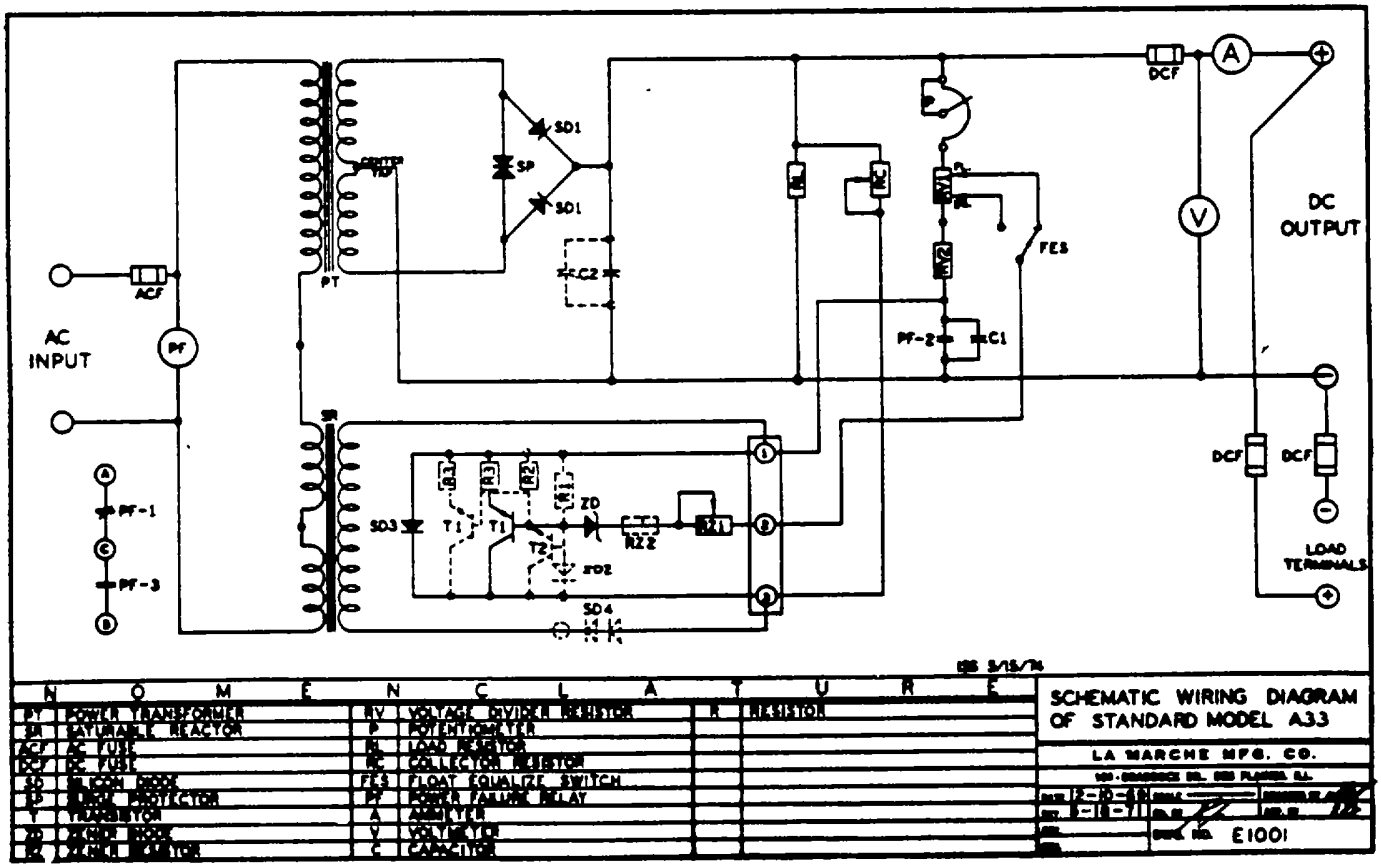
NOMENCLATURE					
PT	POWER TRANSFORMER	RV	VOLTAGE DIVIDER RESISTOR	R	RESISTOR
SR	SATURABLE REACTOR	P	POTENTIOMETER		
ACF	AC FUSE	RL	LOAD RESISTOR		
DCF	DC FUSE	RC	COLLECTOR RESISTOR		
SD	SILICON DIODE	FES	FLOAT EQUALIZE SWITCH		
SP	SURGE PROTECTOR	PF	POWER FAILURE RELAY		
T	TRANSISTOR	A	AMMETER		
ZD	ZENER DIODE	V	VOLTMETER		
RZ	ZENER RESISTOR	C	CAPACITOR		

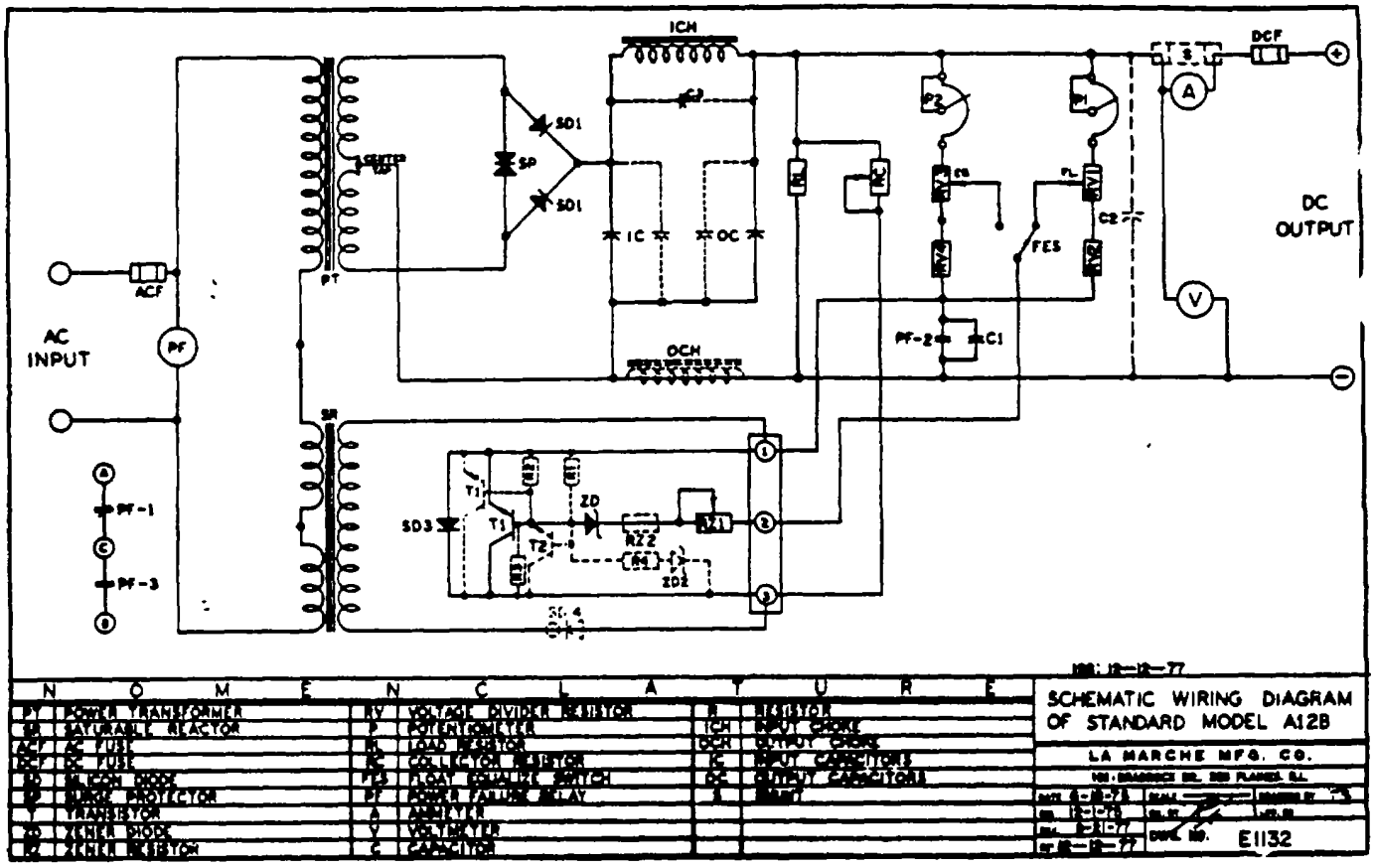
SCHEMATIC WIRING DIAGRA OF STANDARD MODEL A11

LA MARCHE MFG. CO.

DATE	10-27-69
REV.	2-15-72
REV.	12-12-73
REV.	8-20-77
DWG. NO.	E429


3Ø AC INPUT
ACF
PF
PF-1
PF-3
PT1
PT2
PT3
SR1
SR2
SR3
SD1
SD2
SD3
SD4
SP
PF-2
C1
C2
RV1
RV2
FES
P1
T1
T2
ZD
RZ1
RZ2
RC
RL
V
A
S
DCF
DC OUTPUT
ACF FUSE
PF POWER FAILURE RELAY
PT POWER TRANSFORMER
SR SATURABLE REACTOR
SP SURGE PROTECTOR
SD SILICON DIODE
T TRANSISTOR
ZD ZENER DIODE
RZ ZENER RESISTOR
R RESISTOR
RC COLLECTOR RESISTOR
RL LOAD RESISTOR
RV VOLTAGE DIVIDER RESISTOR
P POTENTIOMETER
FES FLOAT EQUALIZE SWITCH
C CAPACITOR
A AMMETER
V VOLTMETER
S SHUNT
DCF DC FUSE
NOMENCLATURE
SCHEMATIC WIRING DIAGRAM OF MODEL A11 3Ø
LA MARCHE MFG. CO
DATE 2-4-70
REV 8-2-71
DWG. NO. E466


AC INPUT
ACF
PF
PF-1
PF-3
PT
SR
SD1
SD2
SD3
SD4
SP
C1
C2
RV1
RV2
FES
T1
T2
ZD
RZ1
RZ2
RC
RL
V
A
DCF
DC OUTPUT
LOAD TERMINALS
SCHEMATIC WIRING DIAGRAM OF STANDARD MODEL A33
LA MARCHE MFG. CO.
DATE 12-10-69
REV 5-18-71
DWG. NO. E1001

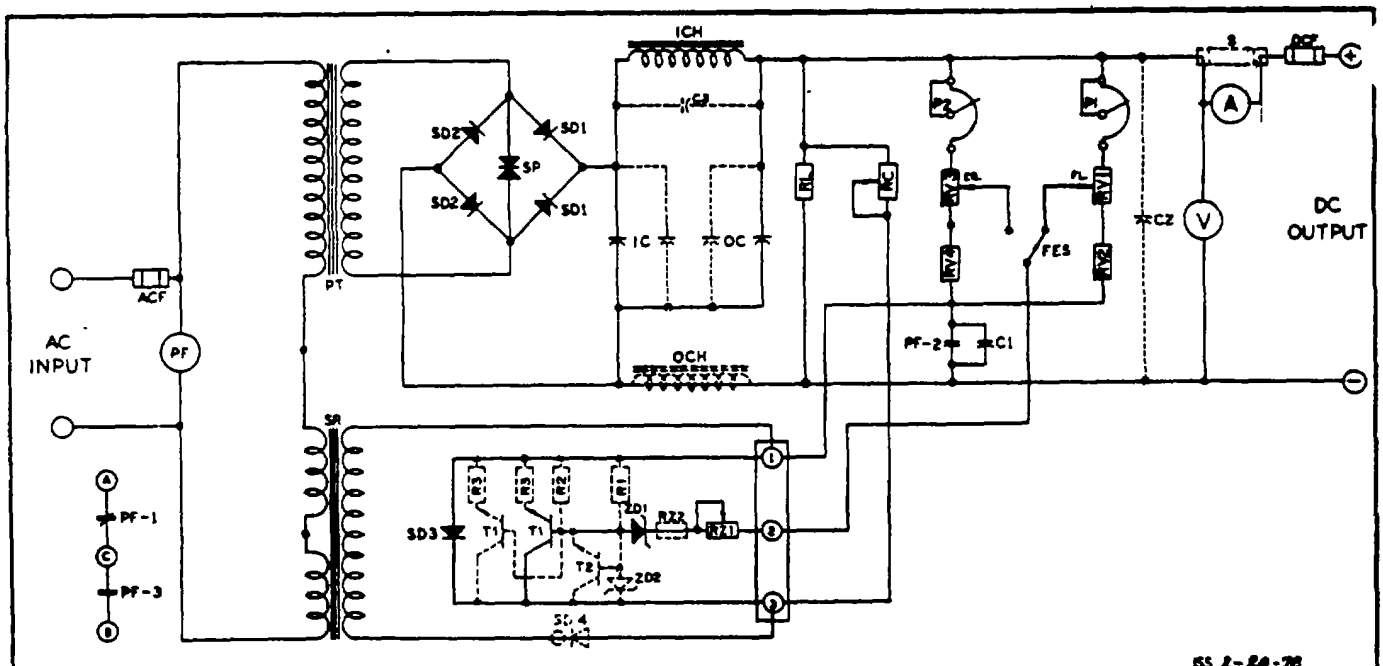


NOMENCLATURE					
PT	POWER TRANSFORMER	RV	VOLTAGE DIVIDER RESISTOR	R	RESISTOR
SR	SATURABLE REACTOR	P	POTENTIOMETER	ICH	INPUT CHOKE
ACF	AC FUSE	RL	LOAD RESISTOR	OCH	OUTPUT CHOKE
DCF	DC FUSE	RC	COLLECTOR RESISTOR	IC	INPUT CAPACITORS
SD	SILICON DIODE	FES	FLOAT EQUALIZE SWITCH	OC	OUTPUT CAPACITORS
SP	SURGE PROTECTOR	PF	POWER FAILURE RELAY	S	SHUNT
T	TRANSISTOR	A	AMMETER		
ZD	ZENER DIODE	V	VOLTMETER		
RZ	ZENER RESISTOR	C	CAPACITOR		

SCHEMATIC WIRING DIAGRAM OF STANDARD MODEL A12B

LA MARCHE MFG. CO.

DWG. NO. E1132



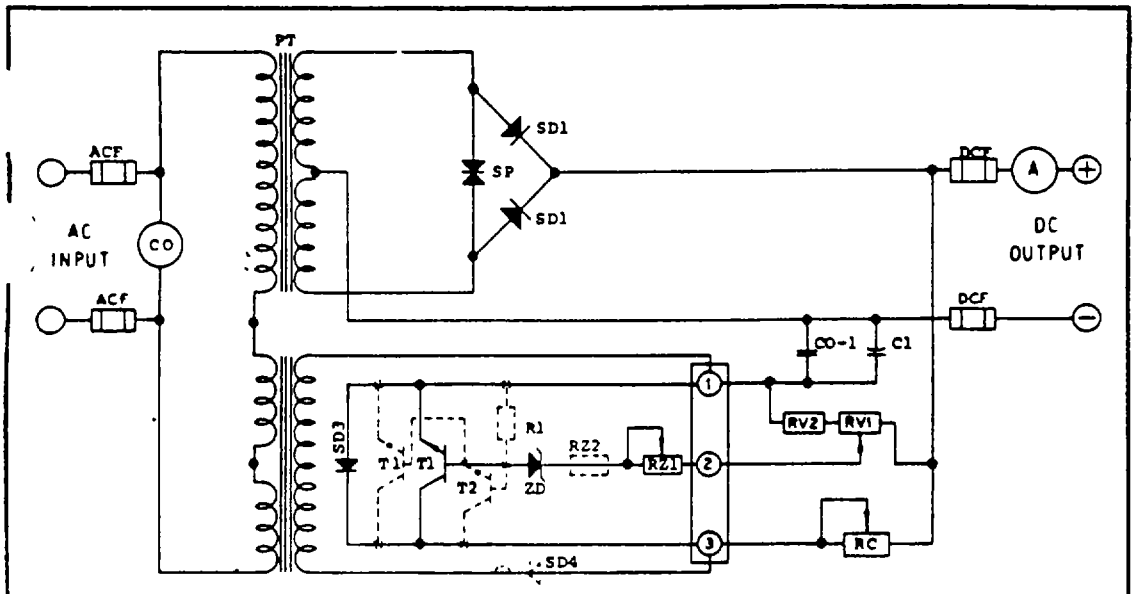
NOMENCLATURE					
PT	POWER TRANSFORMER	RV	VOLTAGE DIVIDER RESISTOR	R	RESISTOR
SR	SATURABLE REACTOR	P	POTENTIOMETER	ICH	INPUT CHOKE
ACF	AC FUSE	RL	LOAD RESISTOR	OCH	OUTPUT CHOKE
DCF	DC FUSE	RC	COLLECTOR RESISTOR	IC	INPUT CAPACITORS
SD	SILICON DIODE	FES	FLOAT EQUALIZE SWITCH	OC	OUTPUT CAPACITORS
SP	SURGE PROTECTOR	PF	POWER FAILURE RELAY	S	SHUNT
T	TRANSISTOR	A	AMMETER		
ZD	ZENER DIODE	V	VOLTMETER		
RZ	ZENER RESISTOR	C	CAPACITOR		

ISS 2-20-78

SCHEMATIC WIRING DIAGRAM OF MODEL A12B

LA MARCHE MFG. CO.

DWG. NO. E1672



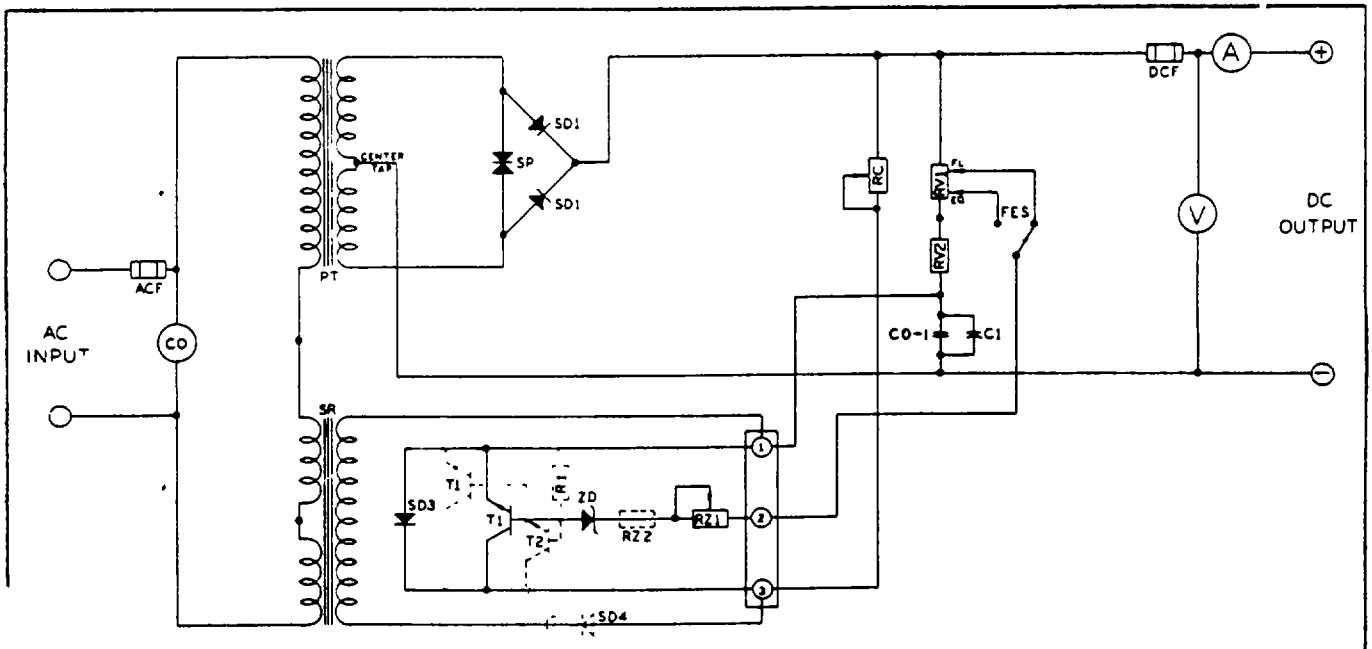
NOMENCLATURE			
ACF	AC FUSE	ZD	ZENER DIODE
CO	CUT OUT RELAY	RZ	ZENER RESISTOR
T	TRANSISTOR	RV	VOLTAGE DIVIDER RESISTOR
SR	SATURABLE REACTOR	RC	COLLECTOR RESISTOR
PT	POWER TRANSFORMER	C	CAPACITOR
SP	SURGE PROTECTOR	DCF	DC FUSE
SD	SILICON DIODE	A	AMMETER

SCHEMATIC WIRING DIAGRAM OF STANDARD MODEL A40 1Ø

LA MARCHE MFG CO.

106 BRADROCK DR DES PLAINES ILL.

DATE 5-14-70	SCALE	DRAWING BY
REV 3-26-71	CH BY	APP BY
REV	DWG NO E205	
REV		



N O M E N C L A T U R E			
PT	POWER TRANSFORMER	RV	VOLTAGE DIVIDER RESISTOR
SR	SATURABLE REACTOR	R	RESISTOR
ACF	AC FUSE	CO	CUT OUT RELAY
DCF	DC FUSE	RC	COLLECTOR RESISTOR
SD	SILICON DIODE	FES	FLOAT EQUALIZE SWITCH
SP	SURGE PROTECTOR		
T	TRANSISTOR	A	AMMETER
ZD	ZENER DIODE	V	VOLTMETER
RZ	ZENER RESISTOR	C	CAPACITOR

SCHEMATIC WIRING DIAGRAM OF STANDARD MODEL A46

LA MARCHE MFG CO

106 BRADROCK DR DES PLAINES ILL.

DATE 3-4-71	SCALE	DRAWING BY
REV.	CH BY	APP BY
REV.	DWG NO E187	
REV.		

APPENDIX C

Preventive maintenance checks and services (PMCS) for Equipment the Monitoring System System

C-1 Introduction to PMCS

NOTE

TM 55-1930-209-14&P-19 contains PMCS FOR ALL SYSTEMS ON THE ROWPU Barge. This appendix contains only PMCS for the Equipment Monitoring System

a. General.

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

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

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

b. PMCS columnar entries.

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

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

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

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

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

NOTE

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

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

(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 equipment monitoring system consists of the alarm/casualty monitoring equipment, two 12 V dry cell batteries, a battery charger, two strobe lights, two horns, and a buzzer. The alarm/casualty monitoring equipment consists of various sensors and switches, a main processor, keyboard, video monitor, alarm relay module, main power switch, and bilge alarm module.

C-3 Equipment Monitoring System Description . This system can accept information from as many as 168 different inputs. On the barge, however, only 39 are used. The keyboard and video monitor make up the station from which an operator selects and views any page of monitored information, acknowledges alarms and sets or changes alarm conditions. The system is designed to operate between 32 and 131 degrees F

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

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

ITEM NO.	INTERVAL									ITEM TO BE INSPECTED	PROCEDURES CHECK FOR AND HAVE REPAIRED OR ADJUSTED AS NECESSARY	EQUIPMENT IS NOT READY/ AVAILABLE IF
	B	D	A	D	W	M	Q	S	A			
										EQUIPMENT MONITORING SYSTEM (EMS)	**WARNING** **Be sure that electrical power Is OFF before performing any maintenance on electrical systems. Redtag appropriate switches and circuit breakers with: "WARNING - DO NOT ACTIVATE. REPAIRS BEING MADE." Observe all safety precautions listed at the beginning of this manual.**	
1										All Components		
	•			•							a. Wipe clean or vacuum major EMS components and check for loose fitting wires. Use insulated tools	
		•									b. Allow EMS 5 to 10 minutes warmup before operation	
			•			•					c. Check for damage or corrosion. Repair touchup paint in accordance with TB 43-0144 as necessary. Do not paint threads or labels	
					•						d. Check all fasteners, mounting hardware, and cable attachments for loose or missing components. Tighten or replace as necessary using insulated tools	
2										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 bums and Is highly toxic to skin, eyes, and respiratory system.**	

Table C-1. Preventive Maintenance Checks and Services for Equipment Monitoring System (Continued)

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

ITEM NO.	INTERVAL									ITEM TO BE INSPECTED	PROCEDURES CHECK FOR AND HAVE REPAIRED OR ADJUSTED AS NECESSARY	EQUIPMENT IS NOT READY/ AVAILABLE IF
	B	D	A	D	W	M	Q	S	A			
	•			•							a. Check that batteries are secure and that electrical cable fittings are tight. Use insulated tools to tighten as necessary.	Batteries and cables are not secure and fittings not tight.
	•		•								b. Check batteries for proper electrolyte level. Add distilled water or clean tap water to bring to proper level	
		•		•							c. Make sure battery charger select switch is on FLOAT for normal charges and voltmeter reads about 24V. The HIGH switch setting is for rapid recharge	
											CAUTION **Do not allow battery charger to remain on HIGH setting for more than 24 hours.**	
3		•		•						Keyboard Lamp and Alarm	a. Perform keyboard lamp and alarm test as follows: 1) Press EDIT key. 2) Press key 6 (KEYBOARD LAMP TEST). All keyboard keys, except ACK key, should light and alarm should sound. Make sure all alarm devices operate.	Keyboard lamp inoperable
		•									b. Using insulated tools, replace bad lamps and fuses.	Monitor does not return to normal operation
		•									c. After completion of test, press EDIT key to initiate normal monitoring. **NOTE** **Keyboard lamp and alarm test may be run without affecting monitoring anytime edit mode Is not in use.**	

Table C-1. Preventive Maintenance Checks and Services for Equipment Monitoring System (Continued)

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

ITEM NO.	INTERVAL									ITEM TO BE INSPECTED	PROCEDURES CHECK FOR AND HAVE REPAIRED OR ADJUSTED AS NECESSARY	EQUIPMENT IS NOT READY/ AVAILABLE IF
	B	D	A	D	W	M	Q	S	A			
4		•								EMS Main Processor	a. Check that EMS main processor internal temperature is maintained between 32° and 131°F.	
											b. When EMS temperature reaches 1250F, Initiate the following	
											1) Check that all ROWPU space overhead fans are operating and hatches and doors are open.	
											2) If available, use additional portable fans blowing on main processor.	
											3) If necessary, cover main processor with damp cloths and portable fans blowing directly on processor.	
											4) If temperature cannot be maintained below 131°F, turn EMS off during hottest part of day, and visually monitor tank level indicators, gauges, flowmeters, etc, to assure all systems are operating normally.	
			•								c. Pull main power switch OFF after operation.	
			•								d. DO NOT turn main processor and video monitor switches to OFF unless barge is to be out of operation for more than 7 days.	
	•		•								e Check fuses. Replace if necessary.	Fuses blown

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
06916

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PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

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

Weights

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

Liquid Measure

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

Square Measure

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

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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