S9314-CS-MMA-010

REVISION 2

**TECHNICAL MANUAL
FOR**

NONMAGNETIC AC GENERATOR (PULSE FREQUENCY CHANGER), 550 KW, 435 VOLTS, 1,404 AMPS, 1,800 RPM, 3 PHASE, 420/362 HERTZ

INSTALLATION, OPERATION, AND MAINTENANCE

SUPERSEDURE NOTICE: THIS MANUAL SUPERSEDES S9314-CS-MMA-010 REVISION 1, DATED 30 NOVEMBER 2005, AND ALL CHANGES THERETO.

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NOTE

FOR OPTIMAL VIEWING OF THIS TECHNICAL MANUAL THE PAGE LAYOUT IN ADOBE ACROBAT READER SHOULD BE SINGLE PAGE. CONTINUOUS PAGE DISPLAY CAN CAUSE PROBLEMS WITH LINK REFERENCES AND THE BOOKMARKS.

FOREWORD

This technical manual provides installation, operation, maintenance, repair and parts support procedures for the Pulse Frequency Changer (Non-Magnetic), manufactured by Hansome Energy Systems, Inc., Linden, New Jersey under contract N00024-89-C-2126. This equipment is used on the US Navy Mine Countermeasures (MCM 1) Class (MCM 9-14) ships. This manual is prepared in accordance with Government Specification NDMS 850069-000B; NDMS 850069-015A. The chapters are arranged as follows:

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SAFETY SUMMARY

GENERAL SAFETY NOTICES

The following general safety notices supplement the specific warnings and cautions appearing elsewhere in this manual. They are recommended precautions that must be understood and applied during operation and maintenance of the equipment covered herein. Should situations arise that are not covered in the general or specific safety precautions, the commanding officer or other authority will issue orders as deemed necessary to cover the situation. No work shall be undertaken on energized equipment or circuits until approval of the commanding officer is obtained, and then only in accordance with Naval Ships' Technical Manual (NSTM) S9086-KC-STM-010/Chapter 300.

DO NOT REPAIR OR ADJUST ALONE

Under no circumstances shall repair or adjustment of energized equipment be attempted alone. The immediate presence of someone capable of rendering first aid is required. Before making adjustments, be sure to protect against grounding. If possible, adjustments should be made with one hand, with the other hand free and clear of equipment. Even when power has been removed from equipment circuits, dangerous potentials may still exist due to retention of charges by capacitors. Circuits must be grounded and all capacitors discharged prior to attempting repairs. Equipment should be deenergized and properly tagged out according to the ship's Standard Operating Procedures.

TEST EQUIPMENT

Make certain test equipment is in good condition. If a metal-cased test meter must be held, ground the case of the meter before starting measurement. Do not touch live equipment or personnel working on live equipment while holding a test meter. Do not ground any measuring devices; these devices should not be held when taking measurements.

INTERLOCKS

Interlocks are provided for safety of personnel and equipment and should be used only for the purpose intended. They should not be battle shorted or otherwise modified except by authorized maintenance personnel. Do not depend solely upon interlocks for protection. Whenever possible, disconnect power at the power distribution source.

MOVING EQUIPMENT

Personnel shall remain clear of moving equipment. If equipment requires adjustment while in motion, a safety watch shall be posted. The safety watch shall be qualified to administer CPR, have a full view of the operations being performed, and have immediate access to controls capable of stopping equipment motion.

FIRST AID

An injury, no matter how slight, shall never go unattended. Always obtain first aid or medical attention immediately, and file an injury report in accordance with OPNAVINST 5102.1 series, subj: Mishap Investigation and Reporting.

SAFETY SUMMARY - Continued

RESUSCITATION

Personnel working with or near high voltage shall be familiar with approved methods of resuscitation. Should someone be injured and stop breathing, begin resuscitation immediately. A delay could cost the victim's life. Resuscitation procedures shall be posted in all electrically hazardous areas.

GENERAL PRECAUTIONS

The following general precautions are to be observed at all times.

1. Install and ground all electrical components associated with this system/equipment in accordance with applicable Navy regulations and approved shipboard practices.
2. Ensure that all maintenance operations comply with Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, OPNAVINST 5100.19 series.
3. Observe precautions set forth in NSTM S9086-KC-STM-010/Chapter 300 with respect to electrical equipment and circuits.
4. Ensure that protective guards and shutdown devices are properly installed and maintained around rotating parts of machinery and high voltage sources.
5. Do not wear loose clothing while working around rotating parts of machinery.
6. Ensure that special precautionary measures are employed to prevent applying power to the system/equipment any time maintenance work is in progress.
7. Do not make any unauthorized alterations to equipment or components.
8. Before working on electrical system/equipment, use the correct tag out procedure and check with voltmeter to ensure that system is not energized.
9. Consider all circuits not known to be "dead," "live" and dangerous at all times.
10. When working near electricity, do not use metal rules, flashlights, metallic pencils, or any other objects having exposed conducting material .
11. Deenergize all equipment before connecting or disconnecting meters or test leads.
12. When connecting a meter to terminals for measurement, use range higher than expected voltage.
13. Before operating equipment or performing any tests or measurements, ensure area is dry of water or other liquid conductive material and that frames of all motors and starter panels are securely grounded.
14. Ensure that area is well-ventilated when using cleaning compound or solvent. Avoid prolonged breathing of fumes and compound or solvent contact with skin or eyes.

WARNINGS AND CAUTIONS

Specific warnings and cautions applying to the system/equipment covered by this manual are summarized below. These warnings and cautions appear elsewhere in the manual following paragraph headings and immediately preceding the text to which they apply. They are repeated here for emphasis.

SAFETY SUMMARY - Continued

WARNING

Warnings identify an operating or maintenance procedure, practice, condition, or statement, which, if not strictly followed, could result in death or serious injury to personnel. (Page 1-1)

WARNING

All covers and guards should be in place before startup. All personnel working on PFC or drive equipment should cease work prior to startup. Severe injury to personnel and damage to equipment may result from starting the turbine while the PFC is being serviced. (Page 2-1)

WARNING

High voltages capable of causing death are used in this equipment. Extreme caution should be used when servicing either the power supplies or their load components. (Page 4-2)

WARNING

Heater circuit must be deenergized before servicing generator. Severe injury or death may result from contact with live electrical leads. (Page 4-2)

WARNING

Before attempting any maintenance or repair work, the PFC, the turbine, and its controls should be deenergized and tagged OUT OF SERVICE. Severe injury to personnel and damage to equipment may result from starting the turbine while the PFC is being serviced. (Page 4-2, page 6-5, page 6-11)

WARNING

All electrical leads should be considered energized until positively proven they are deenergized. Severe injury or death may result from contact with live electrical leads. (Page 4-3, page 6-5)

⚠ WARNING

The AC generator weighs approximately 20,000 pounds. Using lifting equipment with a capacity less than this could result in serious injury to personnel or damage to equipment. (Page 6-5)

⚠ WARNING

The total weight of the rotor is approximately 6,200 pounds. Using lifting equipment with a capacity less than this could result in serious injury to personnel or damage to equipment. (Page 6-8)

⚠ WARNING

The total weight of the flywheel is approximately 6,700 pounds. Using lifting equipment with a capacity less than this could result in serious injury to personnel or damage to equipment. (Page 6-8)

⚠ WARNING

Current Transformers (CT) can store sufficient electrical energy to cause severe injury to personnel. Never open the secondary circuit of a CT. Never leave the secondary windings open while the primary is still connected to the electrical circuit. (Page 6-13)

⚠ WARNING

All covers and guards should be in place before startup. All personnel working on the PFC or the drive equipment should cease work prior to startup. Severe injury to personnel and damage to equipment may result from starting the PFC while it is being serviced. (Page 6-14)

⚠ WARNING

Personnel must take care when moving AC generator as it weighs 20,000 pounds. Fatal injury to personnel or damage to equipment may result if this weight is not properly controlled.

Personnel must take care when moving flywheel assembly as it weighs 8,000 pounds. Fatal injury to personnel or damage to equipment may result if this weight is not properly controlled. (Page 8-1)

CAUTION

Cautions identify an operating or maintenance procedure, practice, condition, or statement, which, if not strictly followed, could result in destruction of, or damage to, equipment or serious impairment of system operation. (Page 1-1)

CAUTION

During normal operation, any smoke or flame, unusual noise, vibration or temperature indicates trouble which could result in electrical or mechanical failure of generator or related equipment. Operation of the generator should be discontinued immediately until the cause is found and corrected. (Page 2-2)

CAUTION

Material that might deposit lint should not be used to clean PFC Lint may block ventilation openings resulting in electrical or mechanical failure of PFC or related equipment. (Page 4-2)

CAUTION

Bearings should not be over-greased. Too much grease will cause bearings to churn and overheat, resulting in possible mechanical failure of PFC. (Page 4-5)

CAUTION

Alternator end housing weighs 600 pounds and should be removed carefully to avoid damage to rotor. (Page 6-7)

CAUTION

PFC should not be operated if resistance is less than 25 megohms. It will damage the windings. (Page 6-14)

CAUTION

No lubricants of any kind should ever be applied to any electrical part at any time, as it may affect conductivity resulting in electrical or mechanical failure of PFC or related equipment. (Page 8-2)

CHAPTER 1

SAFETY PRECAUTIONS AND GENERAL INFORMATION.

1-1. SAFETY PRECAUTIONS.

1-1.1 Warning/Caution Usage. The warnings and cautions appearing throughout this manual are of utmost importance to personnel and equipment safety. Thoroughly review and understand all warnings and cautions before making any attempt to operate, maintain, troubleshoot, or repair any part of the Pulse Frequency Changer (Non-Magnetic). Refer to the Safety Summary, found in the front matter pages of this manual, for a complete listing of warnings and cautions used throughout the manual.

1-1.2 Warning/Caution/Note Definitions. The following paragraphs define dangers, warnings, cautions, and notes as they are used in this manual.

WARNING

Warnings identify an operating or maintenance procedure, practice, condition, or statement, which, if not strictly followed, could result in death or serious injury to personnel.

CAUTION

Cautions identify an operating or maintenance procedure, practice, condition, or statement, which, if not strictly followed, could result in destruction of, or damage to, equipment or serious impairment of system operation.

NOTE

Notes highlight an operating or maintenance procedure, condition, or statement which is essential, but is not of known hazardous nature as indicated by warnings and cautions.

1-2. INTRODUCTION.

This technical manual provides the necessary data for installation, operation, maintenance, repair, and parts support for the Pulse Frequency Changer (PFC). The generator is covered under Hansome Energy Systems, Inc. standard warranty. The warranty is effective for one year from date of shipment. The equipment, accessories, and documents supplied are listed in Table 1-1. The essential equipment, accessories, and documents not supplied are listed in Table 1-2.

1-3. EQUIPMENT DESCRIPTION.

1-3.1 The Pulse Frequency Changer is a non-magnetic generator designed to provide electrical power for pulsing operations and for the light load motor and bow thruster operation on minesweeper type vessels. The PFC consists of an AC generator, a flywheel, a voltage regulator, and two coolers. The PFC is equipped with internal space heaters, imbedded resistance temperature detectors (RTD), and grease lubricated ball bearings. The PFC is air-to-water cooled by internal fans and water coolers. Mechanical energy is supplied to the PFC by means of a gas turbine flexibly coupled to the frequency changer end of the unit. The alternator end of the unit is coupled to the flywheel. A disc is located on the coupling between the flywheel and the alternator end of the generator. Refer to Figure 1-1 for an illustration of the PFC and its general shipboard location.

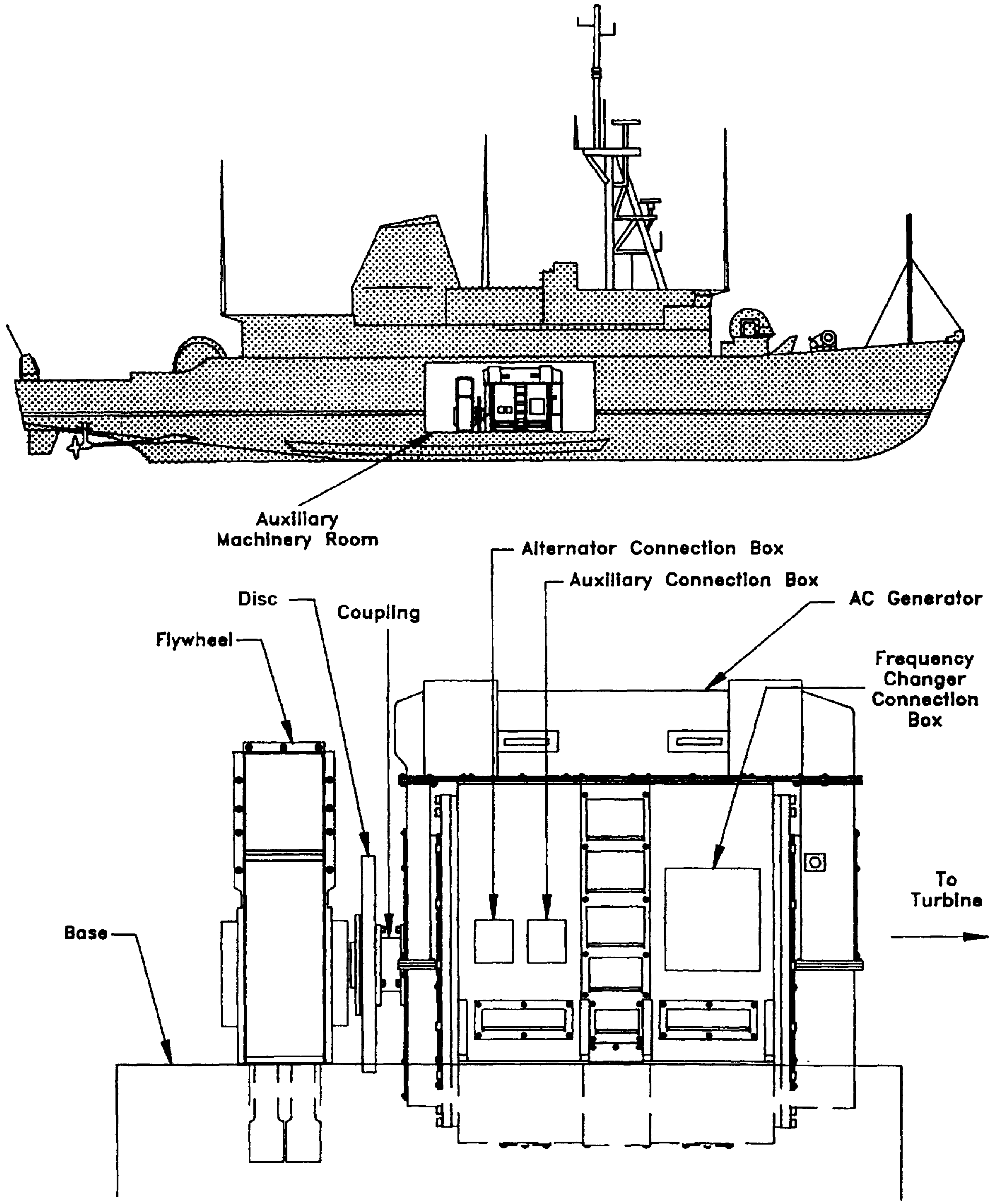


Figure 1-1 Nonmagnetic Ship Service Pulse Frequency Changer

1-3.2 The voltage regulator is located in the AC minesweep switchboard. The voltage regulator is addressed in this manual in its relationship to the PFC.

1-4. REFERENCE DATA.

Reference data for this AC generator is listed in Table 1-3. Reference data for the voltage regulator is listed in Table 1-4.

Table 1-1 Equipment, Accessories, and Documents Supplied

Quantity	Item Name	Unit Number	Overall Dimensions (in Inches)	Weight/Volume (in Pounds)
1	Pulse Frequency Changer	A-1200-173	95 x 80 x 74 (uncrated)	28,000
1	Technical Manual	S9314-CS-MMA-010	8.5 x 11 x 1	1

Table 1-2 Related Equipment, Accessories and Documents Not Supplied

Quantity	Item Name	Unit No.	Description
1 per PFC	NAVSEA Technical Manual	S9234-FG-MMM-010	Saturn Gas Turbine Powerplant Assembly
1 per PFC	NAVSEA Technical Manual	SE681-A2-MMA-010	AC Minesweep Switchboard Operation
1 per PFC	NAVSEA Technical Manual	S9086-KC-STM-010/CH300	Electric Plant General
1 per PFC	Electrician's Mate 3 & 2 RTM & NRCC Manual	0502-LP-052-7325 Revised 1981 Reprinted 1982	Published by the Naval Education and Training Program Development Center, this Rate Training Manual provides information relating to the tasks assigned to the Electrician's Mate Third and Second Class who operate and maintain shipboard power and lighting systems and associated equipment.

Table 1-3 AC Generator Reference Data

Item	Specification
Service	Navy A
Frame	1200
Enclosure	Drip Proof Protected-Sea Water/Air Cooled
Speed Class	Variable
RPM	1800/1550
Special Feature	Nonmagnetic
Ambient Temp.	122°F (50°C) or less
Insulation	Class F
Mounting	Horizontal
Cooling	Two Sea Water to Air Coolers

Temperature Parameters (Minesweeping).

Item	Specification
Ambient Air:	122°F (50°C) Max
Ambient Sea:	85°F (29.5°C) Max
Bearing Temp:	200°F (93.3°C) Max
Stator Temp:	320°F (160°C) Max

Duty/Capacity - Continuous (Minesweeping). 550 KW, 445 Volts, 1400 Amps, 420 Hertz, 3 Phase, 1800 RPM

Duty/Capacity - Intermittent (Minesweeping). 1300 KW, 445 Volts, 3350 Amps, 420/362 Hertz, 3 Phase, 1800/1550 RPM; 5.5 seconds ON; 9.5 seconds OFF

Duty/Capacity (Ship's Service). 650 KW, 435 Volts, 900 Amps, 420 Hertz, 3 Phase, .96 P.F., 1800 RPM

Field Excitation

Item	Specification
At max. intermittent duty	250 V, 36 Amps (approx.)
Ceiling	360V, 52 Amps

Table 1-4 Automatic Voltage Regulator Reference Data

Item	Specification
Regulation	± 1/2% of no load to full load
Regulation Drift	Less than ± 0.5% for 122°F (50°C), temperature change (including warm-up)
Regulation Response	Less than 0.017 second
Voltage Build-up	Provides generator build-up with a residual voltage of 10%
Voltage Adjust Range	± 10% of nominal
Over-voltage Protection	Over-voltage relay-Basler Type BE4-59
Permissible Operating Temperature	-40°F to + 158°F (-40°C to +70°C)
Part Number	9-1256-00-135
Power Input	450 Volts, Single Phase AC
Output Rating	Maximum Continuous: 250 VDC, 36 Amps Forcing Condition: 360 VDC, 52 Amps
Sensing Input	120 VAC, 3 phase, 362 Hz-420 Hz, Burden: 15 VA per phase

CHAPTER 2

OPERATION

2-1. INTRODUCTION.

2-1.1 This chapter covers the operating procedures for the Pulse Frequency Changer (PFC). Also covered in this chapter are the operator maintenance checks and adjustments.

WARNING

All covers and guards should be in place before startup. All personnel working on PFC or drive equipment should cease work prior to startup. Severe injury to personnel and damage to equipment may result from starting the turbine while the PFC is being serviced.

2-1.2 The PFC is controlled and operated from the AC minesweep switchboard. Prior to operating the PFC, the turbine must be operating at required conditions stated in NAVSEA manual S9234-FG-MMM-010. The AC minesweep switchboard must also be operational (see NAVSEA manual SE681-A2-MMA-010). The operator observes indicators on the AC minesweep switchboard and uses controls on this same switchboard to start, stop and perform pulsing operations of the PFC.

2-2. CONTROLS AND INDICATORS.

Most controls and indicators are located on the AC minesweep switchboard and are not supplied with the PFC. Table 2-1 lists those controls and indicators available on the minesweep switchboard for operation of the PFC.

2-3. OPERATING PROCEDURES.

Operating procedures for the PFC are shown in Table 2-2.

2-4. OPERATOR MAINTENANCE INSTRUCTIONS AND SCHEDULE.

The operator is responsible for those maintenance tasks shown in Chapter 4.

Table 2-1 Controls and Indicators

Description	Function	Unit/Position	Range
PFC Ammeter with phase selector switch	Shows current through each phase of PFC.	Amperes	0-4000
PFC Field Current Ammeter	Shows current through field of PFC.	Amperes	0-100
PFC Voltmeter with phase selector switch	Shows voltage across each phase of PFC.	Volts	0-600
Wattmeter	Shows true power output of PFC.	Kilowatts	0-2000
Frequency Meter	Shows PFC frequency.	Hertz	300-500

Table 2-1 Controls and Indicators - Continued

Description	Function	Unit/Position	Range
Temperature Meter with temperature selector switch	Shows the temperature of the PFC windings and bearings.	Degrees F	0-400
PFC Heater Switch and Indicator Lamp	Turns heater on or off and shows whether heater is on or off.	″On″ or ″off″	
Ground Detector Lamp	Shows any low resistance to ground.	Test or ″off″	
Circuit Breaker Switch and Indicator Lamp	Allows operator to open or close circuit.	Trip or Close	
Voltage Adjust Switch	Allows operator to raise or lower PFC voltage.	Spring Return to Center	
Minesweeping Mode Switch	Allows operator to switch between manual and automatic modes.	Manual or Automatic	
System Mode Select Switch	Allows operator to switch between minesweeping or ship service modes.	Minesweeping or DC Ship Service	
Exciter Regulator Control Switch	Allows operator to excite or de-excite generator.	Off/Reset or On	

Table 2-2 Operating Procedures

Operation	Procedural Steps
CAUTION During normal operation, any smoke or flame, unusual noise, vibration or temperature indicates trouble which could result in electrical or mechanical failure of generator or related equipment. Operation of the generator should be discontinued immediately until the cause is found and corrected.	
1. Turn-on procedure for PFC	1.1 Insure that circuit breaker is in the tripped position and the turbine is ready to be operated.
	1.2 Insure that all winding and bearing Resistance Temperature Detectors (RTD) are properly functioning.
	1.3 Check the ground resistance of the PFC to ensure that it is satisfactory.
	1.4 Start the turbine and bring it up to rated speed in accordance with Saturn Gas Turbine Powerplant Assembly NAVSEA manual (S9234-FG-MMM-010) and authorized operating procedures.
	1.5 Using the Exciter Regulator Control Switch, excite the generator.
	1.6 Using the Voltage Adjust Switch, adjust the PFC output voltage to 445 VAC.
	1.7 Close PFC circuit breaker. Observe voltmeter, ammeter and wattmeter. The PFC should pickup the electrical load.
2. Place PFC in Minesweeping Mode	2. Set the System Mode Select Switch to ″Minesweeping″. Select between the ″manual″ or ″automatic″ with the minesweeping mode switch.
3. Place PFC in Ship Service Mode	3. Set the System Mode Switch to ″DC Ship Service″.

Table 2-2 Operating Procedures - Continued

Operation	Procedural Steps
4. Shut down procedure for PFC	4.1 Reduce the load on the PFC to near zero in accordance with Saturn Gas Turbine Powerplant Assembly NAVSEA manual (S9234-FG-MMM-010) and authorized operating procedures.
	4.2 Throw the circuit breaker to off position. Using the Exciter Regulator Control Switch, de-excite the generator.
	4.3 Run PFC unloaded while monitoring RTDs to allow the PFC to cool down.
	4.4 Shut turbine down in accordance with Saturn Gas Turbine Powerplant Assembly manual (S9234-FG-MMM-010) and authorized operating procedures.
5. Emergency shut down procedure for PFC	For emergency shut down, follow step 4.2 shown in item 4.

CHAPTER 3

FUNCTIONAL DESCRIPTION

3-1. INTRODUCTION.

This chapter gives a functional description of the 1300 KW intermittent duty, 550 KW continuous duty Pulse Frequency Changer (PFC). The PFC is an AC generator used on MCM-1 Class (MCM 9-14) Mine Countermeasure vessels.

3-2. GENERAL DESCRIPTION.

The PFC is an electro-mechanical device which converts mechanical energy into electrical energy. Mechanical energy is provided by a gas turbine which is connected to the PFC through a gear box. A voltage regulator provided with the PFC regulates the output voltage of the PFC to a preset value. A functional diagram for the generator and voltage regulator is shown in Figure 3-1. Refer to Figure 7-1 for identification of components reflected in this chapter. The input for power and sensing, and the field output are controlled by various devices located in the AC Minesweep Switchboard. Refer to in the AC Minesweep Switchboard Manual (SE618-A2-MMA-010) for details on operation.

3-3. PULSE FREQUENCY CHANGER THEORY.

The PFC set consists of an AC generator, a flywheel, a voltage regulator and two coolers. The basic theory underlying the generator is that of a revolving armature synchronous machine which is electrically and mechanically connected to an induction-type frequency changer. Once rated speed of the turbine and generator rotors is attained, the field winding of the revolving armature synchronous machine is energized by a DC voltage. This DC voltage is impressed through the automatic voltage regulator which senses the output voltage from the stator of the frequency changer and regulates accordingly, the input voltage of the main field of the revolving armature synchronous machine. The current flowing through the field coil produces a magnetomotive (MMF) force which results in a magnetic flux orientated as shown in Figure 3-2. The rotating armature conductors cut the flux produced by the field winding in the air gap. This induces a voltage in the rotating armature conductors at a frequency determined by the number of poles and rotational speed of the armature. An increase in field excitation increases the voltage output controlled by the magnetic circuit parameters. The armature winding of the synchronous machine and the rotor winding of the frequency changer are assembled on the same shaft and are connected electrically so as to produce a revolving field in the direction of rotation of the rotor. At rated speed, the winding of the frequency changer is excited with a voltage having a frequency of 210 Hertz (Hz). Additional mechanical energy for pulsing operation of the PFC is obtained from a flywheel mounted to the alternator end of the PFC. The PFC is cooled using two water coolers which remove heat from the generator's ventilating system. Fans mounted to the wound rotors circulate air around the frequency changer and the alternator, through inlets in the sides of the machine and back up to the coolers. Heat is transmitted from the airstream, through the finned outer tubes of the coolers, to the inner tubes. From there the heat is carried away by the circulating water.

3-4. PULSE FREQUENCY CHANGER CONSTRUCTION.

3-4.1 The generator frame consists of two halves bolted together. The turbine side of the frame supports the stator laminations of the frequency changer. The flywheel side of the frame supports the stator laminations, poles and field coils of the alternator.

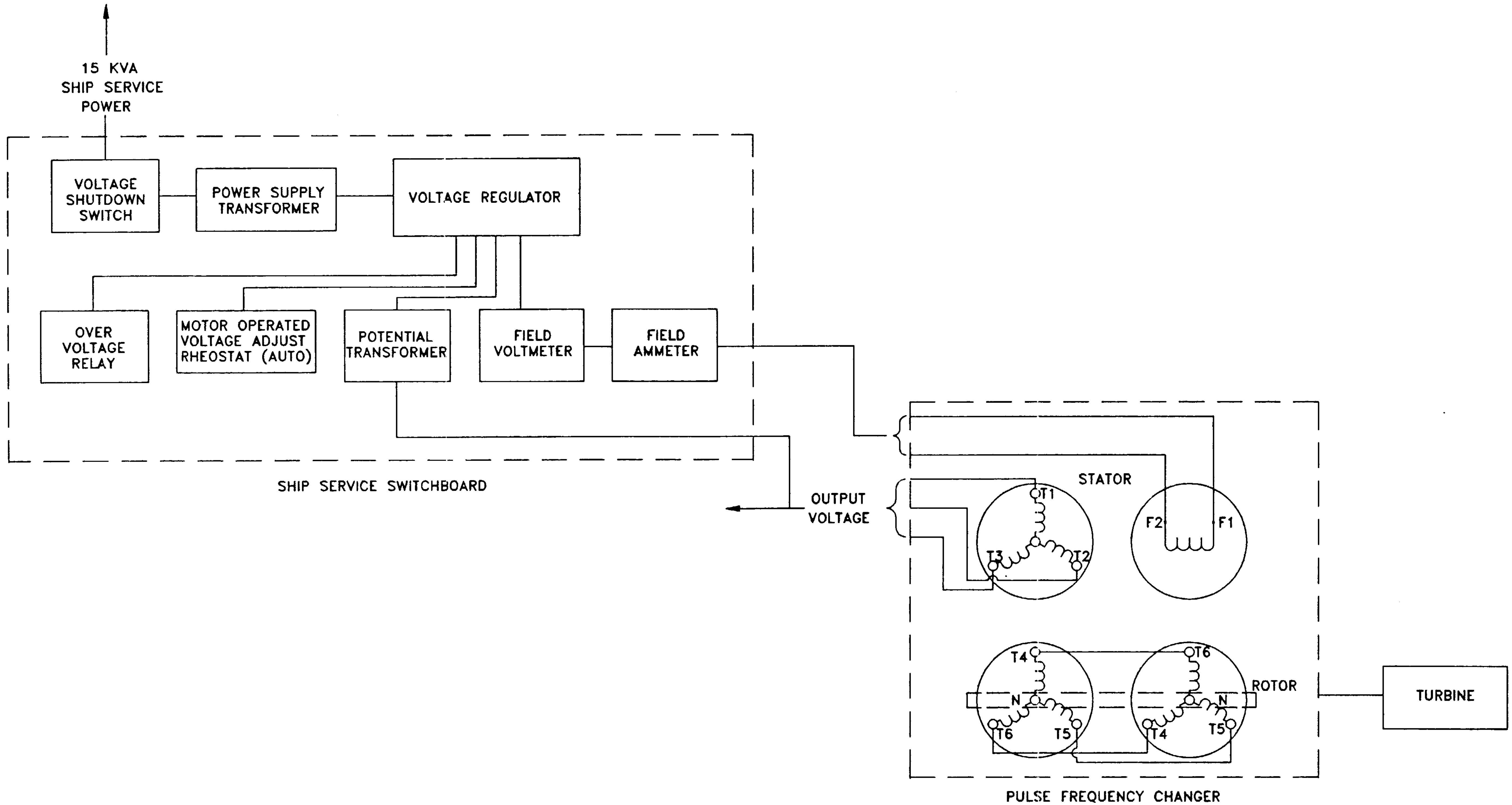


Figure 3-1 PFC Functional Diagram

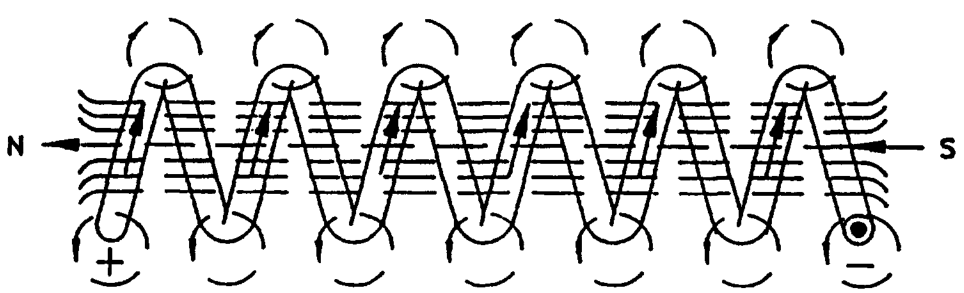


Figure 3-2 Magnetic Field Produced by Energized Field Coil

3-4.2 The Frequency Changer stator assembly is a magnetic structure made from punched laminations (core plate) and two end plates. The laminations are made from low-loss electrical sheet steel. The stator core has semi-open slots and is wound with copper coils to form a double layer lap winding. The core structure is held axially under compression by heavy stator end plates with a step on one end and a circumferential key on the other end. The winding connections are brought to four copper rings (one for each of three phases and one for neutral). Connections from the three phase rings are brought to the frequency changer connection box through bus bars (see Figure 1-1). The bars are stamped A, B and C respectively, as a means to identify their correct phase counterparts.

3-4.3 The alternator stator assembly is constructed from thin ring type laminations forming the magnetic frame supporting the poles. The pole assembly consists of insulated laminations riveted together. Field coils consist of several turns of round copper conductors. Field coils are assembled onto the pole assembly and secured from behind by bolts through the frame. Leads from the field coils are brought to the frame mounted alternator connection box (see Figure 1-1).

3-4.4 The Pulse Frequency Changer has two rotors mounted on a single shaft and spider assembly. The spider, consisting of arms and an inner shell, is shrunk onto the shaft. Two spider keys, one for the frequency changer and one for the alternator, prevent circumferential movement. Axial movement is prevented by a shaft shoulder on the frequency changer side and a spacer and locknut on the alternator side. Both rotors have a magnetic core which consists of steel laminations and end plates. The rotor laminations are punched from low-loss electrical sheet steel. Rotor slots are wound with rectangular copper coils to form a double layer lap bar winding. Connections for three phases and neutral on each rotor are brought to four copper rings. The corresponding rings of both rotors are connected by copper flexibles bolted together.

3-4.5 Resistance temperature detectors are provided for the purpose of monitoring temperatures at various locations throughout the PFC. Resistance values are 100 ohms at 32°F (0°C) and 139.2 ohms at 212°F (100° C). Each detector has two white wires and one red. These wires are brought out to the frame mounted auxiliary connection box (see Figure 1-1), thereby allowing for an external connection to temperature monitoring equipment (see Figure 5-3). All RTDs are connected to temperature monitoring equipment installed in the AC Minesweep Switchboard. Refer to instructions covered in the AC Minesweep Switchboard Manual (SE681-A2-MMA-010) for details on operation. Two resistance temperature detectors are embedded in between the top and bottom coil of each of the three phases of the Frequency Changer stator. One RTD is provided for each bearing for a total of four (two flywheel bearings, one synchronous alternator bearing, and one frequency changer bearing).

3-4.6 Four 250W, 120V space heaters are provided to prevent moisture absorption into the windings during periods when the unit is not in service. The heaters are mounted on the lower half of the frame and are connected in parallel. Leads from the heaters are brought to the frame mounted auxiliary connection box (see Figure 1-1), thereby allowing for connection to external controls located in the AC Minesweep Switchboard. Refer to instructions covered in the AC Minesweep Switchboard Manual (SE681-A2-MMA-010) for details on operation.

3-4.7 The non-magnetic dual flywheel is supported by two pedestal mounted ball bearings. The flywheel is flexibly coupled to the alternator end of the generator.

3-4.8 The automatic voltage regulator controls input voltage of the main field of the revolving armature synchronous machine and output voltage of the frequency changer. The DC voltage from the revolving armature synchronous machine is input to the automatic voltage regulator. The automatic voltage regulator senses the output voltage from the stator of the frequency changer and regulates the input voltage of the main field of the revolving armature synchronous machine, based on a pre-set value. The automatic voltage regulator is made up of an integrated circuit board, silicon transistors, transformers, silicon diodes, resistors and non-electrolytic capacitors. All components are mounted on a formed sheet metal chassis. The voltage regulator may be operated in automatic mode only and has a sensitivity of ± 1% at steady state loads. Power to the voltage regulator is supplied by an external source. The automatic voltage regulator is located in the AC Minesweep Switchboard.

3-4.9 Provided for the purpose of cooling, the PFC is equipped with two identical air-to-water, double tube type, extended fin, heat exchangers; one for the revolving armature synchronous machine and one for the frequency changer. Each cooler consists of a core assembly, two water boxes and four zinc anode pencils. The cooler core consists of a plain inner tube and an internally fluted outer tube which carries aluminum fins. In case of a leaky inner tube, the outer tube provides a passage to the leakage compartment for the water. The ends of the inner tubes are expanded into the outer tube sheets and the ends of the outer tubes are fastened to the inner tube sheets. The spaces provided at each end of the core section, between the inner and outer tube sheets, serve as leak-off compartments. Each leak-off compartment is provided with a tell-tale spacer vent and a tell-tale drain. Water seeping from a tell-tale drain indicates a leak on one of the inner tubes or a loose connection between the inner tube and the outer tube sheet. Flanged connections are provided on the water boxes for inlet and outlet water connections (refer to Navy Standard Technical Manual (NSTM) S9086-KC-STM-010/CH300, Electric Plant, for connections and valve operation details). Two zinc anode pencils are inserted into each water box to minimize electrolytic corrosion of the cooler surfaces which come in contact with the circulating water. Each water box contains a vent and a drain. Both serve to assist in keeping the water boxes dry and free from unnecessary water collection and subsequent water damage.

3-4.10 Style KD1 flexible disc shaft couplings are installed on either side of the AC Generator and a size 403 coupling is installed between the alternator and the flywheel.

3-4.11 The combination of the flywheel, generator rotor, power turbine and gearbox provides a high rotational inertia, resulting in a long duration (within 55 minutes) rundown period upon shut-down of the turbine. The flexible coupling hub nearest the flywheel is provided with an oversized flange to which a 34 inch diameter, 2 inch wide disc is mounted.

CHAPTER 4

SCHEDULED MAINTENANCE

4-1. INTRODUCTION.

4-1.1 PLANNED MAINTENANCE SYSTEM. Required preventive maintenance procedures to be performed on a scheduled basis are provided in Planned Maintenance System (PMS) documentation. OPNAVINST 4790.4 describes this system which also covers departmental and work center record keeping, as well as the Maintenance Index Page (MIP) and Maintenance Requirement Cards (MRCs). MRCs cover scheduled inspection, testing, and lubricating procedures for the equipment covered by this manual.

4-1.2 EXTENT OF COVERAGE. Table 4-1 lists maintenance items, recommended inspections, frequency of inspections, and paragraphs detailing inspection procedures. The scheduled maintenance instructions in this manual are intended to duplicate those furnished in the Planned Maintenance System (PMS). In case of conflicts, the PMS takes precedence. Such conflicts should be reported immediately on the user comment sheet in accordance with the maintenance procedures for this manual.

4-2. SPECIAL TOOLS AND TEST EQUIPMENT.

Special tools and test equipment necessary for carrying out scheduled maintenance procedures for this manual are listed in Table 4-2.

Table 4-1 Maintenance Plan and Inspections

Components	Maintenance Item	Frequency	Reference
Under Normal Operating Conditions			
Pulse Frequency Changer (PFC)	General cleanliness	Daily	4-3
	Insulation resistance	Quarterly	4-4
	Connections	Semi-annually	6-7
Bearings	Lubrication	After first 6 months of operation, and then annually	4-5
	Replacement	After 10, 000 hours total service	6-4
Under Idle Conditions			
PFC	Insulation resistance	Monthly	
Bearings	Lubrication	Prior to operation unless records show previous lubrication within one year	4-5.2
	Rotate shaft	Monthly	4-6.2

Table 4-2 Special Tools and Test Equipment

Tools Materials and Test Equipment	Application
Multimeter (Fluke Model 8000A or equiv).	Measure voltage, Check continuity, etc.
500V Megger (Biddle Series 1 Insulation Resistance Meter or equiv).	Measure winding insulation resistance.
Solvent (FED-SPEC-P-D-680, Type 2)	PFC cleaning.
Grease Cup, (4891-1, Size 0 Female)	
Grease (DOD-G-24508)	Lubricate bearings.

⚠ WARNING

High voltages capable of causing death are used in this equipment. Extreme caution should be used when servicing either the power supplies or their load components.

⚠ WARNING

Heater circuit must be deenergized before servicing generator. Severe injury or death may result from contact with live electrical leads.

4-3. CLEANING.

CAUTION

Material that might deposit lint should not be used to clean PFC Lint may block ventilation openings resulting in electrical or mechanical failure of PFC or related equipment.

To maintain cleanliness of PFC, proceed as follows:

1. Visually inspect the surface of PFC for spills, dirt, oil and other foreign material.
2. If necessary, wipe PFC surface, using clean rags and approved solvent per FED-SPEC-P-D-680, Type 2.
3. Keep ventilation openings clear using vacuum cleaner and brush.

4-4. INSULATION RESISTANCE.

4-4.1 Insulation resistance to ground should be checked quarterly with an approved megger. To check insulation resistance, proceed as follows:

1. Determine PFC winding temperatures from installed RTD.

⚠ WARNING

Before attempting any maintenance or repair work, the PFC, the turbine, and its controls should be deenergized and tagged OUT OF SERVICE. Severe injury to personnel and damage to equipment may result from starting the turbine while the PFC is being serviced.

WARNING

All electrical leads should be considered energized until positively proven they are deenergized. Severe injury or death may result from contact with live electrical leads.

2. Deenergize/Deactivate all power sources including the PFC circuit breaker, starting circuit/system, and PFC space heaters, Tag OUT OF SERVICE.

3. Remove alternator connection box cover located on the side of PFC.

4. Test all leads with multimeter to ensure all circuits are deenergized.

5. Disconnect field leads from power supply.

6. Using an approved megger, take megger reading from F2 to ground and F1 to ground (refer to Figure 5-3).

7. Remove frequency changer connection box cover located on the side of the PFC.

8. Pull circuit board in accordance with AC Switchboard NAVSEA manual (SE681-A2-MMA-010).

9. Test all leads with multimeter to ensure that all circuits are deenergized.

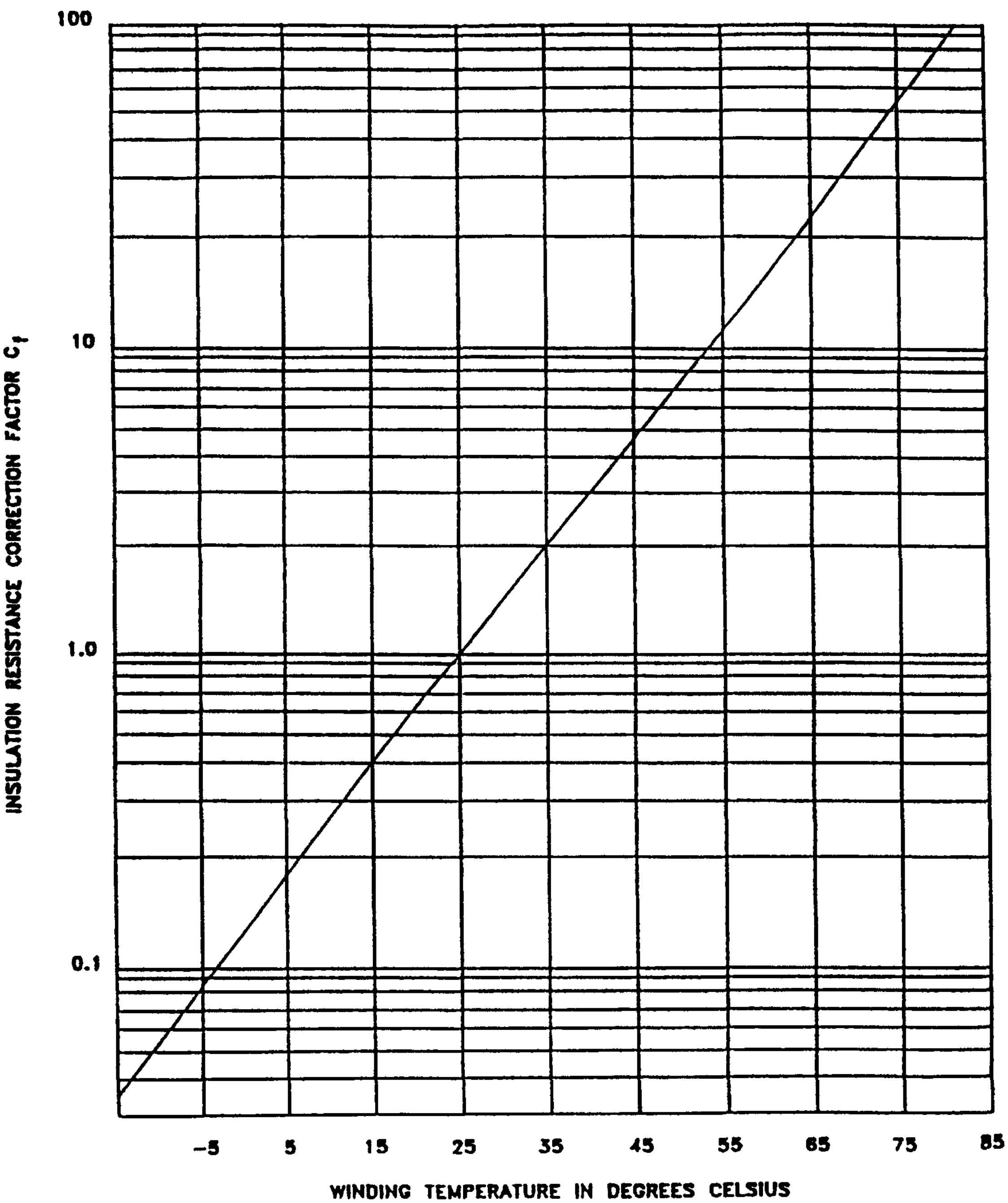
10. Using an approved megger, take megger readings from T1 to ground, T2 to ground, and T3 to ground (refer to Figure 5-3).

11. Remove frame side cover from port (left) side of PFC (refer to Figure 4-2).

12. Rotate rotor until marked test point is accessable. Using an approved megger, take megger reading from test point to ground.

13. Refer to Figure 4-1 and determine correct insulation resistance, based on temperature, from the graph.

14. Remove safety tags and restore equipment to ready condition by reversal of steps 2 through step 5, step 7, step 8, and step 11.



$R_{25} = C_t \times R_{meas.}$

WHERE

R_{25} = INSULATION RESISTANCE IN MEGOHMS CORRECTED TO 25 DEGREES CELSIUS.

$R_{meas.}$ = MEASURED INSULATION RESISTANCE IN MEGOHMS.

Figure 4-1 Insulation Resistance - Temperature Correction

4-4.2 Whenever insulation resistance drops to 25 megohms, it is recommended that a complete check be made of the generator. Refer to Chapter 6, paragraph 6-7.

4-5. LUBRICATION.

Lubrication of all bearings may be performed while the PFC is operating.

CAUTION

Bearings should not be over-greased. Too much grease will cause bearings to churn and overheat, resulting in possible mechanical failure of PFC.

4-5.1 The bearings in the PFC are grease lubricated. The unit has been shipped with the proper amount of grease. The bearings should be lubricated prior to PFC operation if the PFC has been in storage or in extended shutdown. If available records show that the bearings have been lubricated within one year, lubrication is not required. Determination of the relubrication intervals depends wholly on operating conditions. The recommended relubrication interval for the PFC is after 6 months of operation and once a year thereafter, unless required more frequently as determined by experience.

4-5.2 Lubricate bearings as follows (refer to Figure 4-3 for location of lubrication points):

NOTE

Grease cup for each bearing is Size 0 Female. Bearing lubricant for the grease lubricated bearings shall conform to DOD-G-24508 and is available through NSN 9150-00-149-1593.

1. Select appropriate grease cup and clean it thoroughly. Using a clean spatula, fill cup with grease. Screw cup together, squeezing out a ribbon of grease until clean grease emerges.

2. Remove caps or plugs from the grease fill and drain lines. Examine lines for any hardened grease. Remove hardened grease or foreign matter as necessary.

3. Remove fill line pipe nipple, clean, and completely refill with new grease. Reinstall fill line.

4. Inject one cupful of grease through fill line into bearing until grease cup is all the way down.

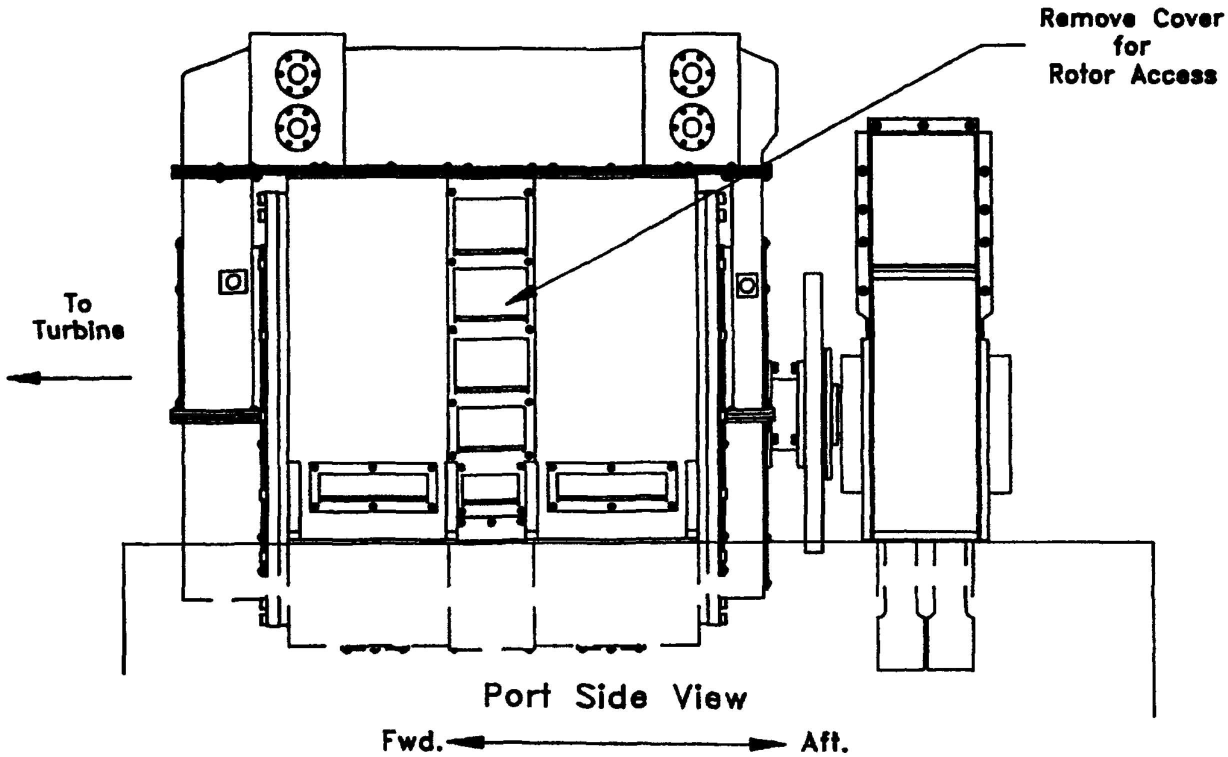


Figure 4-2 PFC Rotor Access for Insulation Resistance Check

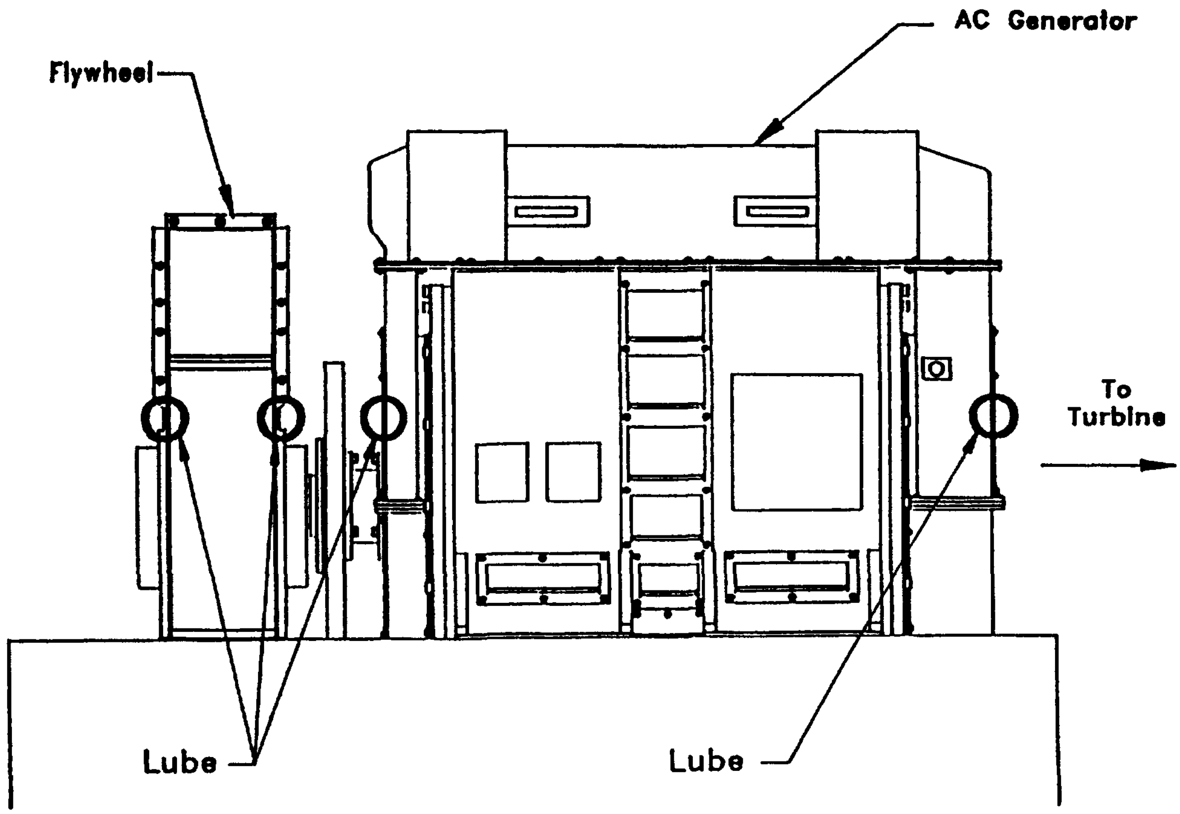


Figure 4-3 PFC Lubrication Points

5. Screw down on grease cup as far as it will go. Additional grease should not be required.
6. Remove grease cup and install supply passage pipe plug. Monitor bearing temperature for a minimum of one hour. When grease no longer emerges from drain line, replace caps or plugs in grease fill and drain lines.

4-5.3 The KD1 flexible disc couplings are non-lubricated and therefore require minimal maintenance. Periodic checks are recommended to make sure all parts are in good operating order.

4-6. IDLE EQUIPMENT.

4-6.1 To determine whether the equipment is in satisfactory operating condition, insulation resistance measurements should be taken monthly (refer to paragraph 4-4). If the insulation resistance of any component shows a marked decrease, corrective measures described in paragraph 6-4 should be initiated immediately to forestall equipment damage. Lubricate in accordance with paragraph 4-5.

4-6.2 The shaft on stored equipment should be rotated twelve turns per month. Installed equipment should be operated weekly.

CHAPTER 5

TROUBLESHOOTING

5-1. INTRODUCTION.

5-1.1 This chapter contains practical troubleshooting information for The Pulse Frequency Changer (PFC). Table 5-1 lists symptoms most commonly encountered, probable causes and suggested remedies. It should be noted that many apparent trouble symptoms are actually the result of improper operation of the PFC. Prior to troubleshooting for faults, ensure that the PFC and related systems are being used in strict accordance with the operating procedures outlined in this, and associated technical manuals.

5-1.2 Figure 5-1, Figure 5-2, and Figure 5-3 are schematic diagrams provided to assist in troubleshooting the PFC. Refer to Chapter 6 for repair procedures.

NOTE

For all symptoms, immediate action shall be to shut down the PFC.

Table 5-1 Troubleshooting Chart

Symptom	Probable Cause	Remedy
1. Voltage does not build up to rated value.	1.1 Voltage adjust switch faulty.	1.1 Replace switch. Refer to AC Switchboard: NAVSEA manual SE681-A2-MMA-010. (Organizational Level Function).
	1.2 Turbine not up to rated speed.	1.2 Adjust turbine to rated speed. Refer to Saturn Gas Turbine Powerplant Assembly: NAVSEA manual S9234-FG-MMM-010. (Organizational Level Function).
	1.3 No voltage or improper voltage to input terminal 3 and 4 on voltage regulator.	1.3 Verify wiring; correct as required. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function).
	1.4 No connections to F+ and F- on the voltage regulator.	1.4 Verify wiring; correct as required. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function).
	1.5 Generator output shorted or heavily loaded.	1.5 Remove load or short. Refer to Table-2. (Organizational Level Function.)

Table 5-1 Troubleshooting Chart - Continued

Symptom	Probable Cause	Remedy
2. Voltage high, uncontrollable with voltage adjust rheostat.	2.1 No sensing voltage on voltage regulator terminals E1, E3 (and E2 if three phase sensing is used).	2.1 Verify wiring; correct as required. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.2 Voltage regulator sensing connections set to wrong tap.	2.2 Connect to correct tap. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.3 Faulty voltage regulator printed circuit (PC) board.	2.3 Replace. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 5-2, paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.4 Voltage regulator silicon control rectifiers (SCR) faulty.	2.4 Replace SCRs or regulator. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 5-2, paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.5 Voltage regulator voltage range adjust (R14) set too high.	2.5 Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.6 Voltage regulator adjust rheostat resistance too low.	2.6 Increase resistance. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.7 Improper connection of voltage regulator sensing leads to generator.	2.7 Verify wiring; correct as required. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.8 Voltmeter inaccurate.	2.8 Verify operation or replace. (Organizational Level Function.)
	2.9 Defective voltage regulator.	2.9 Replace. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 5-2, paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.10 R14 set too low on voltage regulator.	2.10 Adjust. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	2.11 Turbine not up to rated speed.	2.11 Adjust turbine to rated speed. Refer to Saturn Gas Turbine Powerplant Assembly: NAVSEA manual S9234-FG-MMM-010. (Organizational Level Function).

Table 5-1 Troubleshooting Chart - Continued

Symptom	Probable Cause	Remedy
3. Poor regulation.	3.1 Voltage at terminals 3 and 4 of regulator is too low at nominal generator voltage.	3.1 Adjust voltage. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	3.2 Output voltmeter at different location than regulator sensing (voltage drop in leads or wrong phase).	3.2 Connect voltmeter at same point as regulator sensing. Refer to Figure 5-1, Figure 5-2 and Figure 5-3. (Organizational Level Function.)
	3.3 Waveform distortion due to harmonic content in generator voltage. (Regulator senses average voltage; meter may be indicating root-means-square (RMS) values).	3.3 Correct distortion in accordance with Influence Minesweeping Waveform Generator: NAVSEA manual SW565-AB-MMM-010. (Organizational Level Function.)
	3.4 Parallel Compensation not disabled.	3.4 Place jumper between terminals 1 and 2L.
	3.4 Parallel Compensation not disabled.	3.4 Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	3.5 Turbine not up to rated speed.	3.5 Adjust turbine to rated speed. Refer to Saturn Gas Turbine Powerplant Assembly: NAVSEA manual S9234-FG-MMM-010. (Organizational Level Function).
	3.6 Fault in generator.	3.6 Verify operation and correct if necessary. Refer to paragraph 6-4.4. and paragraph 6-7. (Organizational Level Function.) If the above reveals a fault in the generator, disassemble, locate fault and repair. (Depot Level Function-Authorized for accomplishment by Depot Level Activities only.)
	3.7 Faulty voltage regulator PC board.	3.7 Replace. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 5-2, paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	3.8 Faulty SCRs or diodes.	3.8 Replace SCRs and/or diodes or regulator. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 5-2, paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)

Table 5-1 Troubleshooting Chart - Continued

Symptom	Probable Cause	Remedy
4. Voltage unstable.	4.1 Stability adjust R11 misadjusted on voltage regulator.	4.1 Adjust to proper setting. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	4.2 Stability selection on voltage regulator not correct.	4.2 Change selection. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	4.3 Faulty voltage regulator PC board.	4.3 Replace. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	4.4 Fault in generator.	4.4 Verify operation and correct if necessary. Refer to paragraph 6-4.4. and paragraph 6-7. (Organizational Level Function.) If the above reveals a fault in the generator, disassemble, locate fault and repair. (Depot Level Function-Authorized for accomplishment by Depot Level Activities only.)
5. Voltage recovery slow with load.	5.1 R11 misadjusted on voltage regulator.	5.1 Adjust to faster setting. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	5.2 Stability selection on voltage regulator too slow.	5.2 Change selection. Refer to Figure 5-1, Figure 5-2, Figure 5-3 and paragraph 6-3 and paragraph 6-6. (Organizational Level Function.)
	5.3 Slow turbine response.	5.3 Adjust turbine response. Consult Saturn Gas Turbine Powerplant Assembly NAVSEA manual: S9234-FG-MMM-010. (Organizational Level Function.)
6. Generator overheats.	6.1 Mechanical obstruction that prevents rotor from turning.	6.1 Examine and clean unit thoroughly. Check air gap. Check for bearing failure or misalignment. Locate and remove any obstruction. Refer to paragraph 6-4.4 and paragraph 6-7. (Intermediate Level Function-Authorized for accomplishment by Intermediate Level or higher activity.)
	6.2 Obstruction in air gap.	6.2 Clean unit thoroughly. Check for any mechanical failure and remove any air gap obstruction. Refer to paragraph 6-4.4 and paragraph 6-7. (Intermediate Level Function-Authorized for accomplishment by Intermediate Level or higher activity.)
	6.3 Unit is overloaded.	6.3 Check current in each phase. Compare with nameplate rating. If current is balanced and exceeds that shown on nameplate, unit is overloaded. (Organizational Level Function.)

Table 5-1 Troubleshooting Chart - Continued

Symptom	Probable Cause	Remedy
7. Bearings overheat.	7.1 Improper grease.	7.1 Replace grease with that conforming to DOD-G-24508. Refer to Chapter 4. (Organizational Level Function.)
	7.2 Overgreased bearings.	7.2 Check amount of lubricant in bearing chamber. 30% to 50% is proper. If overgreased, remove drain pipe cap and remove grease until proper amount is in unit. (Refer to bearing nameplate for capacity.) Refer to Chapter 4. (Organizational Level Function.)
8. Vibration.	8.1 Misalignment.	8.1 Check air gap. Realign generator. Refer to paragraph 6-2. (Organizational Level Function.)
	8.2 Faulty bearings.	8.2 Check bearings. Replace bearings if deemed necessary. Before replacing bearings, check noise monitoring system baseline. Refer to paragraph 6-4.4.1 and paragraph 6-4.3.2. (Organizational Level Function.)
	8.3 Sprung shaft.	8.3 Remove and replace shaft. Refer to paragraph 6-4. (Depot Level Function-Authorized for accomplishment by Depot Level Activities only.)
	8.4 Short circuited stator winding or open rotor.	8.4 Check resistance between phases. Inspect squirrel cage for continuity. Refer to Figure 5-3. (Organizational Level Function.)
	8.5 Improper mounting.	8.5 Check mounting bolts and shims on generator. Re-shim and tighten any loose mounting bolts. Refer to paragraph 6-2and Figure 8-1. (Organizational Level Function.)
	8.6 Unbalanced current.	8.6 Check terminal voltage and current at generator power supply. Refer to Figure 5-3. (Organizational Level Function.)

Table 5-1 Troubleshooting Chart - Continued

Symptom	Probable Cause	Remedy
9. Low insulation resistance.	9.1 Oil or grease soaked windings.	9.1 Disassemble generator. Clean and dry. Reassemble generator. Check insulation resistance before restarting generator. Refer to paragraph 6-7. (Intermediate Level Function-Authorized for accomplishment by Intermediate Level or higher activity.)
	9.2 Water soaked windings.	9.2 Disassemble generator. Clean and dry. Reassemble generator. Recheck insulation resistance before restarting generator. Refer to paragraph 6-7. (Intermediate Level Function-Authorized for accomplishment by Intermediate Level or higher activity.)
	9.3 Excessive vibration.	9.3 Refer to ″Troubleshooting-Vibration″. (Organizational Level Function.)
	9.4 Wrong voltage.	9.4 Check terminal voltage with nameplate data. Refer to Figure 5-3. (Organizational Level Function.)
	9.5 Mechanical abrasions. **NOTE** Abrasions could be caused by bearing failure, bent or sprung shaft, or obstruction in air gap.	9.5 Check air gap for misalignment or obstruction. Locate and repair damaged areas of insulation. Refer to paragraph 6-2 and paragraph 6-4. (Depot Level Function-Authorized for accomplishment by Depot Level Activities only.)

5-2. VOLTAGE REGULATOR BASIC OPERATIONAL CHECKOUT.

During troubleshooting of the voltage regulator, the importance of eliminating wiring errors cannot be overemphasized. Incorrect connections can result in many of the trouble symptoms listed in Table 5-1 and can cause damage to, or even failure of the voltage regulator. Once wiring errors are ruled out as a possible cause of trouble, the following basic test can be performed to determine if the voltage regulator is operational. (Refer to Figure 5-2 and Figure 5-4):

1. Select single phase and position taps to 480 VAC.
2. Connect voltage regulator as shown in Figure 5-4, using three light bulbs connected in series. The three light bulbs should be identical and rated for 120V and less than 200W.
3. Adjust the Voltage Adjust Rheostat for maximum resistance.
4. Apply power. The light bulbs may flash on momentarily when power is applied. This is normal.
5. Slowly adjust the Voltage Adjust Rheostat toward minimum resistance. The light bulbs should come to near full brilliance before the Voltage Adjust Rheostat reaches minimum resistance.
6. At the regulating point, a small change in the Voltage Adjust Rheostat should turn the light bulbs on or off.

7. If the voltage regulator does not react as described in steps 5 and steps 6, there is a fault in the voltage regulator itself. Refer to Table 5-1 for further steps in troubleshooting the voltage regulator.

8. After completing the previous step and basic operation has been verified, connect the regulator sensing transformer to the original taps before reconnecting the voltage regulator to the system.

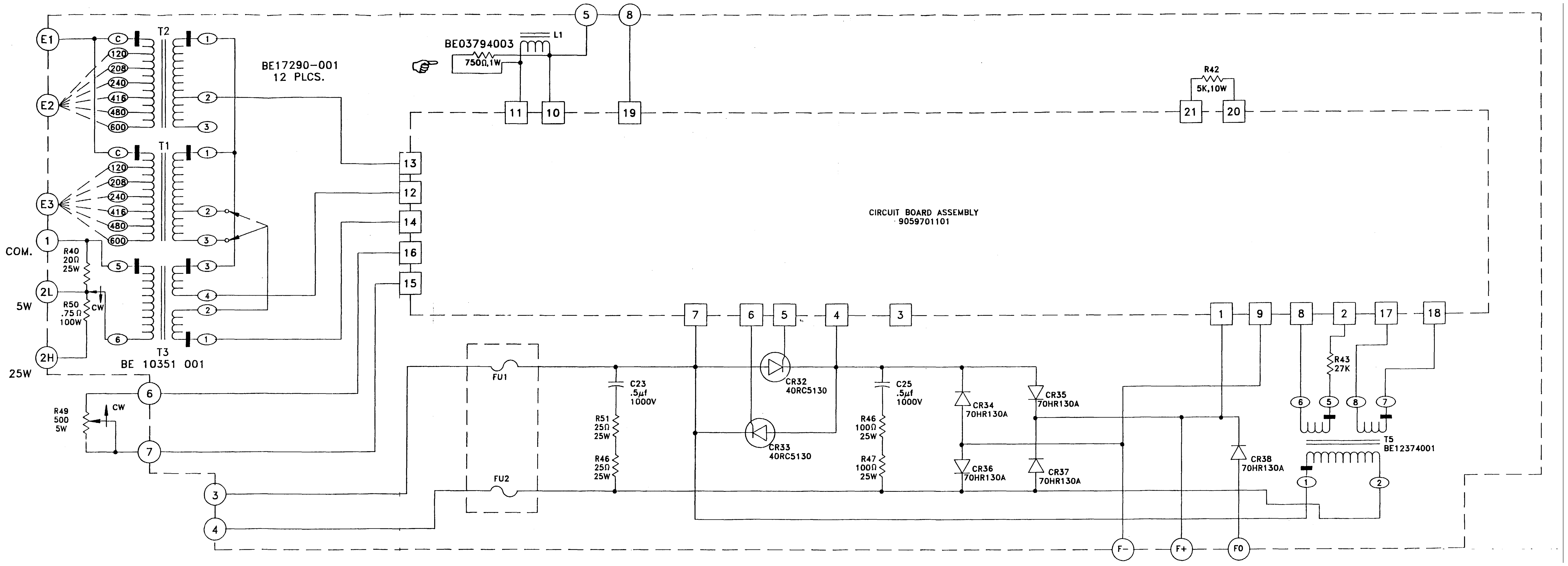


Figure 5-1 Voltage Regulator Schematic

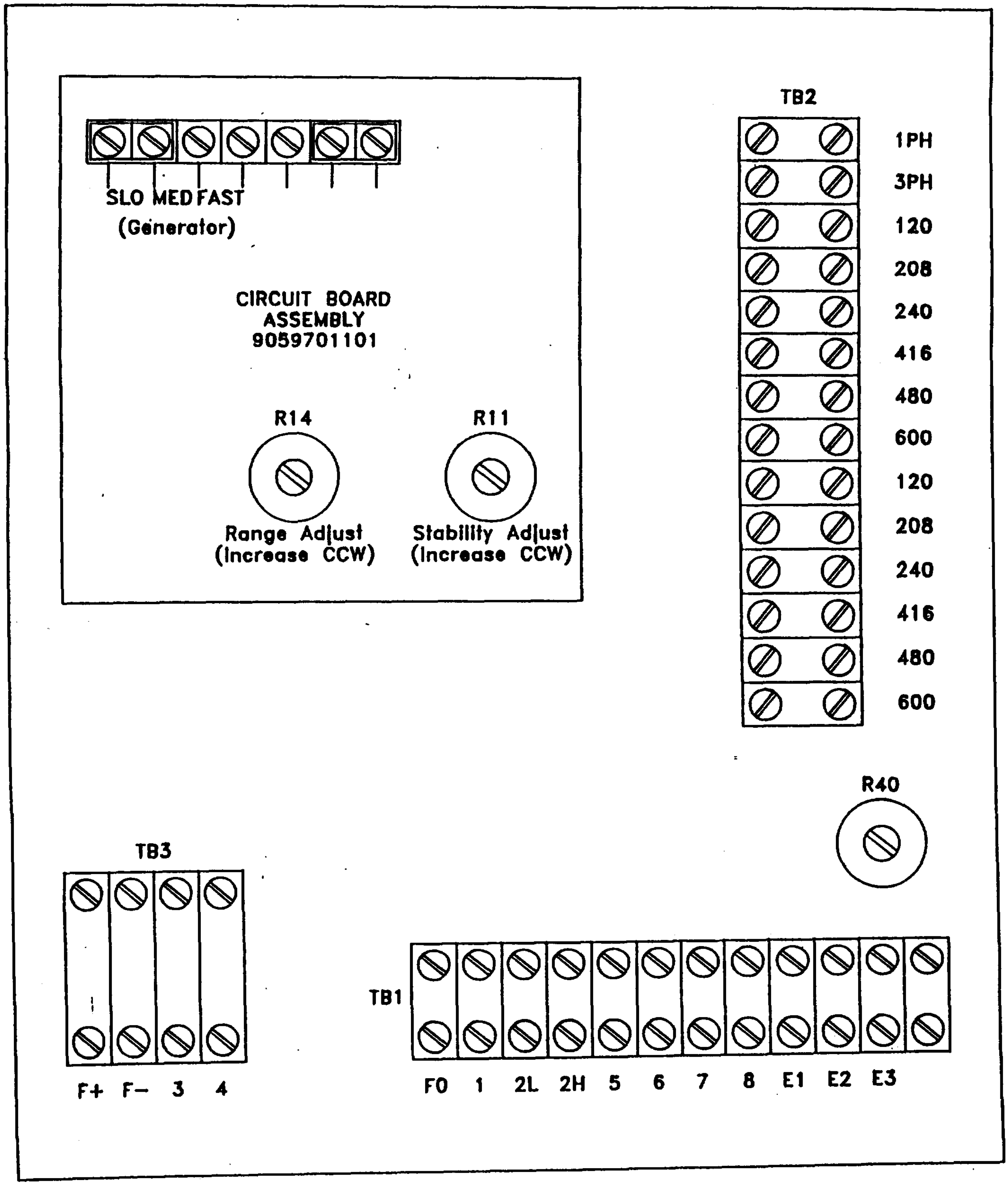


Figure 5-2 Voltage Regulator Circuit Board Assembly Schematic

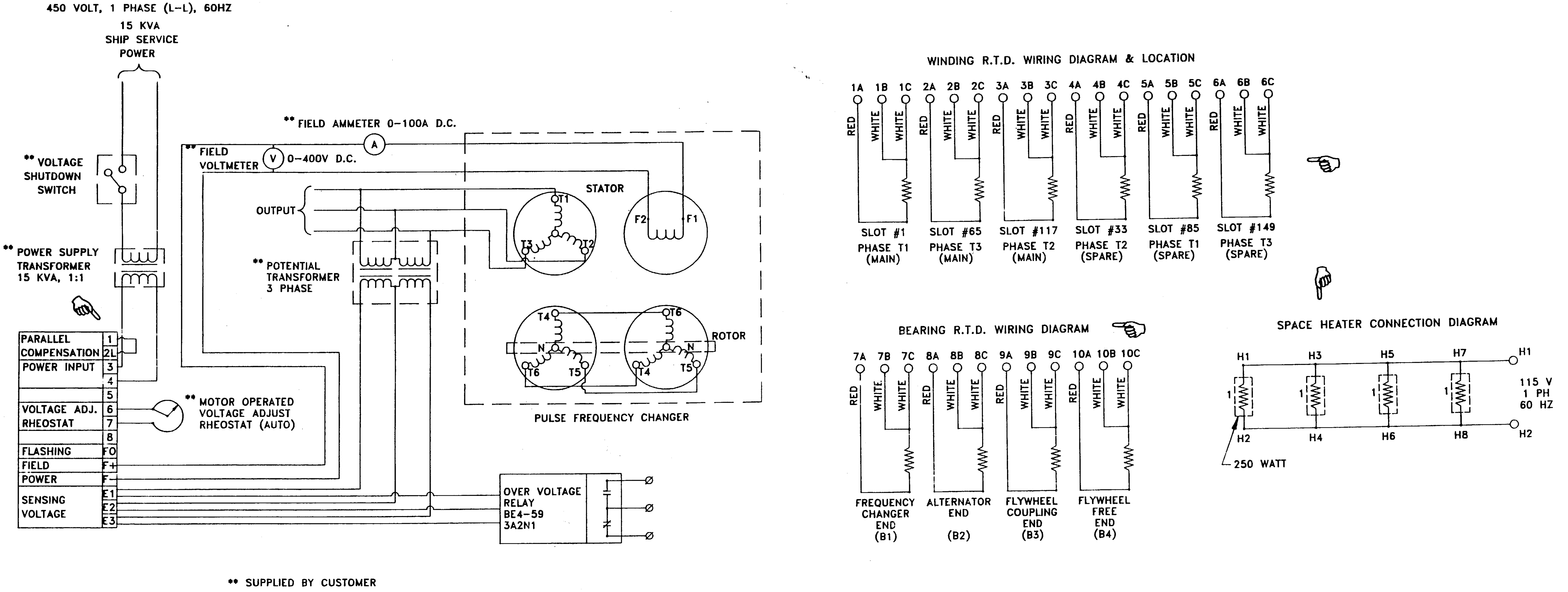


Figure 5-3 PFC External Connection Schematic

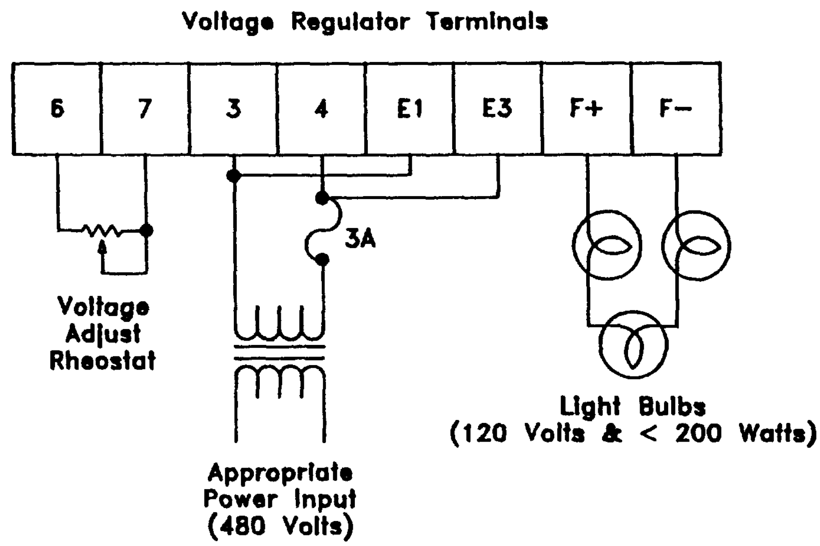


Figure 5-4 Voltage Regulator Basic Operational Checkout Connection Schematic

CHAPTER 6

CORRECTIVE MAINTENANCE

SECTION I.

ADJUSTMENTS AND ALIGNMENTS

6-1. INTRODUCTION.

This chapter is divided into two sections. Section I provides procedures for adjustments and alignments of the Nonmagnetic AC Generator, Pulse Frequency Changer (PFC). Section II provides procedures for removal, disassembly, cleaning, inspection, repair, reassembly, reinstallation and checkout of the PFC. Special tools, materials and test equipment are listed in Table 6-1.

Table 6-1 Special Tools, Materials, and Test Equipment

Tools, Materials, and Test Equipment	Procedures
Multimeter (Fluke Model 8000A or equiv.)	Voltage Regulator Repair. Refer to paragraph 6-6.
	Generator Checkout. Refer to paragraph 6-7.
500V Megger (Biddle Series 1 Insulation Resistance Meter or equiv.)	Generator Checkout. Refer to paragraph 6-7.
Bearing Puller	Bearing replacement. Refer to paragraph 6-4.3.2 and paragraph 6-4.4.1.
Mechanic's Stethoscope	Bearing replacement. Refer to paragraph 6-7.2.
Oscilloscope (Tektronix Model 2211 Dig. Storage Osc. or equiv.)	Voltage regulator repair. Refer to paragraph 6-6.
Dial Indicator Set	Shaft alignment. Refer to paragraph 6-2.
1000 ft-lb Torque Wrench	Generator installation. Refer to paragraph 6-4.5.
Rigging Equipment rated to 28, 000 pounds	Generator removal. Refer to paragraph 6-4.
350 ft-lb Torque Wrench	Torsional coupling assembly. Refer to paragraph 6-5.3.
Solvent (FED-SPEC-P-D-680, type 2)	Generator cleaning. Refer to paragraph 6-4.4.

6-2. AC GENERATOR - SHAFT ALIGNMENT.

When installing the PFC after repairs or replacement, the generator shaft must be carefully aligned with the turbine shaft and the flywheel shaft prior to installing the couplings. Use the following alignment procedure to align the PFC. Proceed as follows:

1. (Refer to Figure 8-1.) Loosely mount the generator after insuring all mounting pads are clean and unpainted.
2. Visually align the generator, flywheel and turbine. Place shim stock under the flywheel and turbine as necessary to ensure a level, accurate fit. Use taper doweling to prevent generator misalignment.
3. Ensure coupling hub spacing is 2.125 ± .015 inches. (Refer to Figure 6-1.) Adjust as necessary.
4. (Refer to Figure 6-1.) Use extension arms and jigs to attach dial indicator to the generator coupling hub flange.
5. Adjust jig so that dial indicator button contacts the face of the opposite hub's flange as shown in Figure 6-1.
6. Place a reference mark on the outside diameter of the coupling hub at the indicator button.

7. Rotate both shafts while keeping the dial indicator button at the reference mark on the coupling hub. Note the reading on the dial indicator every ninety degrees and record on test data recording sheet. (Figure 6-2.)

8. Adjust equipment until readings are within .010 inch Total Indicated Runout (TIR).

9. With indicator now placed on the opposite coupling hub, verify alignment data by repeating steps 4 and steps 5. Adjust as necessary.

10. Use extension arms and jigs to attach dial indicator to the generator coupling hub flange as shown in Figure 6-1b.

11. Repeat steps 4 through steps 9.

12. Remove dial indicator, extension arms and jigs.

13. Repeat steps 1 through steps 12 for aligning the flywheel to the generator.

14. Return the ship to pre-test condition.

6-3. VOLTAGE REGULATOR ADJUSTMENTS.

6-3.1 The Voltage Regulator, which is supplied loose, is to be mounted in the minesweep switchboard. The input for power and sensing and the field output are controlled by various devices located in the AC minesweep switchboard. Refer to AC Minesweep Switchboard manual: NAVSEA SE681-A2-MMA-010 for details.

6-3.2 The voltage regulator normally needs no adjustments other than the following (refer to Figure 5-1 and Figure 5-2):

1. Check that the wire marked PH is connected to the terminal marked 3 PH on the regulator terminal board.

2. Check that the wires marked E2 and E3 (white) are connected to ″120″ Volt terminals on the regulator.

3. Connect 450 VAC, single phase ship’s service to terminals 3 and 4.

4. Connect field winding leads F1 and F2 across terminals F+ and F- on the regulator.

5. See that terminals 1 and 2L on the regulator are shorted. This disables the parallel compensation feature.

6. Using the voltage adjust switch, ensure that the motorized potentiometer is set for the minimum voltage condition.

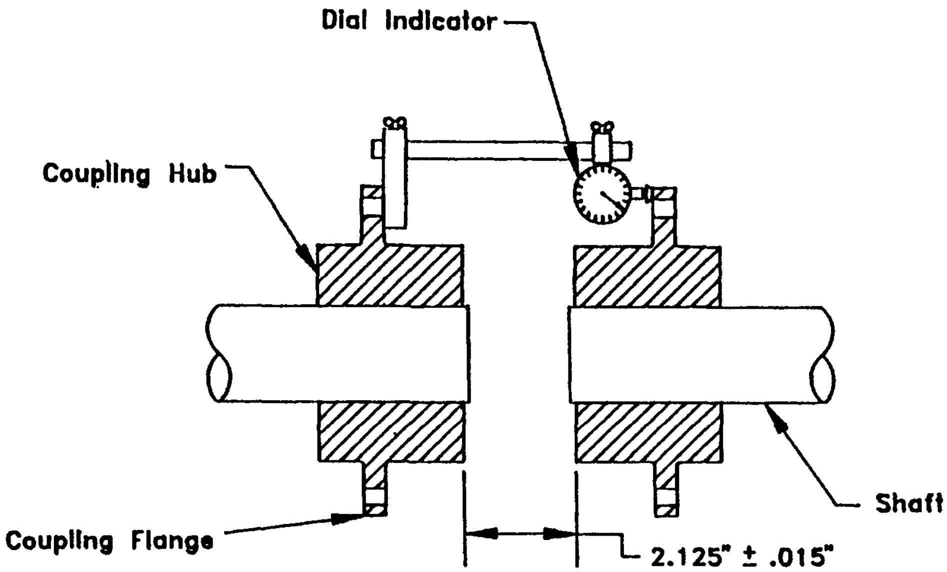


Figure 6-1a Angular Alignment

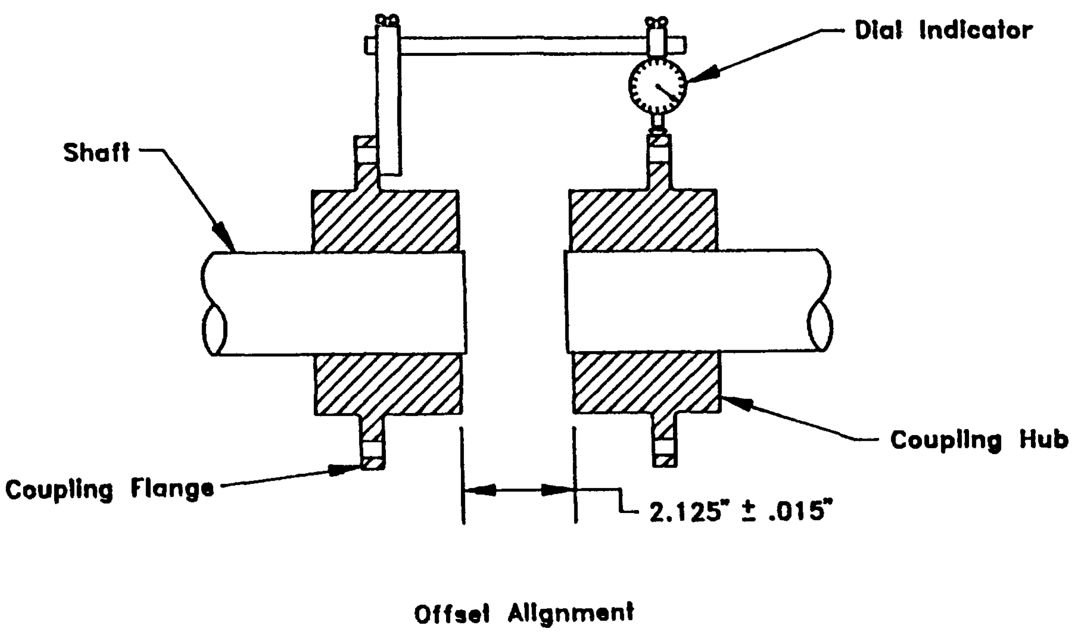
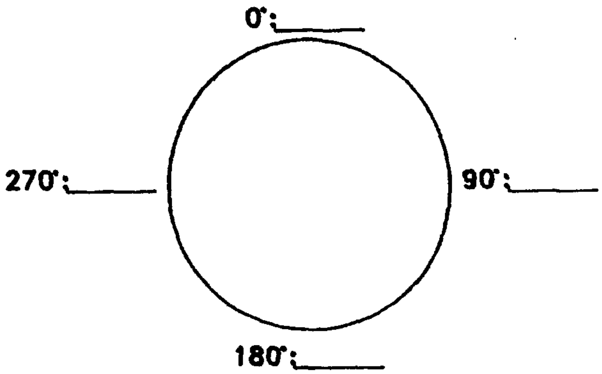
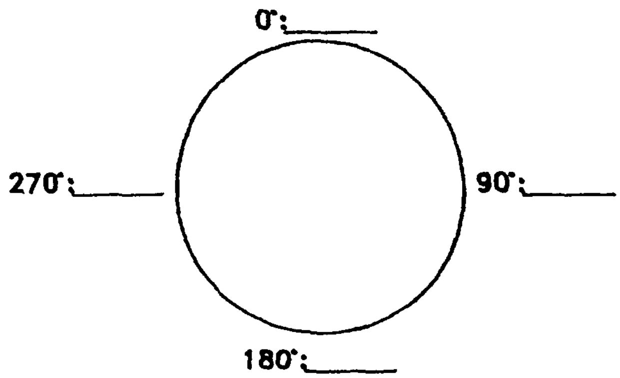


Figure 6-1 Dial Indicator Placement



Location: ____________________
As viewed from: ____________________



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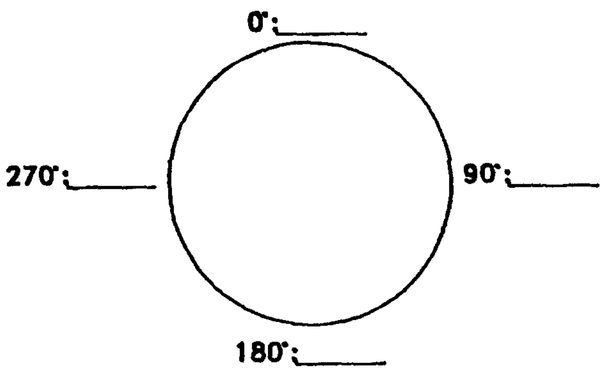

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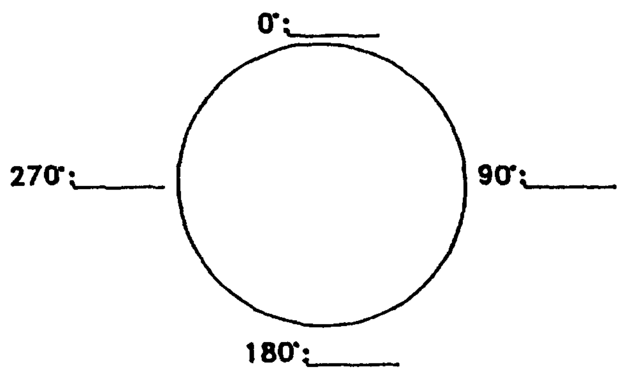


Location: ____________________
As viewed from: ____________________

Checked by: ____________________
Date: ____________________

Figure 6-2 Alignment Data Sheet

SECTION II.

REPAIR PROCEDURES

6-4. PFC REPAIRS.

⚠ WARNING

Before attempting any maintenance or repair work, the PFC, the turbine, and its controls should be deenergized and tagged OUT OF SERVICE. Severe injury to personnel and damage to equipment may result from starting the turbine while the PFC is being serviced.

⚠ WARNING

All electrical leads should be considered energized until positively proven they are deenergized. Severe injury or death may result from contact with live electrical leads.

6-4.1 Removal of the AC Generator is normally a depot level maintenance function. To remove the AC generator from the PFC for repairs, proceed as follows, refer to Figure 7-1:

1. Deenergize PFC and tag: ″OUT OF SERVICE″.
2. Uncouple the AC generator from the turbine in accordance with paragraph 6-5.1.
3. Uncouple the AC generator from the flywheel in accordance with paragraph 6-5.1.
4. Refer to NAVSEA drawings for ship Work Breakdown Structure (SWBS) Group 311 for the applicable hull number. Disconnect all water lines and electrical leads, including Resistance Temperature Detectors (RTDs) and space heaters. Attach marking tags on all leads for easy identification when reinstalling AC generator.

⚠ WARNING

The AC generator weighs approximately 20,000 pounds. Using lifting equipment with a capacity less than this could result in serious injury to personnel or damage to equipment.

5. Remove screws (1) and lockwashers (2) attaching the alternator end top air duct cover (3) to the alternator end cooler mounting plate (4).
6. Remove screws (5) and lockwashers (6) attaching the frequency changer end top air duct cover (7) to the frequency changer end cooler mounting plate (8).
7. Remove screws (9) and lockwashers (10) attaching the center cooler cover (11) to the cooler mounting plates (4 and 8), and the cooler assemblies (14).

8. Remove screws (12) and lockwashers (13) securing each of the two cooler assemblies (14) to the mounting plates (4 and 8). Remove both cooler assemblies (14) using proper lifting equipment.
9. Remove screws (15) and lockwashers (16) securing the two cooler mounting plates (4 and 8) to the frequency changer and alternator frame assembly (17).
10. Remove the two cooler mounting plates (4 and 8) thereby providing access to the four AC generator lifting lugs.
11. Remove socket head capscrews (18) attaching the AC generator to the mounting base.
12. Using suitable lifting gear, the AC generator may now be removed.

6-4.2 To disassemble the AC generator for repairs, proceed as follows (refer to Chapter 7, Figure 7-1):

1. Match mark all adjoining parts when disassembling AC generator.
2. To access the alternator bearing RTD, remove screw (19) and lockwashers (20) which attach alternator end top air duct cover (21) to the alternator end top air duct (22). Remove air duct cover (21).
3. Remove outside bearing RTD from alternator end bearing cap (23).
4. To access the frequency changer bearing RTD, remove screws (24) and lockwashers (25) which attach the frequency changer end top air duct cover (26) to the frequency changer end top air duct (27). Remove frequency changer end top air duct cover (26).
5. Remove outside bearing RTD from frequency changer end bearing cap (28).
6. Remove screws (34) and lockwashers (35) which secure the top air ducts (22 and 27).
7. Using lifting equipment capable of supporting 100 pounds, remove the top air ducts (22 and 27) from both ends of AC generator.
8. Remove screws (31) and lockwashers (32) which attach the alternator end bottom air duct cover (36) to the air duct (37).
9. Attach and snug up lifting equipment to the alternator end bottom air duct (27) on the alternator end of the AC generator. Remove screws (38) and lockwashers (39) which secure the alternator end bottom air duct (37).
10. Remove the alternator end bottom air duct (37).
11. Remove screw (40) and lockwasher (41) which attach the frequency changer end bottom air duct cover (42) to the frequency changer bottom air duct (43).
12. Attach and snug up lifting equipment to the frequency changer bottom air duct (43) on the frequency changer end of AC generator. Remove screws (44) and lockwashers (45) which secure the frequency changer bottom air duct (43).
13. Remove frequency changer end bottom air duct (43).
14. Remove alternator end coupling (105).
15. Remove socket head capscrews (46) and lockwashers (47) from the alternator end outside bearing cap (23).
16. Remove alternator end outside bearing cap (23).
17. Remove socket head capscrews (48) and lockwashers (49) from the frequency changer end outside bearing cap (28).

18. Remove frequency changer end outside bearing cap (28).
19. On the alternator end, remove the two socket head capscrews (50) and lockwashers (51) which extend through the alternator end housing (52) and into the inside alternator end bearing cap (53).
20. Remove frequency changer end coupling (106).
21. On the frequency changer end, remove two socket head capscrews (54) and lockwashers (55) which extend through the frequency changer end housing (56) and into the frequency changer inside bearing cap (57).

CAUTION

Alternator end housing weighs 600 pounds and should be removed carefully to avoid damage to rotor.

22. On frequency changer end housing (56), attach nylon lifting strap around top support web of housing (56). Attach and snug up lifting equipment capable of supporting 600 pounds to nylon strap. Remove Remove socket head capscrews (58) and lockwashers (59) securing the frequency changer end housing (56) to the frequency changer and alternator frame assembly (17).
23. Carefully remove frequency changer end housing (56) taking care not to damage complete shaft assembly (60).
24. Place stiff but bendable pieces of insulating material in the lower part of the alternator end air gap. This is a precautionary measure to protect the windings and keep the rotor level.
25. On alternator end, attach nylon lifting strap around top support web of the alternator end housing (52). Attach and snug up lifting equipment capable of supporting 600 pounds to nylon strap. Remove socket head capscrews (61) and lockwashers (62) securing the alternator end housing (52) to the frequency changer and alternator frame assembly (17).
26. Carefully remove bearing housing (52) taking care not to damage complete shaft assembly (60).
27. Place stiff but bendable pieces of insulating material in the lower part of the alternator end air gap.
28. Bend up tab on alternator end bearing lockwasher (63) to clear notch located on outer diameter of alternator end bearing locknut (64).
29. Remove alternator end bearing locknut (64).
30. Remove alternator end bearing lockwasher (63).
31. Remove alternator end grease slinger (65).
32. Using bearing puller, remove alternator end bearing (66) from the complete shaft assembly (60).
33. Remove alternator end inside bearing cap (53).
34. Bend up tab on frequency changer end bearing lockwasher (67) to clear notch located on outer diameter of frequency changer end bearing locknut (68).
35. Remove frequency changer end bearing locknut (68).
36. Remove frequency changer end bearing lockwasher (67).
37. Remove frequency changer end grease slinger (69).
38. Using bearing puller, remove frequency changer end bearing (70) from complete shaft assembly (60).

39. Remove frequency changer end inside bearing cap (57).

WARNING

The total weight of the rotor is approximately 6,200 pounds. Using lifting equipment with a capacity less than this could result in serious injury to personnel or damage to equipment.

40. Using lifting equipment capable of handling 6,200 pounds, carefully remove complete shaft assembly (60) from frequency changer and alternator frame assembly (17), taking care not to damage any windings.
    40.1 Once the rotor is removed, if it is necessary to further disassemble the frequency changer and alternator frame assembly (17), proceed by removing screws (71), lockwashers (72) and side covers (73) to access the bolts securing the induction frequency changer stator frame to the AC synchronous alternator frame.
    40.2 Should further disassembly of the shaft assembly (60) be required, proceed by disconnecting the phase connections between the alternator and frequency changer rotor windings and removing each rotor core from the shaft spider.

6-4.3 To disassemble flywheel for repairs, proceed as follows (refer to Chapter 7, Figure 7-1):

1. Match mark all adjoining parts.
2. Remove screws (74) and lockwashers (75) which secure the two halves of the flywheel covers (76 and 77).
3. Using proper lifting equipment, remove these two covers.
4. Remove socket head capscrews (78) and lockwashers (79) from free end outside bearing cap (84). Remove this cap.
5. Remove two socket head capscrews (81) and lockwashers (82) which extend through the free end pillow block (83) and into the free end inside bearing cap (84). Remove this cap.

WARNING

The total weight of the flywheel is approximately 6,700 pounds. Using lifting equipment with a capacity less than this could result in serious injury to personnel or damage to equipment.

6. Attach and snug up proper lifting equipment to support flywheel assembly (85).
7. Remove socket head capscrews (86) and flatwashers (87) which secure the free end pillow block (83) to the support base.
8. Remove the free end pillow block (83).
9. Remove socket head capscrews (88) and lockwashers (89) which secure the coupling end outside bearing cap (90) to the coupling end pillow block (91). Remove coupling end outside bearing cap (90).
10. Remove two socket head capscrews (92) and lockwashers (93) which extend through the coupling end inside pillow block (91) and into coupling end inside bearing cap (94). Remove this cap.

11. Remove socket head capscrews (95) and flatwashers (96) which secure the coupling end pillow block (91) to the support base.

12. Remove coupling end pillow block (91).

13. Flywheel can now be lifted free of the unit.

14. Bend up tab on free end bearing locknut (97) to clear notch located on outer diameter of outside free end flywheel locknut (98).

15. Remove outside free end flywheel locknut (98).

16. Remove outside free end flywheel locknut (97).

17. Remove inside free end flywheel locknut (99).

18. Using appropriate bearing puller, remove free end flywheel bearing (100) from the flywheel shaft assembly (85).

19. Remove free end inside bearing cap (84).

20. Bend up tab on coupling end bearing lockwasher (101) to clear notch located on outer diameter of coupling end flywheel lockwasher (102).

21. Remove coupling end flywheel lockwasher nut (102).

22. Remove spring washer (103).

23. Using appropriate bearing puller, remove coupling end flywheel bearing (104) from the flywheel assembly (85).

6-4.3.1 For assembly of the flywheel, perform steps described in paragraph 6-4.3, in reverse order. Align the flywheel to the AC generator as described in 6-2.

6-4.3.2 For replacement of flywheel bearing, proceed as follows (refer to Chapter 7, Figure 7-1): Remove defective bearing as described in paragraph 6-4.3, steps 4 through steps 12 and steps 13 through steps 23. Heat replacement bearing in an oven at 250° F (121° C) for 30 minutes. Slide heated replacement bearing onto flywheel shaft. Reassemble as described in paragraph 6-4.4.1.

6-4.4 For AC generator cleaning, inspection and repair, proceed as follows:

1. Visually inspect windings for evidence of dust or other foreign matter. If necessary, clean windings using a vacuum cleaner with non-metallic attachment. Vacuuming is preferable to blowing out with compressed air. Compressed air has a tendency to drive dust and particles into gaps which can potentially damage windings. If compressed air is used, pressure shall not exceed 30 PSI.

2. If moisture, oil, or grease is evident on the windings, clean with an approved solvent (FED-SPEC-P-D-680).

3. Inspect areas susceptible to or suspected of being cracked using nondestructive test methods in accordance with MIL-STD-271.

4. Rotate bearings to check for smooth operation. Remove and replace bearings only as necessary. (Refer to Naval Ships Technical Manual (NSTM) 244.)

NOTE

Rewinding the AC generator or repairing the rotor requires facilities available only at the Intermediate or Depot maintenance levels.

5. For repair of the AC generator, refer to data provided in tables 6-2, NSTM 300 General Electric Plant, NSTM 302 Electric Motors and Controllers, NAVSEA 0900-060-2020 Electric Machinery Repair, Electric Motor Repairs, NAVSEA 0900-060-2020 Electric Machinery Repair, Vibration Analysis and Rotor Balance.
6. Clean and inspect all coupling hub keys for nicks, burrs, pitting, and corrosion. If necessary, replace keys.
7. Inspect rotor shaft to ensure it is true and straight to within .001 inches maximum allowable runout.

6-4.4.1 To replace AC generator bearing, proceed as follows (refer to Chapter 7, Figure 7-1): Remove defective bearing as described in paragraph 6-4.2, step 1 through step 21. Heat replacement bearing in an oven at 250°F (121°C) for 30 minutes. Slide heated replacement bearing onto rotor assembly shaft. Reassemble as described in paragraph 6-4.5.1.

6-4.4.2 Using an appropriate multimeter, check the space heater strips and RTD probes for shorts, grounds, or opens. Replace as necessary.

6-4.5 For reassembly and installation the AC generator, proceed as follows:

6-4.5.1 To reassemble the AC generator, reverse the procedure in paragraph 6-4.2. Refer to table 6-2 and verify proper air gap tolerances, and Table 6-3 for Fastener Torque Values.

6-4.5.2 To install the AC generator, reverse procedure in paragraph 6-4.1, except that prior to reassembling the torsional coupling, the alignment procedure in paragraph 6-2 must be performed.

Table 6-2 AC Generator Specification Data

Pulse Frequency Changer		
Stator inside diameter		36 inches
Stator gross core length		11 inches
Rotor outside diameter		35.8 inches
Rotor net core length		10.45 inches
Air gap		0.1 inches
Rotor skew		4 degrees, 38 minutes on O.D.
Winding Data	Stator	Rotor
Number of poles	14	14
Type of connection	14 Ckt. star	2 Ckt. Star
Number of slots	168	126
Number of coils	168	126
Grouping of coils	4	3
Winding pitch in slots	1 to 11	1 to 7
Turns in series per coil	2	1
Conductor copper	22 #14	24 #10

Table 6-2 AC Generator Specification Data - Continued

Pulse Frequency Changer		
Conductor insulation	Class 155/L2, Type Dgv. Round	Class 155/Dgv. Rectangular
Resistance of windings at 77° F (25° C)	0.00028 ohms	0.0009 ohms
Weight of copper	430 pounds #14	440 pounds #10
Field (Stator) inside diameter		36.2 inches
Gross core length		12 inches
Net core length		11.4 inches
Armature (Rotor) outside diameter		35.8 inches
Air gap		0.2 inches (min.)
		0.3 inches (max.)
Type of Field Structure		Salient Pole
Pole Core length		13 inches
Winding Data	Stator	Rotor
Number of poles	14	14
Type of connection	1 Ckt. series	2 Ckt. Star
Number of slots	---	126
Number of coils	14	126
Grouping of coils	---	3
Winding pitch in slots	---	1 to 7
Turns in series per coil	230	1
Conductor copper	#8 square	24 #10
Conductor insulation	155 L2/Dgv.	155 L2/Dgv.
Resistance of windings at 77o F (25o C)	6.9 ohms	0.00095 ohms
Weight of copper	650 pounds #8	460 pounds #10

6-5. COUPLING REPAIRS.

WARNING

Before attempting any maintenance or repair work, the PFC, the turbine, and its controls should be deenergized and tagged OUT OF SERVICE. Severe injury to personnel and damage to equipment may result from starting the turbine while the PFC is being serviced.

6-5.1 For coupling disassembly and removal, proceed as follows (refer to Chapter 6, Figure 6-3):

1. Remove coupling spacer bolts (1).
2. Use coupling spacer bolts to collapse the disk pack rings (2) and free up the split spacers (3).
3. Remove the split spacers (3).
4. Remove disk pack bolts (4).

5. Remove disk pack rings (2).

6. Heat coupling hubs (5) and remove.

6-5.2 Repair procedures for the couplings consist of replacing the disk packs and checking the shaft alignments. To check the alignment, refer to paragraph 6-2, step 9. To replace the disk packs, perform step 1 through step 5 of paragraph 6-5.1 and step 7 through step 14 of paragraph 6-5.3.

6-5.3 Prior to installing couplings, the equipment must be properly aligned as described in paragraph 6-2. Once alignment is complete, proceed as follows:

1. Clean any dirt or burrs from the shafts.

2. Install keys (7) in keyways.

3. Heat coupling hubs (5) to a temperature of approximately 300°F (149°C).

4. Mount hubs on shafts with the hub face flush with the shaft end.

5. Check machine alignment as described in paragraph 6-2.

6. Install bushings (6) into coupling hub flange holes.

7. Install disk pack bolts (4) from inboard side of the coupling hubs (5) and place nuts (7) on the outboard side.

8. Torque disk pack bolts to 290 foot-pounds.

9. Install disk pack rings (2) with pilot groove facing inboard and nuts (7) placed outboard. Torque nuts to 290 foot-pounds.

10. Install and tighten coupling spacer bolts (1) until disk pack rings (2) pull inward and clear the spacer rabbet.

11. Install split spacers (3) between the disk pack rings (2). Line up reference grooves on outer diameter of spacer flanges.

12. Remove coupling spacer bolts (1) used to collapse the disk pack rings (2) and verify that the spacer rabbets are engaged with the ring rabbets.

13. Install all coupling spacer bolts (1) and verify that the spacer flange outer diameters are even with the ring outer diameters.

14. Torque coupling spacer bolts to 150 foot-pounds.

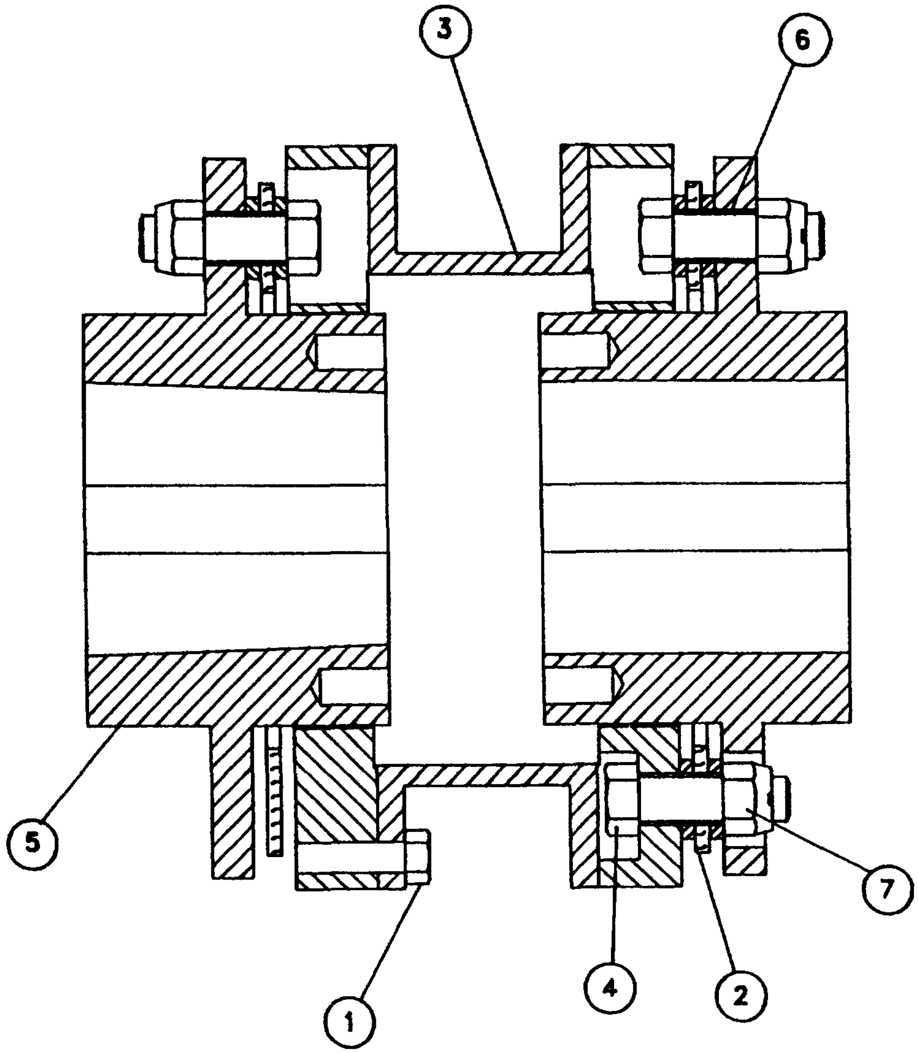


Figure 6-3 Coupling Schematic

6-6. VOLTAGE REGULATOR REPAIRS.

WARNING

Current Transformers (CT) can store sufficient electrical energy to cause severe injury to personnel. Never open the secondary circuit of a CT. Never leave the secondary windings open while the primary is still connected to the electrical circuit.

6-6.1 The voltage regulator components generally require removal and replacement if determined faulty (see Table 5-1). The printed circuit card assembly and various parts of the voltage regulator may require special techniques and tools available only at a Miniature Module Repair Station (2M Repair). Refer To Electrician's Mate 3 &2 RTM & NRCC Manual for information on basic techniques for working on shipboard power and electronic systems. Also refer to AC Minesweep Switchboard manual: NAVSEA SE681-A2-MMA-010 for details on the mounting of the voltage regulator in the minesweep, switchboard and its relationship with other devices located in the minesweep switchboard.

6-7. AC GENERATOR CHECKOUT.

6-7.1 After installation of PFC has been completed but before energizing PFC for the first time, proceed an follows:

1. Inspect unit thoroughly.
2. Make sure there is no foreign material in PFC and shaft rotates freely.
3. Test insulation resistance to ground with an approved megger.

NOTE

If the cold insulation resistance corrected to 77° F (25° C) in less than 25 megohms, the unit should be baked with drying lamps and the installed. PFC heaters.

4. After drying, recheck the resistance. Keep rebaking and rechecking the insulation as long as resistance is low.
5. Check nameplate of turbine to see that it agrees with the PFC's power supply and rating.
6. Ensure all terminals and current carrying parts are clean and tight.
7. Turn shaft to ensure it rotates freely.
8. Ensure PFC is now securely coupled to turbine. (If possible, the coupling should be free from vibration.)

6-7.2 For initial startup and preliminary tests of the PFC, proceed as follows:

WARNING

All covers and guards should be in place before startup. All personnel working on the PFC or the drive equipment should cease work prior to startup. Severe injury to personnel and damage to equipment may result from starting the PFC while it is being serviced.

CAUTION

PFC should not be operated if resistance is less than 25 megohms. It will damage the windings.

1. Start unit and note immediately direction of rotation. If rotation table is incorrect, see Table 5-1, Troubleshooting Chart.

2. Note temperature of unit and bearings during a one hour, no load trial run. Observe temperature of various parts of unit and, where excessive temperature exists, determine actual temperature with a centigrade thermometer placed directly on the part with the bulb protected from surrounding atmosphere with putty.

3. Using a mechanic's stethoscope, check for any unusual noise or vibration due to bearings, overload, or misalignment.

4. Following the one hour trial run, run the PFC at nameplate rated load for a minimum of 4 hours or until winding RTDs stabilize to within 1 °C (1.8 °F) rise between 2 readings taken 15 minutes apart. Record temperature data on the data sheet supplied as Figure 6-4.

5. Monitor bearing temperatures and check for any unusual noise or vibration during the 4 hour full load run.

NOTE

Temperatures during their full load run should not exceed total ambient temperature plus the rated temperature rise indicated on the nameplate.

PULSE FREQUENCY CHANGER HEAT RUN DATA																		
ELECTRICAL DATA						TEMPERATURES *												
TIME	ALTERNATOR		FREQUENCY CHANGER			STATOR WDG.			BEARINGS				HOT AIR INLET	HOT AIR INLET	COLD AIR INLET	COLD AIR INLET	WATER INLET	AMBIENT
									GENERATOR		FLYWHEEL							
–	FIELD VOLTAGE	FIELD CURRENT	VOLTAGE (VOLTS.)	CURRENT (AMPS)	FREQUENCY (Hz)	T1	T2	T3	FWD.	AFT.	FWD.	AFT.	FREQ. CHG.	ALT.	FREQ. CHG.	ALT.		
SHUTDOWN TEMPERATURES																		

FIELD TEMPERATURE RISE DATA

COLD ______ OHMS @ ______ F°

HOT ______ OHMS @ ______ F°

RISE BY RESISTANCE ______ F°

REMARKS:

UNIT	SERIAL	TESTER	DATE

* ALL TEMPERATURES ARE IN DEGREES F UNLESS OTHERWISE SPECIFIED

Figure 6-4 Heat Run Data Sheet

Table 6-3 Fastener Torque Values

(Dry Condition)			
Item Number (Figure 7-1)	**Nomenclature**	**Material**	**Torque (foot-pounds)**
64, 68	Locknut, Bearing	Stainless Steel	213-284
98, 99, 102	Locknut, Bearing Flywheel	Stainless Steel	382-287
81	1″-8 Screw, Cap, Socket Head	K Monel	497-620
48, 54	3/4-10 Screw, Cap, Socket Head	K Monel	181-226
50, 58	5/8-11 Screw, Cap, Socket Head	Stainless Steel	41-51
1, 15, 74	3/8-16 Screw, Cap, Socket Head	Stainless Steel	20-22
71	1/4-20 Screw, Cap, Socket Head	Stainless Steel	5-6

CHAPTER 7

PARTS LIST

7-1. INTRODUCTION.

This chapter provides a complete listing of all parts used on the Pulse Frequency Changer (PFC). The parts list is supported by an exploded view drawing showing the location of each part.

7-2. GENERAL.

Table 7-1, Parts List and Figure 7-1 Exploded View Drawing are cross referenced. To identify the particular item, locate the part and its index number on the exploded view drawing. Use this index number to obtain the manufacturer's part number and the manufacturer's FSCM. Using the FSCM, consult the List of Manufacturers, Table 7-2, for the specific name and address. When ordering repair parts, the following information should be included: PFC type, PFC serial number or drawing number; part name, number and quantity required.

7-3. EXPLODED VIEW DRAWING.

The exploded view drawing illustrates the parts in relationship to each other during assembly/disassembly. Each part is identified by an index number which is cross referenced to the Parts List.

7-4. PARTS LIST.

7-4.1 Table 7-1, Parts List is organized with a Figure and Index Number column, Description column, Quantity column, Manufacturer's Code column, and Manufacturer's Part Number column.

7-4.2 The Figure and Index Numbers are shown in the first column of the Parts List and are separated by a comma. The Figure and Index Number corresponds to the Exploded View Drawing.

7-4.3 The Description column is shown in the second column of the Parts List. This column contains a brief description which uniquely identifies the part.

7-4.4 The Quantity column is shown in the third column of the Parts List. This column specifies the quantity per unit of the appropriate part.

7-4.5 The Manufacturer's Code is shown in the fourth column of the Parts List. This column contains the five digit Federal Supply Code for Manufacturers (FSCM). The FSCM identifies the supplier of each part.

7-4.6 The Manufacturer's Part Number is shown in the fifth column of the parts list. This column contains the original manufacturer's part number for parts shown on the exploded view drawing.

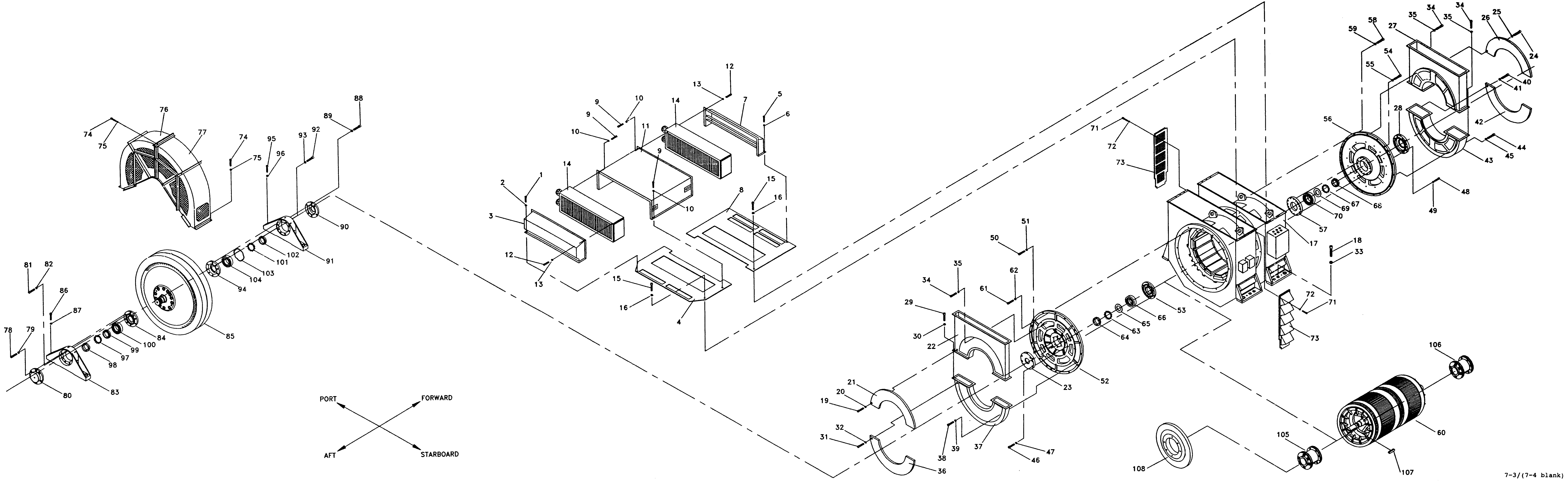


Figure 7-1 PFC Exploded View

Table 7-1 Parts List

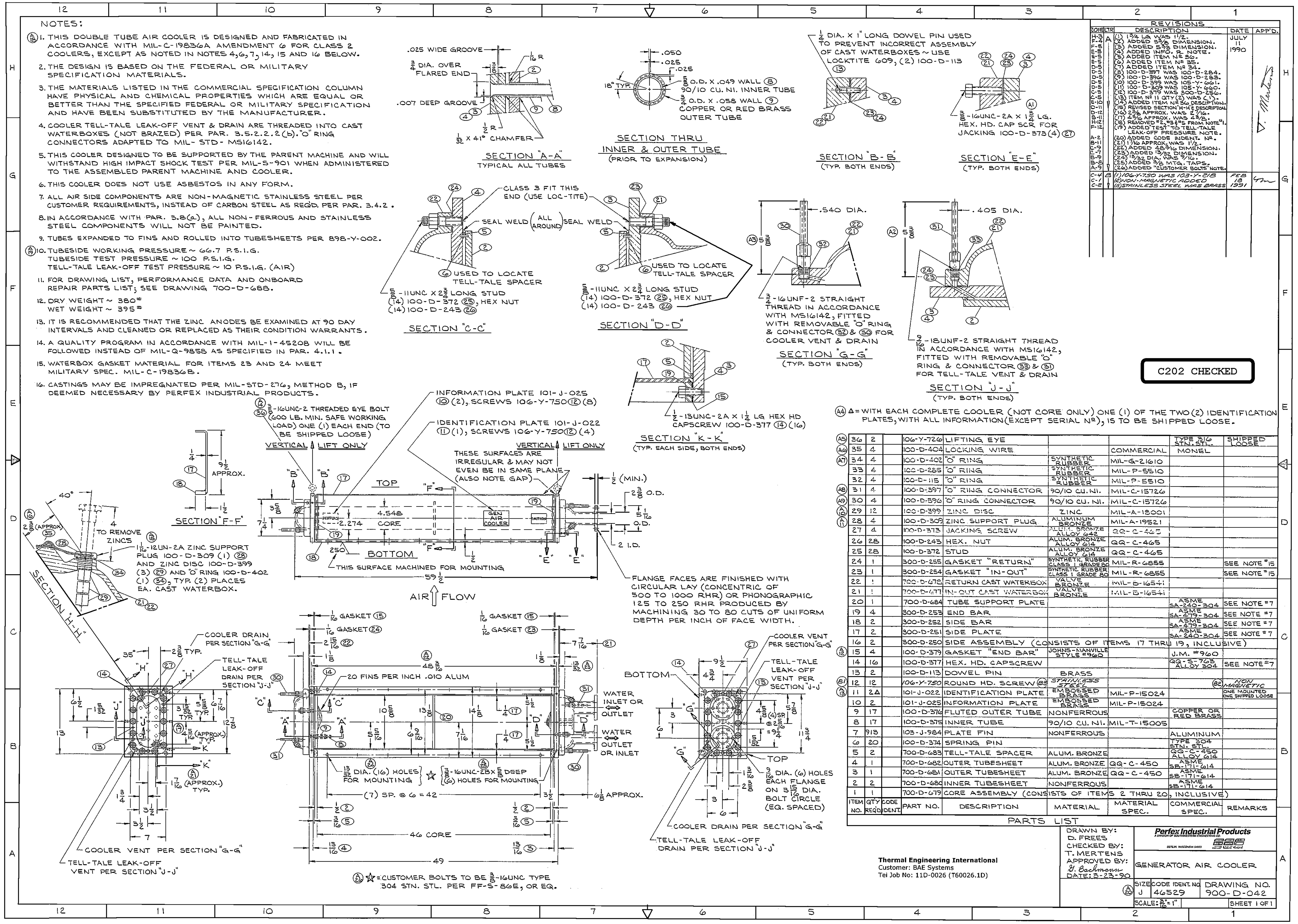
Figure and Index No.	Description	Qty.	FSCM	Mfg. Part No.
7-1, 1	Screw, Machine Rd. Hd.	56	COML	3/8-16 X 3/4
2	Lockwasher, Pos.	38	COML	3/8 Std.
3	Cover, Air Duct, Top Alt. End	1	51802	HAN 4658-1
4	Cooler Mounting Plate-Alt. End	1	51802	HAN 4644-1
5	Screw, Machine Rd. Hd.	56	COML	3/8-16 X 3/4
6	Lockwasher, Pos.	38	COML	3/8 Std.
7	Cover, Air Duct, Top Freq. Chg. End	1	51802	HAN 4658-1
8	Cooler Mounting Plate-Freq. Chg. End	1	51802	HAN 4644-1
9	Screw, Machine Rd. Hd.	56	COML	3/8-16 X 3/4
10	Lockwasher, Pos.	38	COML	3/8 Std.
11	Cooler Cover	1	51802	HAN 4670-1
12	Screw, Machine Rd. Hd.	56	COML	3/8-16 X 3/4
13	Lockwasher, Pos.	38	COML	3/8 Std.
14	Cooler Assembly	2	1GT86	900-D-042 **NOTE** 70/30 CuNi (Copper Nickel) may be used for the outer tube sheet in place of Aluminum Bronze, and 90/10 CuNi may be used for the inner tube sheet in place of Aluminum Bronze. See Figure 7-2.
15	Screw, Flat Head, Socket	24	COML	
16	Lockwasher, Pos.	38	COML	3/8 Std.
17	Assy, Frame Freq. Chg. & Alt.	REF	51802	HAN 4525G1
18	Screw, Cap, Socket Head	12	COML	1″-8 X 4 3/4
19	Screw, Special	35	51802	HAN 4656-2
20	Lockwasher, Pos.	35	COML	1/4 Std.
21	Cover, Top Air Duct, Alt. End	1	51802	HAN 4658-1
22	Air Duct, Top, Alt. End	1	51802	HAN 4650-1
23	Cap, Bearing, Outside, Alt. End	1	51802	HAN 4683-1
24	Screw, Special	35	51802	HAN 4656-2
25	Lockwasher, Pos.	35	COML	1/4 Std.
26	Cover, Top Air Duct, Freq. Chg. End	1	51802	HAN 4658-1
27	Air Duct, Top, Freq. Chg. End	1	51802	HAN 4650-1
28	Cap, Bearing, Outside Freq. Chg. End	1	51802	HAN 4692-1
29	Screw, Special	35	51802	HAN 4656-2
30	Lockwasher, Pos.	35	COML	1/4 Std.
31	Screw, Special	35	51802	HAN 4656-2
32	Lockwasher, Pos.	35	COML	1/4 Std.
33	Flat Washer	12	COML	1″ Std.
34	Screw, Special	35	51802	HAN 4656-2

Table 7-1 Parts List - Continued

Figure and Index No.	Description	Qty.	FSCM	Mfg. Part No.
35	Lockwasher, Pos.	35	COML	1/4 Std.
36	Cover, Bottom Air Duct, Alt. End	1	51802	HAN 4658-1
37	Air Duct, Bottom, Alt. End	1	51802	HAN 4652-1
38	Screw, Special	35	51802	HAN 4656-2
39	Lockwasher, Pos.	35	COML	1/4 Std.
40	Screw, Special	35	51802	HAN 4656-2
41	Lockwasher, Pos.	35	COML	1/4 Std.
42	Cover, Bottom Air Duct, Freq. Chg. End	1	51802	HAN 4658-1
43	Air Duct, Bottom, Frq. Chg. End	1	51802	HAN 4653-1
44	Screw, Special	35	51802	HAN 4656-2
45	Lockwasher, Pos.	35	COML	1/4 Std.
46	Screw, Cap, Socket Head	6	COML	5/8-11 X 5
47	Lockwasher, Pos.	6	COML	5/8 Hi-Collar
48	Screw, Cap, Socket Head	14	COML	3/4-10 X 5
7-1, 49	Lockwasher	14	COML	3/4 Hi-Collar
50	Screw, Cap, Socket Head	2	COML	5/8-11 X 3 1/2
51	Lockwasher	2	COML	5/8 Hi-Collar
52	Housing, Alt. End	1	51802	HAN 4568G1
53	Cap, Bearing, Inside, Alt. End	1	51802	HAN 4569-1
54	Screw, Cap, Socket Head	2	51802	3/4-10 X 3 1/4
55	Lockwasher	2	51802	3/4 Hi-Collar
56	Housing, Freq. Chg. End	1	51802	HAN 4562-1
57	Cap, Bearing, Inside, Freq. Chg. End	1	51802	HAN 4563-1
58	Screw, Cap, Socket Head	16	COML	5/8-11 x 2 3/4
59	Lockwasher, Pos.	16	COML	5/8 Hi-Collar
60	Assembly, Shaft, Complete	REF	51802	HAN 4577G1
61	Screw, Cap, Socket Head	16	COML	5/8-11 x 2 3/4
62	Lockwasher, Pos.	16	COML	5/8 Hi-Collar
63	Lockwasher, Bearing, Alt. End	1	79568	WH-21
64	Locknut, Bearing, Alt. End	1	79568	NH-21
65	Slinger, Grease, Alt. End	1	51802	HAN 4571-1
66	Bearing, Ball (#321), Alt. End	1	51802	ESB 050-19
67	Lockwasher, Bearing, Freq. Chg. End	1	79568	WH-28
68	Locknut, Bearing, Freq. Chg. End	1	79568	NH-28
69	Slinger, Grease, Freq. Chg. End	1	51802	HAN 4565-1
70	Bearing, Ball (#228), Freq. Chg. End	1	51802	ESB 050-26
71	Screw, Machine, Rd. Hd.	20	COML	1/4-20 X 3/4
72	Lockwasher, Pos.	20	COML	1/4 Std.
73	Cover, Frame, Side	2	51802	HAN 4634-1
74	Screw, Machine, Rd. Hd.	15	COML	3/8-16 X 1
75	Lockwasher, Pos.	15	COML	3/8 Std.
76	Cover, Flywheel	1	51802	HAN 4695-1
77	Cover, Flywheel	1	51802	HAN 4695-1
78	Screw, Cap, Socket Head	6	COML	1″-8 X 4 3/4

Table 7-1 Parts List - Continued

Figure and Index No.	Description	Qty.	FSCM	Mfg. Part No.
79	Lockwasher, Pos.	6	COML	1″ Hi-Collar
80	Cap, Bearing, Outside, Free End	1	51802	HAN 4692-1
81	Screw, Cap, Socket Head	2	COML	1″-8 X 2 1/2
82	Lockwasher, Pos.	2	COML	1″ Hi-Collar
83	Block, Pillow, Free End	1	51802	HAN 4682-1
84	Cap, Bearing, Inside, Free End	1	51802	HAN 4691-1
85	Assembly, Flywheel, Complete	REF	51802	HAN 4676G1
86	Screw, Cap, Socket Head	2	COML	
87	Flatwasher	2	COML	
88	Screw, Cap, Socket Head	6	COML	1″-8 X 4 3/4
89	Lockwasher, Pos.	6	COML	1″ Hi-Collar
90	Cap, Bearing, Outside, Coupling End	1	51802	HAN 4683-1
91	Block, Pillow, Coupling End	1	51802	HAN 4681-1
92	Screw, Cap, Socket Head	2	COML	1-8 X 2 1/2
93	Lockwasher, Pos.	2	COML	1″ Hi-Collar
94	Cap, Bearing, Inside, Coupling End	1	51802	HAN 4684-1
95	Screw, Cap, Socket Head	2	COML	
96	Flatwasher	2	COML	
97	Locknut, Bearing, Free End	1	79568	WH-26
98	Locknut, Flywheel, Free End, Outside	1	79568	NH-26
99	Locknut, Flywheel, Free End, Inside	1	79568	NH-26
100	Bearing, Ball (#226) Flywheel, Free End	1	51802	ESB 053-24
101	Lockwasher, Bearing, Coupling End	1	79568	WH-26
102	Lockwasher, Flywheel, Coupling End	1	79568	NH-26
103	Washer, Spring, (#226) Ball Bearing	1	COML	SSB 0906
104	Bearing, Ball (#226) F'wheel, Cplg. End	1	51802	ESB 053-24
105	Coupling, Alternator End (Components shown in Figure 6-3 are provided with coupling)	1	75394	403 KD1
106	Coupling, Freq. Chg. End (Components shown in Figure 6-3 are provided with coupling)	1	75394	454 KD1
107	Key, Shaft Extension	1	51802	HAN 4590-1
108	Disc	1	38658	N/A
(Not Shown)	Regulator, Voltage	1	8G429	SR250EX
(Not Shown)	Regulator, Voltage Circuit Board Assy.	1	8G429	9059701101
(Not Shown)	Cup, Grease, Size 0 Female	1	51802	4891-1



NOTES:

(A18) 1. THIS DOUBLE TUBE AIR COOLER IS DESIGNED AND FABRICATED IN ACCORDANCE WITH MIL-C-19836A AMENDMENT 6 FOR CLASS 2 COOLERS, EXCEPT AS NOTED IN NOTES 4, 6, 7, 14, 15 AND 16 BELOW.

2. THE DESIGN IS BASED ON THE FEDERAL OR MILITARY SPECIFICATION MATERIALS.

3. THE MATERIALS LISTED IN THE COMMERCIAL SPECIFICATION COLUMN HAVE PHYSICAL AND CHEMICAL PROPERTIES WHICH ARE EQUAL OR BETTER THAN THE SPECIFIED FEDERAL OR MILITARY SPECIFICATION AND HAVE BEEN SUBSTITUTED BY THE MANUFACTURER.

4. COOLER TELL-TALE LEAK-OFF VENT & DRAIN ARE THREADED INTO CAST WATERBOXES (NOT BRAZED) PER PAR. 3.5.2.2.2(b). "O" RING CONNECTORS ADAPTED TO MIL-STD-MS16142.

5. THIS COOLER DESIGNED TO BE SUPPORTED BY THE PARENT MACHINE AND WILL WITHSTAND HIGH IMPACT SHOCK TEST PER MIL-S-901 WHEN ADMINISTERED TO THE ASSEMBLED PARENT MACHINE AND COOLER.

6. THIS COOLER DOES NOT USE ASBESTOS IN ANY FORM.

7. ALL AIR SIDE COMPONENTS ARE NON-MAGNETIC STAINLESS STEEL PER CUSTOMER REQUIREMENTS, INSTEAD OF CARBON STEEL AS REQ'D. PER PAR. 3.4.2.

8. IN ACCORDANCE WITH PAR. 3.8(a), ALL NON-FERROUS AND STAINLESS STEEL COMPONENTS WILL NOT BE PAINTED.

9. TUBES EXPANDED TO FINS AND ROLLED INTO TUBESHEETS PER 898-Y-002.

(A19) 10. TUBESIDE WORKING PRESSURE ~ 66.7 P.S.I.G.
TUBESIDE TEST PRESSURE ~ 100 P.S.I.G.
TELL-TALE LEAK-OFF TEST PRESSURE ~ 10 P.S.I.G. (AIR)

11. FOR DRAWING LIST, PERFORMANCE DATA AND ONBOARD REPAIR PARTS LIST; SEE DRAWING 700-D-688.

12. DRY WEIGHT ~ 380#
WET WEIGHT ~ 395#

13. IT IS RECOMMENDED THAT THE ZINC ANODES BE EXAMINED AT 90 DAY INTERVALS AND CLEANED OR REPLACED AS THEIR CONDITION WARRANTS.

14. A QUALITY PROGRAM IN ACCORDANCE WITH MIL-I-45208 WILL BE FOLLOWED INSTEAD OF MIL-Q-9858 AS SPECIFIED IN PAR. 4.1.1.

15. WATERBOX GASKET MATERIAL FOR ITEMS 23 AND 24 MEET MILITARY SPEC. MIL-C-19836B.

16. CASTINGS MAY BE IMPREGNATED PER MIL-STD-276, METHOD B, IF DEEMED NECESSARY BY PERFEX INDUSTRIAL PRODUCTS.

(A4) Δ = WITH EACH COMPLETE COOLER (NOT CORE ONLY) ONE (1) OF THE TWO (2) IDENTIFICATION PLATES, WITH ALL INFORMATION (EXCEPT SERIAL №), IS TO BE SHIPPED LOOSE.

ITEM NO.	QTY REQ'D	CODE IDENT.	PART NO.	DESCRIPTION	MATERIAL	MATERIAL SPEC.	COMMERCIAL SPEC.	REMARKS
(A5) 36	2		106-Y-726	LIFTING EYE			TYPE 316 STN. STL.	SHIPPED LOOSE
(A6) 35	4		100-D-404	LOCKING WIRE		COMMERCIAL	MONEL	
(A7) 34	4		100-D-402	"O" RING	SYNTHETIC RUBBER	MIL-G-21610		
33	4		100-D-265	"O" RING	SYNTHETIC RUBBER	MIL-P-5510		
32	4		100-D-115	"O" RING	SYNTHETIC RUBBER	MIL-P-5510		
(A8) 31	4		100-D-397	"O" RING CONNECTOR	90/10 CU. NI.	MIL-C-15726		
(A9) 30	4		100-D-396	"O" RING CONNECTOR	90/10 CU. NI.	MIL-C-15726		
(A10) 29	12		100-D-399	ZINC DISC	ZINC	MIL-A-18001		
(A11) 28	4		100-D-309	ZINC SUPPORT PLUG	ALUMINUM BRONZE	MIL-A-19521		
27	4		100-D-373	JACKING SCREW	ALUM. BRONZE ALLOY 642	QQ-C-465		
26	28		100-D-243	HEX. NUT	ALUM. BRONZE ALLOY 614	QQ-C-465		
25	28		100-D-372	STUD	ALUM. BRONZE ALLOY 614	QQ-C-465		
24	1		300-D-255	GASKET "RETURN"	SYNTHETIC RUBBER CLASS 1 GRADE 80	MIL-R-6855		SEE NOTE #15
23	1		300-D-254	GASKET "IN-OUT"	SYNTHETIC RUBBER CLASS 1 GRADE 80	MIL-R-6855		SEE NOTE #15
22	1		700-D-678	RETURN CAST WATERBOX	VALVE BRONZE	MIL-B-16541		
21	1		700-D-677	IN-OUT CAST WATERBOX	VALVE BRONZE	MIL-B-16541		
20	1		700-D-684	TUBE SUPPORT PLATE			ASME SA-240-304	SEE NOTE #7
19	4		300-D-253	END BAR			ASME SA-479-304	SEE NOTE #7
18	2		300-D-252	SIDE BAR			ASME SA-479-304	SEE NOTE #7
17	2		300-D-251	SIDE PLATE			ASME SA-240-304	SEE NOTE #7
16	2		300-D-250	SIDE ASSEMBLY (CONSISTS OF ITEMS 17 THRU 19, INCLUSIVE)				
(A12) 15	4		100-D-379	GASKET "END BAR"	JOHNS-MANVILLE STYLE #960		J.M. #960	
14	16		100-D-377	HEX. HD. CAPSCREW			QQ-S-763 ALLOY 304	SEE NOTE #7
13	2		100-D-113	DOWEL PIN	BRASS			
(B1) 12	12		106-Y-750	ROUND HD. SCREW (B3)	STAINLESS STEEL			(B2) NON MAGNETIC
(A13) 11	2Δ		101-J-022	IDENTIFICATION PLATE	EMBOSSED BRASS	MIL-P-15024		ONE MOUNTED ONE SHIPPED LOOSE
10	2		101-J-025	INFORMATION PLATE	EMBOSSED BRASS	MIL-P-15024		
9	17		100-D-376	FLUTED OUTER TUBE	NONFERROUS		COPPER OR RED BRASS	
8	17		100-D-375	INNER TUBE	90/10 CU. NI.	MIL-T-15005		
7	913		103-J-984	PLATE FIN	NONFERROUS		ALUMINUM	
6	20		100-D-374	SPRING PIN			TYPE 304 STN. STL.	
5	2		700-D-683	TELL-TALE SPACER	ALUM. BRONZE		QQ-C-450 ALLOY 614	
4	1		700-D-682	OUTER TUBESHEET	ALUM. BRONZE	QQ-C-450	ASME SB-171-614	
3	1		700-D-681	OUTER TUBESHEET	ALUM. BRONZE	QQ-C-450	ASME SB-171-614	
2	2		700-D-680	INNER TUBESHEET	NONFERROUS		ASME SB-171-614	
1	1		700-D-679	CORE ASSEMBLY (CONSISTS OF ITEMS 2 THRU 20, INCLUSIVE)				

PARTS LIST

DRAWN BY: D. FREES
CHECKED BY: T. MERTENS
APPROVED BY: G. Bachmann
DATE: 8-23-90

Perfex Industrial Products
A DIVISION OF SOUTHWESTERN ENGINEERING CO.
BERLIN, WISCONSIN 54923

GENERATOR AIR COOLER

SIZE J | CODE IDENT. NO. 46529 | DRAWING NO. 900-D-042
SCALE: 3/8"=1" | SHEET 1 OF 1

C202 CHECKED

Thermal Engineering International
Customer: BAE Systems
Tel Job No: 11D-0026 (T60026.1D)

Figure 7-2 Cooler Assembly

Table 7-2 List of Manufacturers

Fed. Mfg. Code	Name and Address of Manufacturer
51802	Hansome Energy Systems, Inc. 365 Dalziel Road Linden, New Jersey 07036
74197	Barnes Group, Inc. 370 W. Dussel Dr Ste. A Maumee, OH 43537
8G429	Basler Electric Co. P.O. Box 269 Route 143 Highland, Illinois 62249
09359	Minco Products, Inc. 7290 Commerce Circle W. Minneapolis, Minnesota 55432
38658	Kobelt Mfg. Co., Inc. 8238 129TH ST Surry, British Columbia, Canada V3W 0A6
75394	Emerson Power Transmission Corporation 7565 Harmans Road Harmans, MD 21077
1GT86 Cancelled/Replaced by: 1MME1	Thermal Engineering International Usa, Inc. Milwaukee, WI 53225
79568	Whittet-Higgins Company 33 Higginson Avenue Central Falls, RI 02863

CHAPTER 8

INSTALLATION

8-1. INTRODUCTION.

This chapter covers the installation, handling and initial checkout instructions for the PFC.

8-2. SITE SELECTION.

Site location information can be obtained by referencing NAVSEA Drawings for Ship Work Breakdown Structure (SWBS) Group 311 for the applicable hull number.

8-3. LIST OF REFERENCES.

Refer to the following NAVSEA Technical Manuals for additional information:

1. S9086-HN-STM-000, Chapter 244, Bearings, Ball and Roller.
2. S9086-KC-STM-000, Chapter 300, Section 3, Electric Plant, General.
3. S9086-KE-STM-000, Chapter 302, Electric Generators.

8-4. TOOLS AND MATERIALS REQUIRED.

No special tools or materials are required for installation. When lifting or moving the PFC, rigging equipment shall be rated for a weight in excess of 28,000 pounds.

8-5. PACKING.

The PFC is shipped in two components. These components are the Flywheel Assembly and the AC Generator.

WARNING

Personnel must take care when moving AC generator as it weighs 20,000 pounds. Fatal injury to personnel or damage to equipment may result if this weight is not properly controlled.

Personnel must take care when moving flywheel assembly as it weighs 8,000 pounds. Fatal injury to personnel or damage to equipment may result if this weight is not properly controlled.

8-5.1 To unpack the AC generator, proceed as follows:

1. Visually inspect for shipping damage.
2. Check to be sure all associated items have been included.

3. Remove the eight screws, two in each mount, which secure generator to cradle.

4. Remove shaft bracing and rotate the shaft by hand to be certain there is no rubbing or binding.

8-5.2 To unpack the flywheel, proceed as follows:

1. Visually inspect for shipping damage.

2. Remove cradle and shaft bracing.

8-6. INITIAL INSPECTION.

The PFC should be examined carefully on arrival, and rust or moisture removed. Surfaces which have been treated with Cosmoline or the equivalent should be cleaned. Cosmoline or equivalent can be removed easily by using a good solvent such as petroleum spirits.

8-7. STORAGE.

The PFC should be stored in its original shipping cradle whenever possible. Store unit in a clean, dry location. In order to give additional protection, the unit should be covered to prevent damage and entrance of foreign material.

8-7.1 Exposed surfaces should be protected from rust, where necessary. Rust, once started, will continue if surfaces are protected without first removing all signs of rust and moisture. Special attention should be given to the shaft and journal surfaces to prevent rusting and pitting. Machines held in storage must be examined at frequent intervals.

8-7.2 During storage, the windings of the AC generator should be protected against sweating and freezing by a safe, reliable heating system which will always keep the temperature of the AC generator above the dew point temperature of the surrounding environment.

8-7.3 Rotate shaft at least 12 turns each month during any extended inoperative period. This exercise will dispense fresh lubricant to bearings, thereby protecting them. If the unit has been stored for more than 3 months, the plugs in the bottom of bearing chambers should be removed and a portion of the lubricant drained. An equivalent amount of medium grade neutral grease per DOD-G-24508 should be replenished after drain plugs have been reinstalled.

8-7.4 If units are in a cold or damp location for any period of time, heating elements inside units should be turned on.

CAUTION

No lubricants of any kind should ever be applied to any electrical part at any time, as it may affect conductivity resulting in electrical or mechanical failure of PFC or related equipment.

8-8. PREPARATION OF BASE.

The AC generator is resiliently mounted. The shipyard installed base should be machined to accept the AC generator in accordance with the applicable shipyard drawing. Flatness, parallelism and mounting bolt hole pattern must meet specifications of shipyard drawing to prevent damage to AC generator. The base must be flat within .002 in. The distance between each PFC mounting and the base should be equal; coplanarity should not exceed .004 in. Base should be clear of burrs, dirt or foreign matter.

The AC generator, flywheel and turbine are directly mounted to the sub-base. The sub-base in turn is resiliently mounted to the ship's foundation. Mounting pads (feet) of AC generator, flywheel bearing housings and turbine supports are bolted to raised and accurately machined pads on the sub-base. The AC generator feet are mated to the sub-base pads without shim stock. Mounting pads for the flywheel bearing housings and turbine supports have been machined 1/8″ lower so that shim stock must be used to achieve alignment. The AC generator is always installed and positioned first, followed by positioning and aligning the flywheel at the forward side and the turbine on the aft side of the generator. Before equipment is positioned, all four coupling hubs must be shrink fitted to their respective shafts. Note that certain bolts may need to be inserted in the coupling hubs before hubs attain their final position. After acceptable alignment of equipment has been achieved, permanent locations are secured with fitted bolts and tapered dowel pins.

8-9. INPUT REQUIREMENTS.

8-9.1 The PFC requires a 120 VAC, 60 Hz, single phase power source with appropriate wiring and switching for the space heaters.

8-9.2 The resistance temperature detectors require provisions for connection to the appropriate circuits.

8-10. INSTALLATION PROCEDURES.

8-10.1 Refer to Chapter 6, paragraph 6-4.5.2 for PFC installation procedures. Refer to Figure 8-1, for physical dimensions, and mounting dimensions.

8-10.2 No undue force should be used to install shipyard furnished couplings as this will damage the PFC bearings.

8-10.3 Bearings are factory lubricated and should not require additional lubrication for approximately 6 months after initial startup.

8-11. INSTALLATION CHECKOUT PROCEDURES.

After PFC installation, and prior to initial startup, perform complete checkout procedures as described in Chapter 6, paragraph 6-2 and paragraph 6-7.

Figure 8-1 PFC Installation Layout

8-12. CARE AFTER INSTALLATION.

8-12.1 After mounting the equipment on board the vessel and prior to initial startup, the PFC should be protected with canvas wrapping, or a hood, to prevent entrance of dirt, weld spatter, or any other foreign matter into exposed parts of the unit. If subjected to extreme humidity and rapid changes in temperature, tube or rod type heaters should be installed under the canvas covering and kept on at all times until the unit is ready to be connected and operated. The cover should have ventilation holes. The shaft should be rotated by hand periodically.

8-12.2 Once the PFC is placed in service, follow maintenance procedures as called out in Chapter 4 of this manual.

Ref: NAVSEAINST 4160.3 NAVSEA S0005-AA-GYD-030/TMMP

NAVSEA/SPAWAR TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)

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