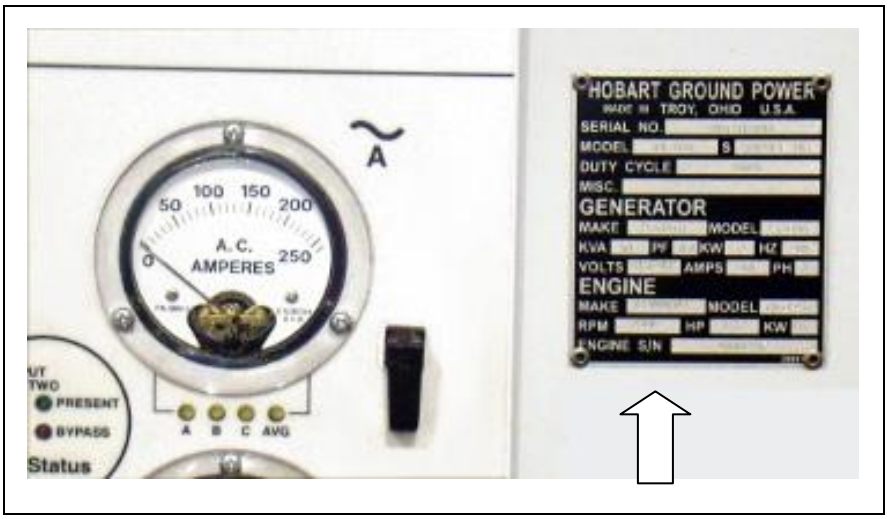
Preventive Maintenance

Here are the replacement filters for 60CU20 (500061) ground power unit (GPU). This list is provided as a quick reference chart for the maintenance technician or diesel mechanic in charge of routine preventative maintenance to the ground power unit.

Generator Set Model Number

Make sure your generator set is the model listed above. Identify the model number by looking on the data plate, which is located next to the gauges on the back of the unit.



Filter Part Numbers

The table below lists the filter part numbers for your generator set. You can also order sets of filters as kits.

Filter Number	Hobart Part Number	Filter Kit 290300-13	Filter Kit 290300-14
Engine Fuel Filter Element	286897-036	✓	✓
Lubricity Fuel Water Separator Element	286897-031	✓	✓
Oil Filter Element	286897-029	✓	✓
Air Filter Replacement Element	290941	✓	--

Filter Kits

Preventative maintenance kits contain replacement filter elements packaged together.

- Kit 290300-013 contains all the filter elements.
- Kit 290300-014 contains only the oil and fuel filter elements.

Hobart Ground Systems - Supply Contact Information

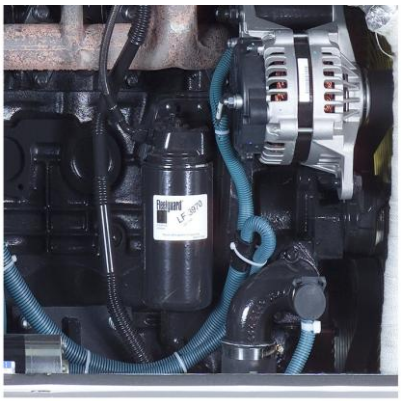
Hobart Ground Systems has a supply staff that is able to help with the quote and sale of parts. Our helpful supply staff is also able to provide delivery information for the customer.

Contact the Hobart Ground Systems supply department staff for all the preventative maintenance parts:
e-mail: service@hobartsystems.com
call (inside USA) (800) 899-1841
call (other countries) (941) 721-1025

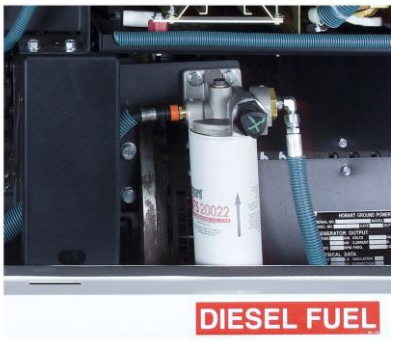
Air Filter

Filter Pictures

Fuel Filter



Oil Filter



Lubricity Element

OM-2175A
01/23/2013 – Original

Operation and Maintenance Manual
with
Illustrated Parts List
for
60CU20

60 kVA, 3 Phase, 115/200 Volt,
400 Hz. Generator Set

Series 500061A

ITW GSE Group
Hobart Ground Systems
Palmetto, Florida 34221
U.S.A.

Warranty

Data Sheet 165
Index: 990223
Replaces: 980601

HOBART GROUND POWER
TROY, OHIO 45373

1. Hobart Brothers Company (hereinafter called HOBART) warrants that each new and unused Hobart Ground Power Equipment, (hereinafter called the PRODUCT) is of good workmanship and is free from mechanical defects, provided that (1) the PRODUCT is installed and operated in accordance with the printed instructions of HOBART, (2) the PRODUCT is used under the normal operating conditions for which it is designed, (3) the PRODUCT is not subjected to misuse, negligence or accident, and (4) the PRODUCT receives proper care, lubrication, protection, and maintenance under the supervision of trained personnel.
2. This warranty expires 15 months after shipment by HOBART to the first user, or 12 months after installation, whichever first occurs.
3. This warranty does not apply to: primary and secondary switch contacts, cable connectors, carbon brushes, fuses, bulbs, and filters unless found to be defective prior to use.
4. Hobart DOES NOT WARRANT THE FOLLOWING COMPONENTS: Engines, engine components; such as: starters, alternators, regulators, governors, etc., and cable retrieving devices. Many of the foregoing components are warranted directly by the manufacturer to the first user and serviced by a worldwide network of distributors and others authorized to handle claims for component manufacturers. A first user's claim should be presented directly to such an authorized component service outlet. In the event any component manufacturer has warranted its component to HOBART and will not deal directly with a first user then HOBART will cooperate with the first user in the presentation of a claim to such manufacturer. Under NO circumstances does HOBART assume any liability for any warranty claim against or warranty work done by or in behalf of any manufacturer of the foregoing components.
5. This warranty is extended by HOBART only to the purchaser of new PRODUCTS from HOBART or one of its authorized distributors. The PRODUCTS purchased under this warranty are intended for use exclusively by the buyer and his employees and by no other persons and, therefore, there shall be no third party beneficiary to this warranty.
6. A claim of defects in any PRODUCT covered by this warranty is subject to HOBART factory inspection and judgment. HOBART'S liability is limited to repair of any defects found by HOBART to exist, or at HOBART'S option the replacement of the defective product, F.O.B. factory, after the defective product has been returned by the purchaser at its expense to HOBART'S shipping place. Replacement and exchange parts will be warranted for the remainder of the original Warranty, or for a period of ninety (90) days, whichever is greater.
7. UNDER NO CIRCUMSTANCES whatsoever shall HOBART and its authorized distributors be liable for any special or consequential damages, whether based on lost goodwill, lost resale profits, work stoppage impairment of other goods or otherwise, and whether arising out of breach of any express or implied warranty, breach of contract, negligence or otherwise, except only in the case of personal injury as may be required by applicable law.
8. Continued use of the PRODUCT(S) after discovery of a defect VOIDS ALL WARRANTIES.
9. Except as authorized in writing, this warranty does not cover any equipment that has been altered by any party other than HOBART.
10. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HERE OF. HOBART MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.
11. HOBART neither assumes nor authorizes any person to assume for HOBART any liability in connection with the PRODUCTS sold, and there are no oral agreements or warranties collateral to or affecting this written Warranty. This warranty and all undertakings of HOBART thereunder shall be governed by the laws of the State of Ohio, United States of America.

WARNING: AT ALL TIMES, SAFETY MUST BE CONSIDERED AN IMPORTANT FACTOR IN THE INSTALLATION, SERVICING AND OPERATION OF THE PRODUCT, AND SKILLED, TECHNICALLY QUALIFIED PERSONNEL SHOULD ALWAYS BE EMPLOYED FOR SUCH TASKS.

Safety Warnings and Cautions

WARNING

ELECTRIC SHOCK can **KILL**. Do not touch live electrical parts.

ELECTRIC ARC FLASH can injure eyes, burn skin, cause equipment damage, and ignite combustible material. **DO NOT** use power cables to break load and prevent tools from causing short circuits.

IMPROPER PHASE CONNECTION, PARALLELING, OR USE can damage this and attached equipment.

IMPORTANT

Protect all operating personnel. Read, understand, and follow all instructions in the Operating/Instruction Manual before installing, operating, or servicing the equipment. Keep the manual available for future use by all operators.

WARNING

CALIFORNIA PROPOSITION 65 - DIESEL ENGINES. Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

1) General

Equipment that supplies electrical power can cause serious injury or death, damage to other equipment or property. The operator must strictly observe all safety rules and take precautionary actions. Safe practices have been developed from past experience in the use of power source equipment. While certain practices below apply only to electrically powered equipment, other practices apply to engine-driven equipment, and some practices to both.

2) Shock Prevention

Bare conductors, terminals in the output circuit, or ungrounded, electrically live equipment can fatally shock a person. Have a certified electrician verify that the equipment is adequately grounded and learn what terminals and parts are electrically **HOT**. Avoid hot spots on machine. Use proper safety clothing, procedures, and test equipment.

The electrical resistance of the body is decreased when wet, permitting dangerous currents to flow through it. When inspecting or servicing the equipment, do not work in damp areas. Stand on a dry rubber mat or dry wood, and use insulating gloves when dampness or sweat cannot be avoided. Keep clothing dry, and never work alone.

a) Installation and Grounding of Electrically Powered Equipment

This equipment must be installed and maintained in accordance with the National Electrical Code, ANSI/NFPA 70, or other applicable codes. A power disconnect switch or circuit breaker must be located at the equipment. Check the nameplate for voltage, frequency, and phase requirements. If only 3-phase power is available, connect any single-phase rated equipment to only two wires of the 3-phase line. **DO NOT CONNECT** the equipment grounding conductor (lead) to the third live wire of the 3-phase line, as this makes the equipment frame electrically **HOT**, which can cause a fatal shock.

Always connect the grounding lead, if supplied in a power line cable, to the grounded switch box or building ground. If not provided, use a separate grounding lead. Ensure that the current (amperage) capacity of the grounding lead will be adequate for the worst fault current situation. Refer to the National Electrical Code ANSI/NFPA 70 for details. Do not remove plug ground prongs and use correctly mating receptacles.

b) Output Cables and Terminals

Inspect cables frequently for damage to the insulation and the connectors. Replace or repair cracked or worn cables immediately. Do not overload cables. Do not touch output terminal while equipment is energized.

3) Service and Maintenance

This equipment must be maintained in good electrical condition to avoid hazards stemming from disrepair. Report any equipment defect or safety hazard to the supervisor and discontinue use of the equipment until its safety has been assured. Repairs should be made by qualified personnel only. Before inspecting or servicing this equipment, take the following precautions:

a) Shut off all power at the disconnecting switch, or line breaker, or by disconnecting battery, before inspecting or servicing the equipment.

b) Lock switch OPEN (or remove line fuses) so that power cannot be turned on accidentally.

c) Disconnect power to equipment if it is out of service.

d) If troubleshooting must be done with the unit energized, have another person present who is trained in turning off the equipment and providing or calling for first aid.

4) Fire And Explosion Prevention

Fire and explosion are caused by electrical short circuits, combustible material near engine exhaust pipes, misuse of batteries and fuel, or unsafe operating or fueling conditions.

a) Electrical Short Circuits and Overloads

Overloaded or shorted equipment can become hot enough to cause fires by self-destruction or by causing nearby combustibles to ignite. For electrically powered equipment, provide primary input protection to remove short circuited or heavily overloaded equipment from the line.

b) Batteries

Batteries may explode and/or give off flammable hydrogen gas. Acid and arcing from a ruptured battery can cause fires and additional failures. When servicing, do not smoke, cause sparking, or use open flame near the battery.

c) Engine Fuel

Use only approved fuel container or fueling system. Fires and explosions can occur if the fuel tank is not grounded prior to or during fuel transfer. Shut unit **DOWN** before opening fuel tank cap. **DO NOT** completely fill tank, because heat from the equipment may cause fuel expansion overflow. Remove all spilled fuel **IMMEDIATELY**, including any that penetrates the unit. After clean-up, open equipment doors and blow fumes away with compressed air.

5) Toxic Fume Prevention

Carbon monoxide - Engine exhaust fumes can kill and cause health problems. Pipe or vent the exhaust fumes to a suitable exhaust duct or outdoors. Never locate engine exhausts near intake ducts of air conditioners.

6) Bodily Injury Prevention

Serious injury can result from contact with fans or hot spots inside some equipment. Shut **DOWN** such equipment for inspection and routine maintenance. When equipment is in operation, use extreme care in doing necessary troubleshooting and adjustment. Do not remove guards while equipment is operating.

7) Medical and First Aid Treatment

First aid facilities and a qualified first aid person should be available for each shift for immediate treatment of all injury victims. Electric shock victims should be checked by a physician and taken to a hospital immediately if any abnormal signs are observed.

EMERGENCY FIRST AID	Call physician immediately. Seek additional assistance. Use First Aid techniques recommended by American Red Cross until medical help arrives. **IF BREATHING IS DIFFICULT**, give oxygen, if available, and have victim lie down. **FOR ELECTRICAL SHOCK**, turn off power. Remove victim; if not breathing, begin artificial respiration, preferably mouth-to-mouth. If no detectable pulse, begin external heart massage. **CALL EMERGENCY RESCUE SQUAD IMMEDIATELY.**

8) Equipment Precautionary Labels

Inspect all precautionary labels on the equipment monthly. Order and replace all labels that cannot be easily read.

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Introduction

This manual contains operation and maintenance information for a diesel engine-generator manufactured by Hobart Ground Systems, Palmetto, Florida 34221.

This manual is not intended to be a textbook on electricity or electronics. Its primary purpose is to provide information and instructions to experienced operators, electricians, and mechanics that have never operated this equipment. It is the intent of this manual to guide and assist operators and maintenance personnel in the proper use and care of the equipment.

Use of the manual should not be put off until trouble or a need for help develops. Read the instructions before starting the unit. Learn to use the manual and to locate information contained in it. Its style and arrangement are very similar to commercial aircraft manuals.

The manual is divided into five chapters plus an appendix. Each chapter is divided into as many sections as required. Each new section starts with page 1. Each page is identified by chapter, section and page number, which are located in the lower, outside corner.

When information located in another portion of the manual is referred to, a chapter, section, and paragraph or figure number identify its location. For example: “(see Section 2-3, Paragraph 1.a.)” refers to information located in Chapter 2, Section 3, Paragraph 1.a. If a chapter and section are not indicated in a reference, the referenced material is located in the same section as the reference, for example: “(see Paragraph 1.a.).”

The appendix is the last section. It contains a list of available options that may be purchased or have been purchased with that unit. Items on the list with check marks next to them have been added to the standard unit per the customer’s order. Literature for each option follows. The appendix will help control the information in the manual making it unique to the unit purchased.

In addition to operation and maintenance instructions, the manual contains an illustrated parts list in Chapter 4 and a collection of manufacturer’s literature and supplemental information in Chapter 5.

Contents of the manual are arranged as follows:

Chapter 1 Description/Operation

Chapter 2 Servicing/Troubleshooting

Chapter 3 Overhaul/Major Repair

Chapter 4 Illustrated Parts List

Chapter 5 Manufacturer’s Literature

Appendix A Options

If you have any questions concerning your Hobart Ground Power equipment, immediately contact our Service Department by mail, telephone, FAX, or E-Mail.

Write:	Hobart Ground Systems Service Department 11001 US Highway 41, North Palmetto, FL 34221 U.S.A.
Call Inside U.S.A.:	(800) 899-1841 (Parts) (877) 874-5322 (Service)
Call From Foreign Countries:	(941) 721-1025 (Parts) (941) 721-1092 (Service)
FAX Inside U.S.A.	(800) 367-4945
FAX From Foreign Countries:	(937) 332-5121
E-Mail :	service@hobartsystems.com
Web Page :	www.hobartsystems.com

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Chapter 1 Description/Operation

Section 1 Description

1) General

The basic generator set covered in this manual, manufactured by ITW GSE Group, Hobart Ground Systems is rated at 60 kVA and is designed to produce and deliver 115/200-volt, 400 Hz, 3-phase AC power to a parked aircraft or other load. Some generator models with the TR option also provide 28.5 volts DC for aircraft having those requirements.

The number 500061 identifies the model or series of the GPU. The part number is followed by a different dash number that separates the basic units available. Figure 1 uses the part number to identify the variations covered in this manual.

Part & Dash Number	Fuel Tank	Exhaust	Mounting	AC Outputs	28.5 DC Output
500061A-001	Stainless	Vertical	Trailer	Single	Yes
500061A-101	Composite	Vertical	Trailer	Single	---
500061A-102	Composite	Vertical	Trailer	Dual	---
500061A-103	Composite	Vertical	Fixed	Single	---
500061A-104	Composite	Vertical	Fixed	Dual	---
500061A-105	Composite	Vertical	Trailer	Single	Yes
500061A-106	Composite	Vertical	Fixed	Single	Yes
500061A-107	Composite	Vertical	Truck	Single	Yes
500061A-201	Composite	Horizontal	Trailer	Single	---
500061A-202	Composite	Horizontal	Trailer	Dual	---
500061A-203	Composite	Horizontal	Fixed	Single	---
500061A-204	Composite	Horizontal	Fixed	Dual	---
500061A-205	Composite	Horizontal	Trailer	Single	Yes
500061A-206	Composite	Horizontal	Fixed	Single	Yes

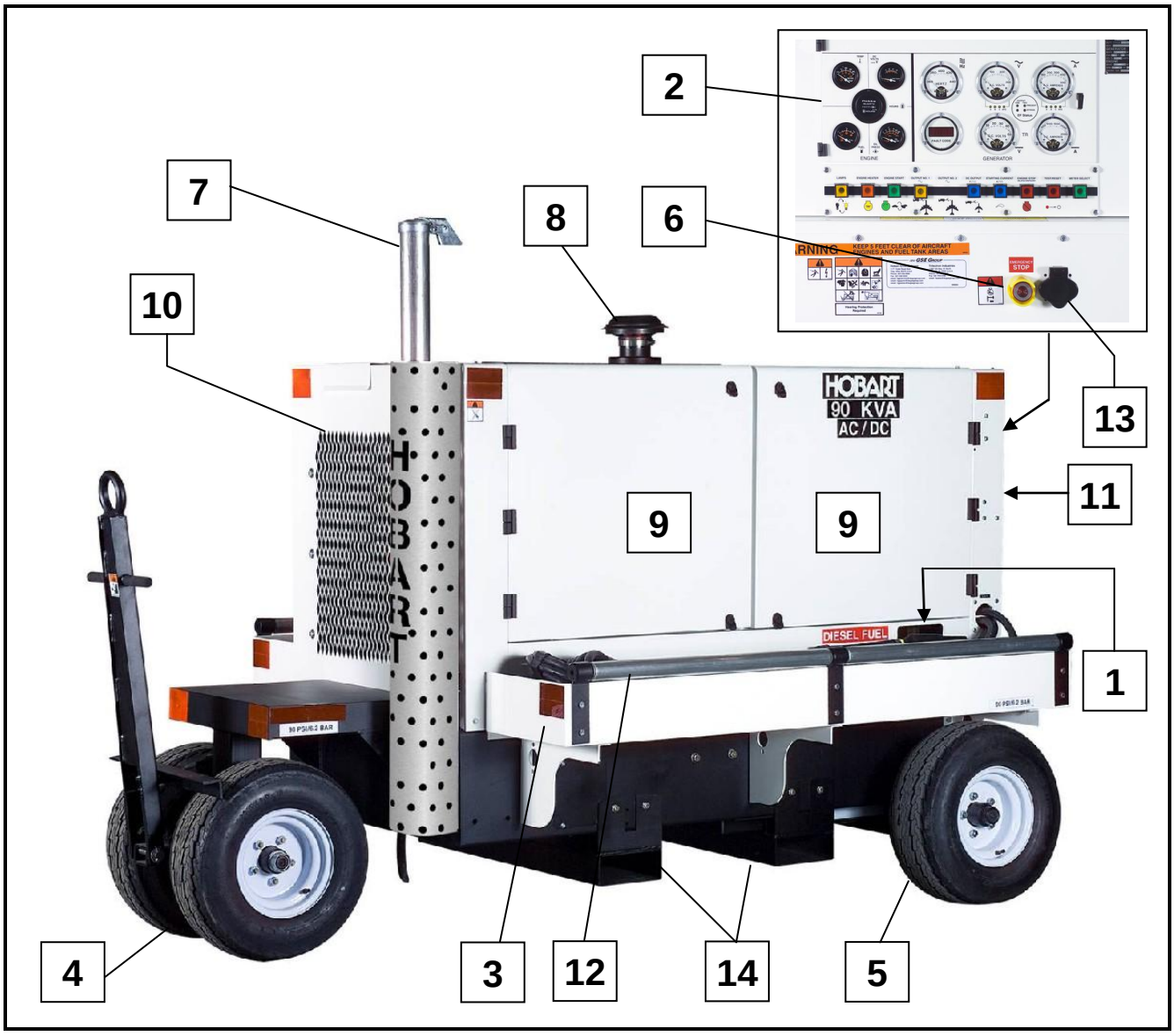
Table 1: Series 500061A Generator Set Part Number Descriptions

2) Optional Equipment - Appendix A

Chapters 1 through 5 of this Operation and Maintenance Manual identify only the stripped down version of the 60CU20 generator set. A list of optional equipment appears in Appendix A.

3) Orientation

For purpose of orientation when designating RIGHT and LEFT throughout this manual, the radiator is considered to be at the FRONT of the unit and the generator and controls are at the REAR. RIGHT and LEFT are determined by standing at the REAR facing the machine. As an example, the fuel filler neck is mounted on the LEFT REAR side of the unit.



1. Fuel Filler Neck
2. Operator's Control Panel
3. Output Cable Trays
4. 5th Wheel Assembly
5. Rear Drop Axle Assembly
6. Emergency Stop Switch (S28)
7. Exhaust Stack Outlet
8. Engine Air Intake
9. Lift Off Access Doors
10. CAC/Radiator End
11. Generator End
12. Cable Rollers (optional)
13. Block Heater Receptacle (optional)
14. Forklift Pockets (optional)

Figure 1: General Assembly of Generator Set

4) Specifications

a) Physical Specifications

Physical	Basic Unit (Fixed Mount)	With Trailer
Length	74 in. (1880 mm)	101 in. (2570 mm) w/ tow bar up
Width	67 in. (1702 mm)	67 in. (1702 mm)
Height	59 in. (1499 mm)	67 in. (1702 mm)
Weight	4000 lb. (1814 kg.)	4300 lb. (1950 kg.)
Weight with 28.5 VDC T-R	4300 lb. (1950 kg.)	4600 lb. (2087 kg.)

b) AC Generator Specifications

Output power rating	60 kVA (48 kW)
Output voltage	115 / 200 VAC
Rated load capacity	174 Amps
Frequency (at not load and rated load)	400 Hz. ± 2 Hz.
Power factor	0.8
Duty Cycle	100%
Operating speed	2000 RPM
Overload capacity 125% rated load	218 Amps
Output cable size	2/0

c) AC Generator Protective System Specifications

Condition	Trip Point	Time Delay
Over voltage	126 volts	1-second
	140 volts	160 milliseconds
	180 volts	50 milliseconds
Under voltage	any voltage below 100 volts	7 seconds
Over frequency	420 Hz to 480 Hz	5 seconds
	above 480 Hz	immediate
Under frequency	380 Hz. or less	7-seconds
Output overload	125% load of 60 kVA on either or both outputs	approximately 5 minutes
	150% load	30 seconds
	200% load	10 seconds

d) DC Output Specifications (with optional TR unit)

Output Power Rating	17.1 kW
Output Voltage	28.5 VDC
Load Capacity (Continuous)	600 A
Current Limiting Capability	100 to 2500 A
Peak/Starting Load Capacity	2000 A for 10 seconds
Output cable size	4/0

e) DC Protective System Specifications

Condition	**Trip Point**	**Time Delay**
Over Voltage	32-34 VDC	2 seconds
Output Overload	2700 A	2 seconds
	2000 A	10 seconds
	1500 A	30 seconds
	1200 A	90 seconds
	750 A	600 seconds

f) Engine Specifications

Manufacturer and Model	Cummins Engine Company / QSB4.5
Type	4 cylinder, 4 cycle diesel, electronic controlled
Bore and Stroke	4.21 in. x 4.88 in. (107 mm x 124 mm)
Displacement	275 in^3 (4.5 L)
Horsepower	109 hp (81 kW)
Idle speed	1000 ± 50 rpm
Normal governed speed	2000 rpm
Firing Order	1-3-4-2
Electrical system	12 VDC
Lubricating oil capacity (w/ filter)	11.6 quarts (11 liters)
Coolant capacity system	20 quarts (18.9 liters)

g) Normal Operating Characteristics

Engine oil pressure (warm and at rated speed 2000 RPM)	45 to 90 PSI (445 to 621 kPa).
Engine coolant temperature (normal operation)	160 to 200º F (71 to 93º C).

5) Special Features

The generator set has special features that are described more fully under the assemblies in which they appear.

a) Protective Monitoring

The protective monitoring system receives signals from the fault sensing components in the generator output circuit and functions to cause the load to be disconnected from the generator if an abnormal condition of voltage, frequency, or load develops.

b) Voltage Regulator

A microprocessor-type, adjustable voltage regulator provides automatic voltage regulation at the aircraft. The regulated out is also adjustable for a variety of output cable sizes and lengths.

c) Engine Electronic Control Module

The engine is equipped with an electronic control module that monitors, records, and controls engine performance.

d) Battery System Disconnect Switch

The generator set is equipped with a battery disconnect switch inside the unit on the LEFT side. The disconnect switch can be placed in the off position during long periods of shutdown.

6) Canopy

A sheet metal enclosure, identified as a canopy, provides protection for the engine, generator and electrical controls. The canopy is designed to reduce the operational noise level in the immediate area of the machine.

7) Engine and Generator

The engine and generator comprise the principal components of the generator set. They are mounted on a welded steel frame chassis. Some of the following figures are showing the locations of all major components and sub-assemblies.

a) Diesel Engine

The diesel engine is a fuel injection, 4-cylinder, electronically controlled engine rated at 155 horsepower. See Figure 3 for specifications and capabilities.

b) Engine Manufacturer's Components

As received from the engine manufacturer, the engine includes some of the following components, which are more fully described in the engine manufacturer's manual.

(1) Electrical System

The 12 VDC electrical generating and starting system includes an alternator and starter with solenoid switch.

.

(2) Lubricity Additive Fuel Filter

The fuel filter is a spin-on disposable type located on the inside near the engine's fuel pump. The fuel filter's primary function, other than remove contaminants from the fuel, is to automatically add a lubricity additive to the fuel. Although, the engine manufacturer does not recommend low lubricity fuels, this additive can extend the life of the fuel pump.

CAUTION	The use of low lubricity fuels can shorten life and/or damage the engine's fuel pump. Only diesel fuel is recommended by the engine manufacturer. Refer to engine manufacturer's manual for approved fuels.

(3) Oil Filter

The engine oil filter is a spin-on, full-flow type, located on the right side of the engine near the front.

(4) Pre-programmed Electronic Control Module (ECM)

The ECM is a pre-programmed engine control module, mounted directly to the engine block.

c) Factory Installed Components and Protective Systems

This generator set is assembled at with the following components and protective systems:

(1) Shutdown/Reset Systems

- Emergency Shutdown / Reset Switch (S28)

  The emergency shutdown switch has two purposes. One is to reset the starting circuit following a failed starting sequence. The other is to provide instant manual shut off of the generator set by disconnecting power to the ECM through the control box. It is located on the rear of the generator set under the control box.

  To operate the **EMERGENCY SHUTDOWN/RESET SWITCH**:

  - Push button in until engine stops or until button travel stops
  - Pull the button back out to reset

- Coolant high temperature shutdown system

  The coolant temperature shutdown system consists of a factory supplied temperature switch. This switch is monitored by the microprocessor on the EIB (Engine Interface Board) PC Board, which will stop the engine if the temperature reaches 210º F (99º C).

- Low coolant shutdown system

  The low coolant shutdown system consists of an engine manufactured supplied switch. This switch is mounted in the radiator top tank and monitored by the engine's ECM, which will stop the engine when a low coolant level is reached.

- Oil pressure shutdown system

  The oil pressure shutdown system consists of a factory supplied oil pressures switch. This switch is monitored by the microprocessor on the EIB (Engine Interface Board) PC Board, which will stop the engine if the oil pressure is under 12 PSI (82.7 kPA).

- Low fuel shutdown system

  The low fuel shutdown system monitors the fuel level in the fuel tank. When the fuel tank level reaches approximately $^1/_4$ tank the word fuel is displayed on the fault code gauge signifying that it is time to put fuel in the tank. Once the fuel level reach approximately $^1/_8$ tank the engine will shutdown.

(2) Radiator and Charge-Air-Cooler (CAC)

The radiator and charge-air-cooler is a two-piece type designed for long periods of operation without servicing. Refer to Section 2-1 for servicing procedure.

(3) Engine-cooling fan

The engine fan is designed to blow air outward through the radiator, rather than pulling the air inward as a conventional fan does.

(4) Master [Battery] Disconnect Switch (MD1)

The master disconnect switch is designed to isolate the batteries from the entire electrical system to eliminate the possibility of battery current draw by the engine ECM or any other components between long periods of no operation. The switch can also be used to prevent starting of the equipment for maintenance conditions.

(5) Air cleaner

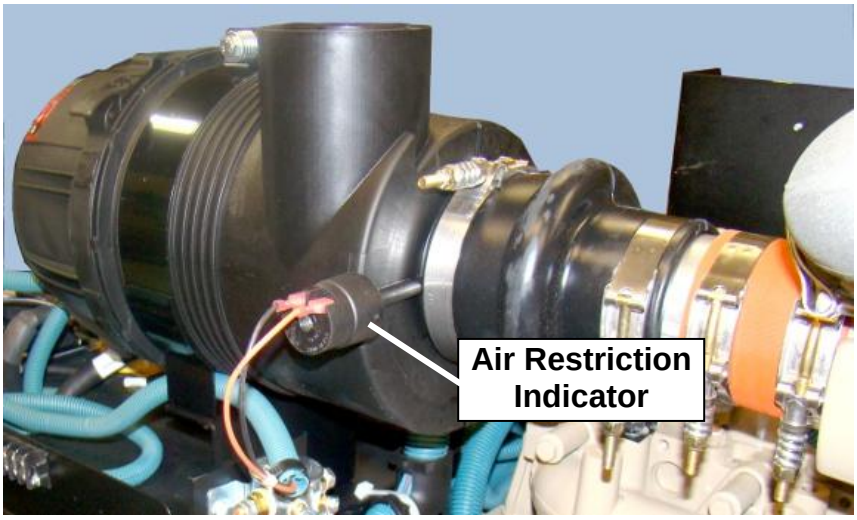


Figure 2: Air Cleaner

The diesel engine air cleaner is so constructed that air enters through its cylindrical body, and then is filtered before being passed into the engine turbo-charger assembly. An air cleaner service indicator device is mounted on the air cleaner assembly to monitor the airflow into the air cleaner. As the air cleaner becomes filled with dust, dirt, and carbon, the intake system airflow becomes increasingly restricted. This restriction causes a diaphragm inside the indicator to move toward an electrical contact. When the maximum allowable restriction level is reached, the circuit closes and the air cleaner indicator fault appears on the control panel fault display to warn the operator that the air cleaner must be changed. The electrical indicator automatically resets when the restriction level drops sufficiently.

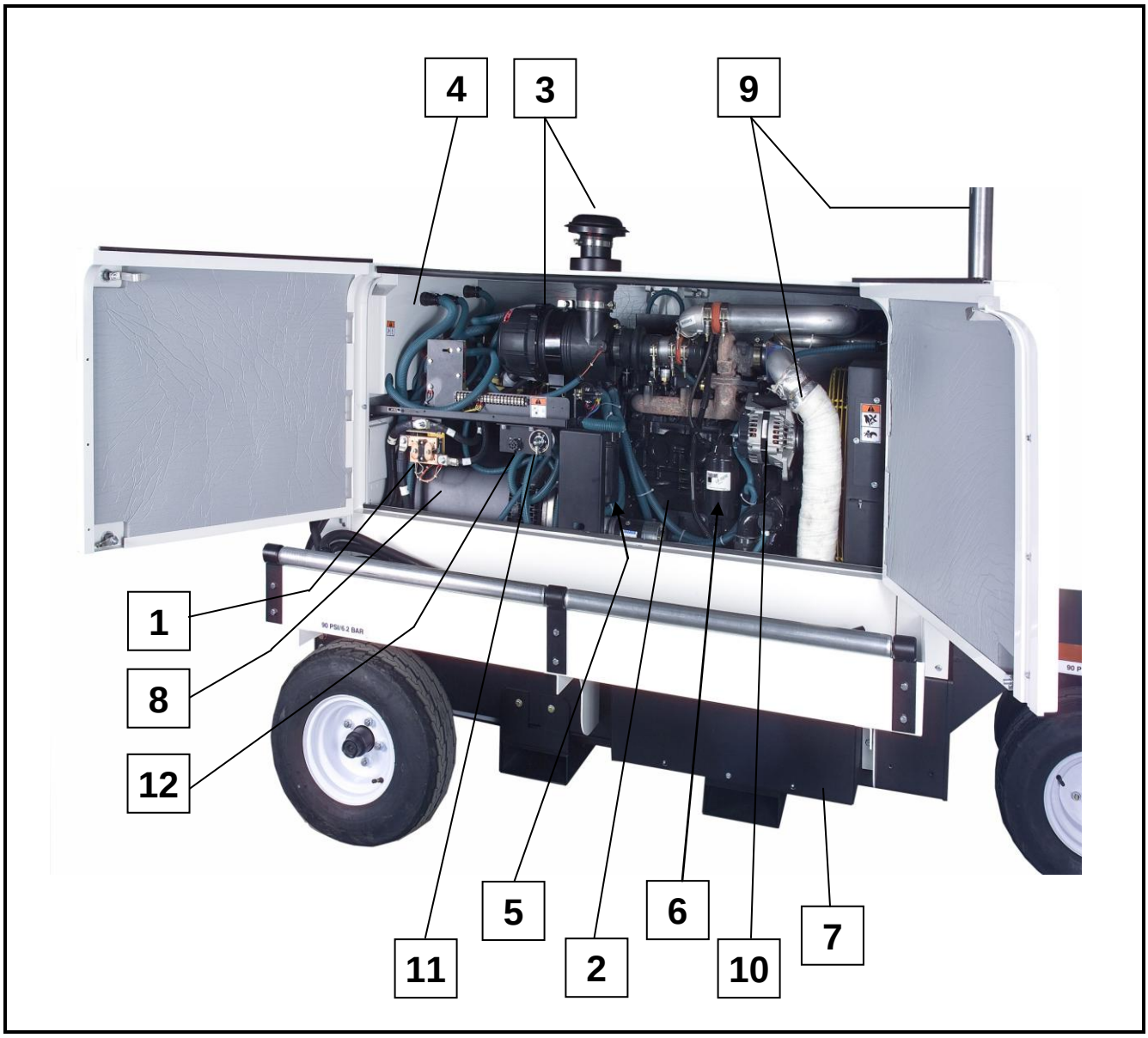
d) Engine faults

The following is a table listing faults, which may occasionally occur. Column two of the table explains what happens in the engine's circuitry when the fault occurs, and column three tells how to return the generator set to service once the problem is solved. Refer to Chapter 2 for more details on all other faults.

ENGINE FAULTS		
Engine Fault Condition	**What Occurs**	**How To Reset**
Over temperature or low oil pressure	Shuts down the engine, and will be indicated will appropriate fault code.	**a)** Press the engine stop button to reset the fault code and reset the protective system. **b)** Or use E-STOP button for immediate reset.
Low fuel warning and shutdown	Turns on the low fuel indication on the fault code meter. The GPU is programmed at the factory to warn at $^1/_4$ tank and to shutdown at $^1/_8$ tank.	**a)** The low fuel fault indicating function must be reset by pressing the engine stop button Fuel must be added prior to attempting another engine start. **b)** Or use E-STOP button for immediate reset.
Clogged air cleaner or other restriction in the combustion air inlet.	Turns on the air cleaner restriction indicating fault code.	**a)** Press the engine stop button. The restriction must be removed prior to attempting another engine start. **b)** Or use E-STOP button for immediate reset.

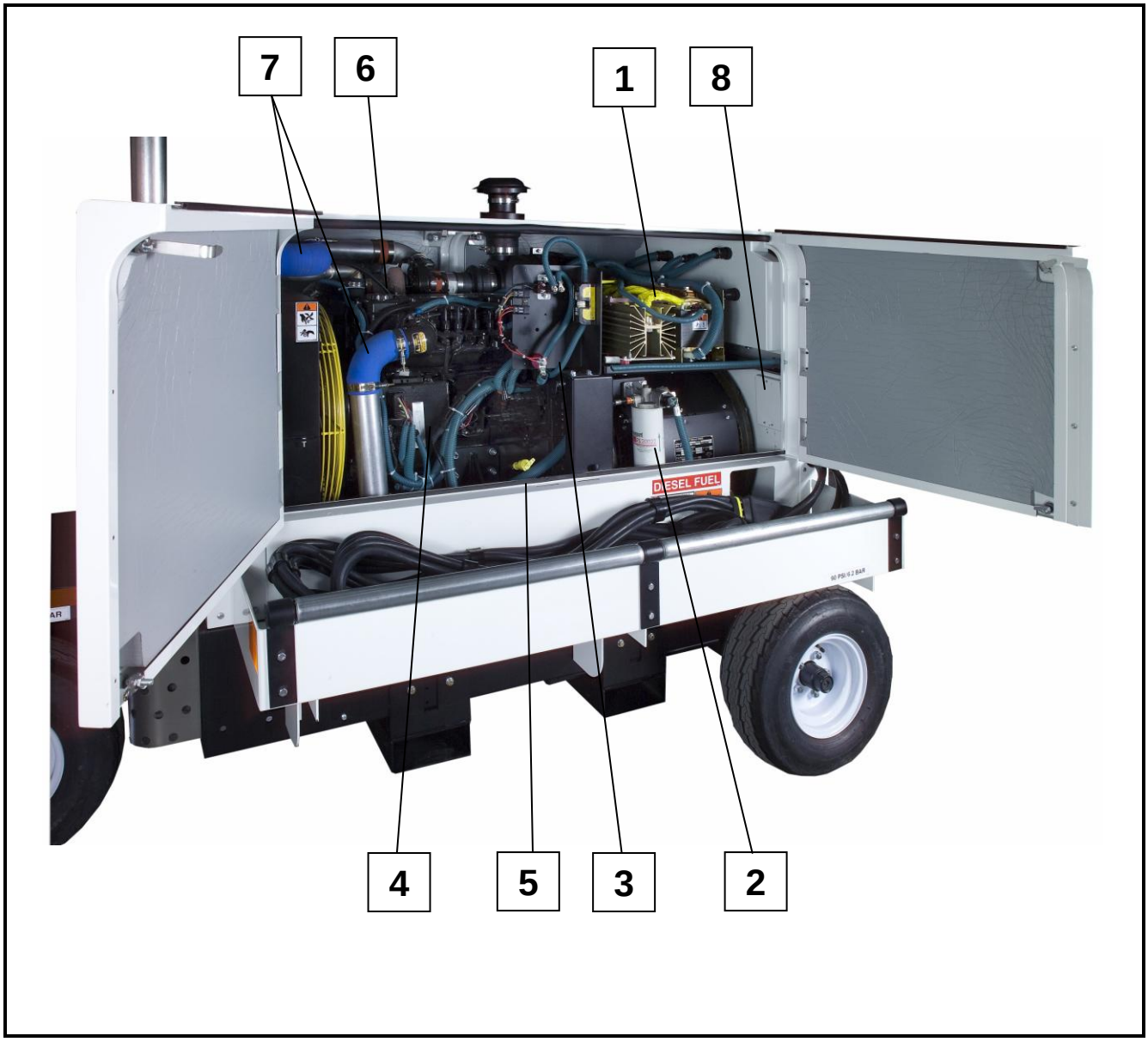
e) Generator

The 400 Hz generator is a brushless, dual bearing, revolving field, three-phase, alternating current type. The front end of the rotor shaft extends forward beyond the front bearing and is coupled to the engine flywheel by a flexible coupling assembly. The rear end of the rotor shaft extends rearward beyond the rear bearing and into the exciter stator housing. The exciter rotor is mounted on this shaft extension with a key and is secured by a washer and 1/2-13 thread cap screw. A rectifier has six diodes mounted on the exciter rotor and converts exciter AC output to DC for excitation of the generator revolving fields. The exciter DC output to the generator fields, and consequently the generator output, is controlled by the voltage regulator PC board (REG). A centrifugal, radial-blade fan draws cooling air over all internal windings. Air enters at the exciter end and is discharged at the drive end. The complete generator assembly is bolted to the engine's flywheel and housing.



1. 28.5 VDC Contactor (optional)
2. Cummins QSB4.5 Engine
3. Air Filter Assembly
4. Operator's Control Panel (back side)
5. Engine Fuel Filter (behind support leg)
6. Engine Oil Filter
7. 12 VDC Batteries (incase in housing)
8. Generator
9. Turbo Exhaust Pipe / Exhaust Outlet
10. Engine Alternator
11. Battery Disconnect Switch
12. Engine ECM Connector

Figure 3: Main Components of Generator Set (Right Side)



1. 28.5 VDC Transformer-Rectifier (optional)
2. Lubricity Additive Fuel Pre-Filter
3. Engine Electronic Fuse and Relay Panel
4. Engine Control Module (ECM)
5. Engine Oil Level Check
6. Engine Air Intake Heater
7. Charge-Air-Cooler Piping
8. Power Module / Contactor Panel (back side)

Figure 4: Main Components of Generator Set (Left Side)

8) Control Box Assembly

The control box is a sheet metal enclosure that houses and provides mounting facilities for engine and generator controls, as well as, monitoring device and circuits.

a) Operator Controls

The control system is divided into three sections. On the left side of the control panel, as one faces it, are engine meters. On the right side of the control panel are generator meters. Below the control panel are pushbutton switches for operating the engine and generator.

(1) Engine Monitoring Section

- Engine coolant temperature gage (M24)

  The temperature gage is an electrical type that is connected by a wire to a water temperature sensor installed in the engine cooling system. The gage indicates engine coolant temperature in the range of 100-280 º F (38-138º C).

- Engine hour meter (M4)

  The hour meter is electrically driven from the 12 VDC battery system. The hour meter measures and records the engine's running time and will record up to 9999.9 hours on five revolving drums. It is only functional when the engine is running.

- Engine voltmeter (M5)

  The voltmeter indicates the voltage across the 12 VDC batteries. The meter scale is graduated 10 V to 16 V.

- Engine fuel gage (M13)

  An electric fuel gauge receives its controlling signal from a sending unit in the fuel tank. 12 VDC operating power is supplied to the fuel gauge when the **ENGINE START** pushbutton switch is pressed. The fuel level can also be checked when the unit isn't running by pressing the panel light **LAMPS** pushbutton switch.

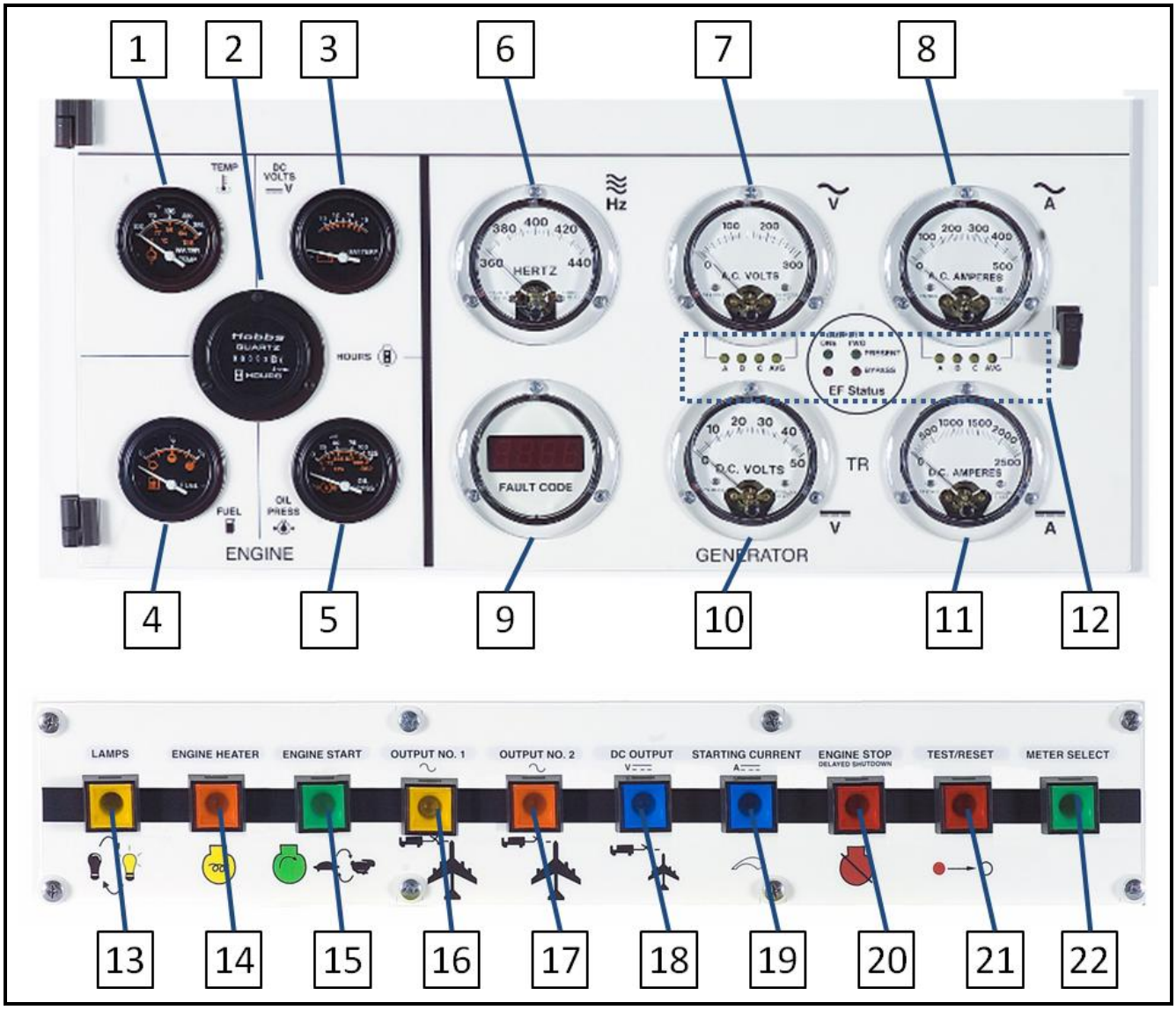
- Engine oil pressure gage (M25)

  The oil pressure gage is an electrical type that is connected by a wire to an oil pressure sensor installed in the engine lubricating system. The range is 0 to 125 PSI (0 to 862 kPA).

(2) Generator Monitoring Section (shown with analog meters)

- Frequency Meter (M3)

  The frequency meter is an analog type and indicates the frequency of the generator output alternating current in the range of 360 to 440 Hz (cycles per second).



1. Engine Coolant Temperature Gauge (M24)
2. Running Time Meter (M4)
3. Battery Voltmeter (M5)
4. Fuel Gauge (M13)
5. Oil Pressure Gauge (M25)
6. Frequency Meter (M3)
7. AC Generator Voltmeter (M2)
8. AC Generator Ammeter (M1)
9. Fault Code Meter (M6)
10. DC Voltmeter *[Optional with TR]*
11. DC Ammeter *[Optional with TR]*
12. Front LED Display (A5)

13. Panel Light Switch (S74)
14. Air Intake Heater Switch (S79)
15. Engine Start Switch (S24)
16. AC Output No. 1 Switch (S75)
17. AC Output No. 2 Switch (S275)
18. DC Output Switch (S430) *[Optional with TR]*
19. DC Starting Current Switch (S431) *[Optional with TR]*
20. Engine Stop Switch (S76)
21. Test/Reset Switch (S77)
22. Meter Selector Switch (S3)

Figure 5: Operator Controls

- AC Voltmeter (M2)

  The voltmeter indicates the generator output voltage in each phase-to-neutral (A-N, B-N and C-N) or phase-to-phase (A-B, B-C and C-A) as selected by the METER SELECT switch. The voltmeter has a scale of 0 to 300 V.

- AC Ammeter (M1)

  The ammeter indicates the generator output current in each phase (A, B and C) as selected by the METER SELECT switch. The ammeter has a scale of 0 to 520 A.

- Fault Code meter (M6)

  The function of the fault code meter is to indicate to the operator, that an abnormal condition of over voltage, under frequency, etc. occurred, which caused the protective monitoring system to function. When one of the circuits are activated, it shows the code on the fault code meter. The fault will remain on for a short period or until the TEST/RESET switch is pressed. Pressing the TEST/RESET switch can also test the fault code meter operation. A meter test should be performed only when disconnected from a load, as the contactor(s) will open during the test cycle.

- Front LED Display (A5)

  The front LED display indicates which voltage (A-N, A-B, etc…) and amperage are shown on the meters and whether EF BY-PASS is present or bypassed. This EF BY-PASS indicator serves to warn the operator that if the plug interlock system was by-passed any exposed cable may be live.

- DC Voltmeter [Optional with TR]

  The voltmeter monitors and displays the transformer-rectifier's output voltage. The voltmeter is an analog type and indicates the output voltage from 0 to 50 VDC.

- DC Ammeter [Optional with TR]

  The ammeter monitors and displays the transformer-rectifier's output current. The ammeter is an analog type and indicates the output voltage from 0 to 2500 A.

(3) Operator Pushbutton Switch Section

- **LAMPS** switch (S74)

  The LAMPS switch controls the lights. Meters are lighted from inside the control panel.

- **ENGINE HEATER** switch (S79)

  The ENGINE HEATER switch activates the standard cold starting aid (manifold air intake heater), which is totally controlled by the engine's ECM. Once the heater is activated, the engine's ECM will control the operation. The heater typically stays on for a period of approximately 30 seconds, which is indicated by the light on the push-button. When the light goes out, the engine is ready to start. Starting a cold engine without first warming the engine will lead to excessive white smoke exhaust and the engine may be hard to start.

- **ENGINE START** switch (S24)

  The ENGINE START switch, when pressed, connects 12 VDC power to the starter solenoid coil, which actuates the solenoid switch to connect power to the engine starting motor. The 12 VDC power is supplied directly to the engine ECM and the oil pressure shutdown switch is bypassed (This bypass is necessary for engine starting because the low oil pressure switch is CLOSED until the engine is running normally). When the engine is running at idle speed, a green indicating light, within the ENGINE START push button switch, flashes at a rate of 1 second on, 1 second off.

  When pressed a second time, this switch provides a signal to the ECM to adjust the engine speed to 2000 RPM. The green indicator light glows continuously. At the same time, a ground signal is provided to the regulator, enabling the generator to build up voltage for 400-Hz generator output. Pressing the switch once more removes these signals and the engine reverts to idle speed with a blinking green indicator light.

- **OUTPUT** switch(s) [Yellow # 1 and/or Orange # 2] (S75, S275)

  The load contactor push button switch, when pressed, closes the output contactor and turns on the respective indicating light within contactor control switches (OUTPUT NO. 1 and or OUTPUT NO. 2), indicating that power is available at the plug. When the load contactor opens for any reason, the light is turned OFF.

- **ENGINE STOP** switch (S76)

  When the ENGINE STOP switch is pressed, the red indicator will blink. Then a 3 to 5 minute delay will occur to permit the turbo and other engine components to cool evenly. After the delay, power is disconnected from the engine ECM causing the engine to shut down.

- **TEST/RESET** switch (M6, S77)

  The function of the fault code meter is to indicate to the operator, that an abnormal condition of over voltage, under frequency, etc. occurred, which caused the protective monitoring system to function. When one of the circuits is activated, it shows the code on the fault code meter. The fault will remain on for a short period of time or until the TEST/RESET switch is pressed. Pressing the TEST/RESET switch can also test the fault code meter operation. A meter test should be performed only when disconnected from a load, as the contactor(s) will open during the test cycle.

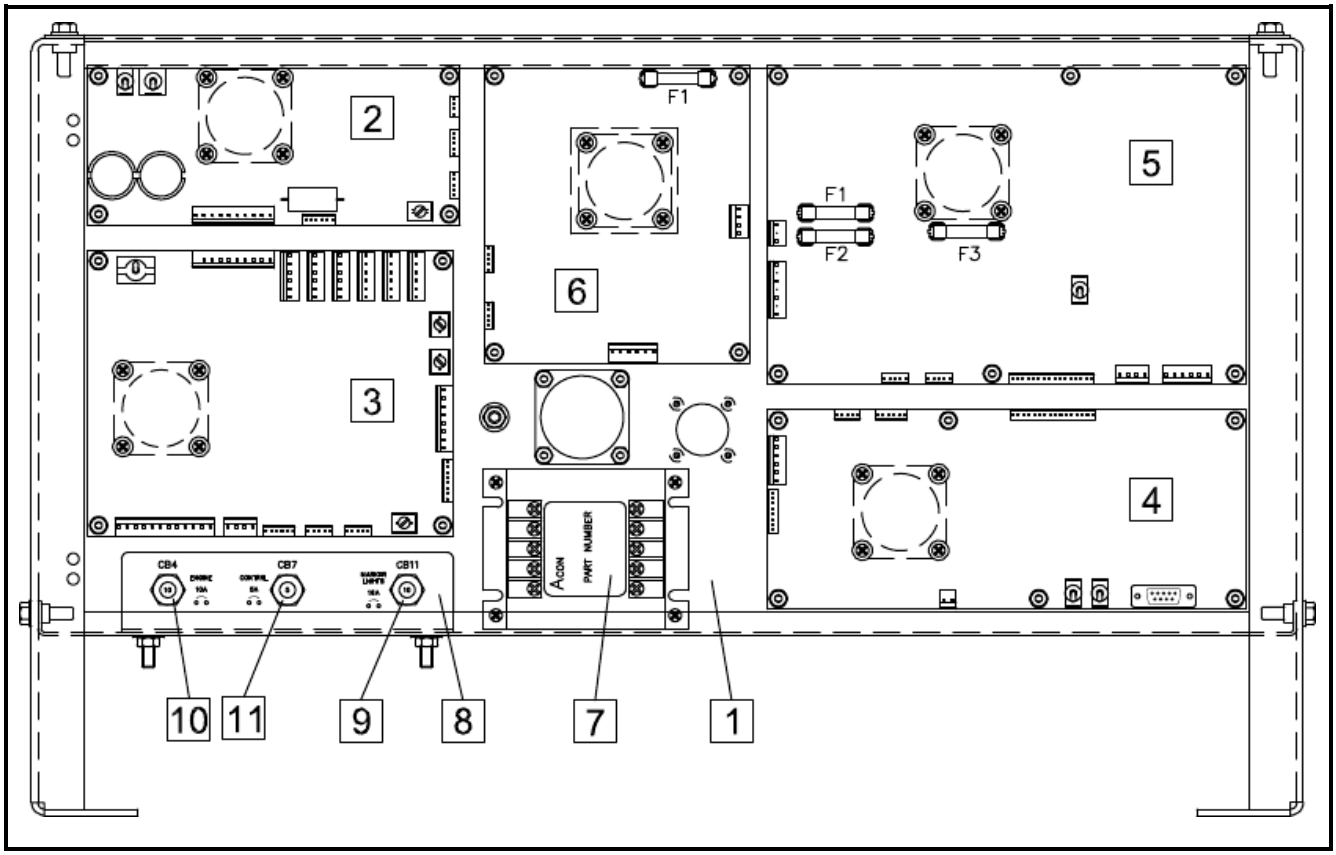
- **STARTING CURRENT** Switch (S431) [Optional with TR]

  Each time the STARTING CURRENT switch is pressed, the BLUE indicator will glow. The present current limiting amperage setting will be displayed on the fault code meter for a short time delay, before incrementing, at 100 A increments, up to 2500 A. Once 2500 A has been reached, the incrementing will start over from the beginning.

- **DC OUTPUT Switch (S430)** [Optional with TR]

  Each time the **DC OUTPUT** switch is pressed, the BLUE indicator will glow when the circuit is energized, indicating that power is available at the plug. When the load contactor opens for any reason, the light is turned OFF.

b) Control Box Interior Components



1. Control Box Wrapper
2. Engine Specific PC Board [ESB] (A1)
3. Engine Interface PC Board [EIB] (A2)
4. Digital Control PC Board [CTL] (A3)
5. Voltage Regulator PC Board [REG] (A4)
6. Transformer-Rectifier PC Board [TRB] (A404) *{Optional}*
7. +5, -12 VDC Power Supply (PS1)
8. Circuit Breaker Support Bracket
9. Marker Lights Circuit Breaker, 10 A (CB1)
10. Engine Circuit Breaker, 10 A (CB4)
11. Controls Circuit Breaker, 5 A (CB7)

Figure 6: Control Box Interior Components

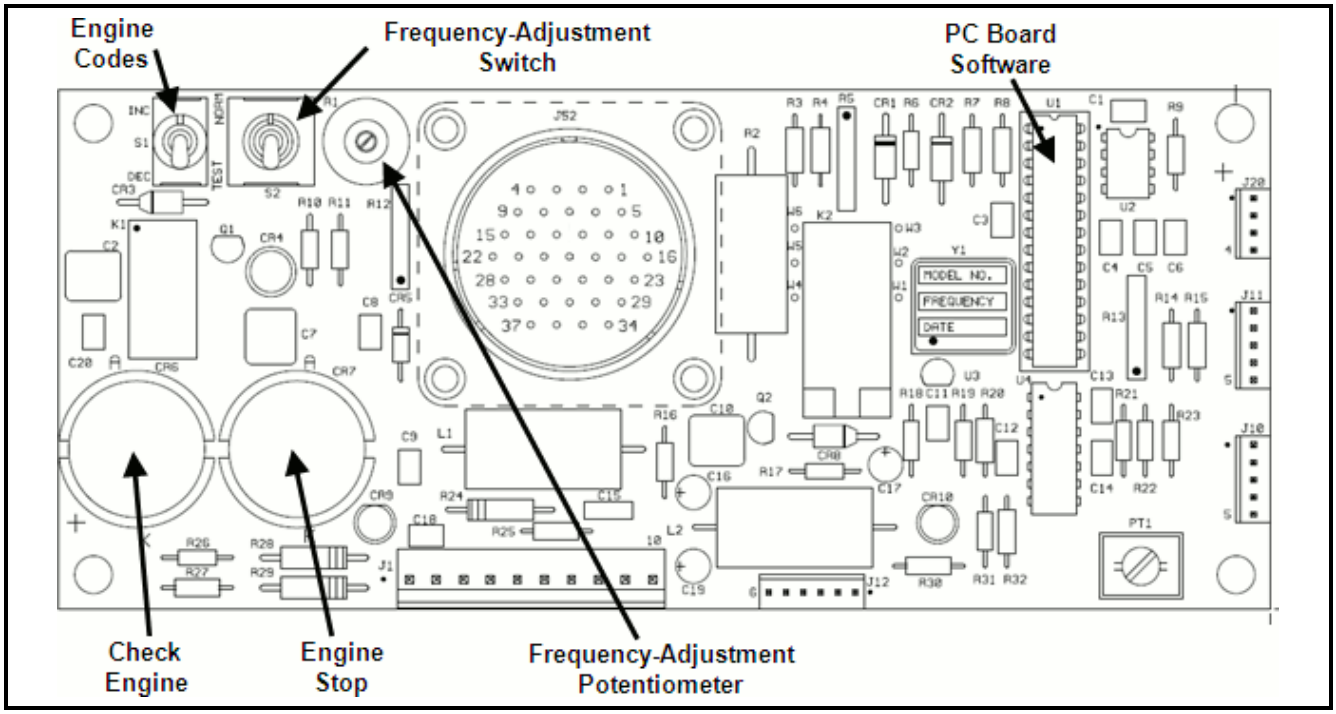


Figure 7: Engine Specific PC Board

(2) Engine Specific PC Board [ESB] (A1)

The ESB is the primary interface between the control system and the engine's electronic control module. The ESB is unique to the specific engine model. When the CTL senses the engine start button has been pressed it signals to the ESB, which then communicates to the engine control module what mode of operation is required (idle or rated speed).

The ESB controls the **FREQUENCY ADJUST** switch that is used to enable the **FREQUENCY ADJUST ENABLE/DISABLE** potentiometer to test the over/under frequency fault limits of the generator set system. The ESB also controls the **DATA REQUEST** button and diagnostic indicator light to read the engine's ECM diagnostic error codes.

(3) Engine Interface PC Board [EIB] (A2)

The EIB is common between all engine models and monitors coolant temperature, oil pressure, battery voltage, and fuel tank level monitoring. The EIB is also responsible for the monitoring the warning switches for high coolant temperature, low oil pressure, high air restriction, and low coolant level (optional). The warning switches signal the EIB when a fault occurs, which then the EIB relays this information to the CTL. The CTL will issue the command to the system that fits the fault event.

The EIB also controls the power distribution in the control system, hour meter, lights, and the engine starter operation.

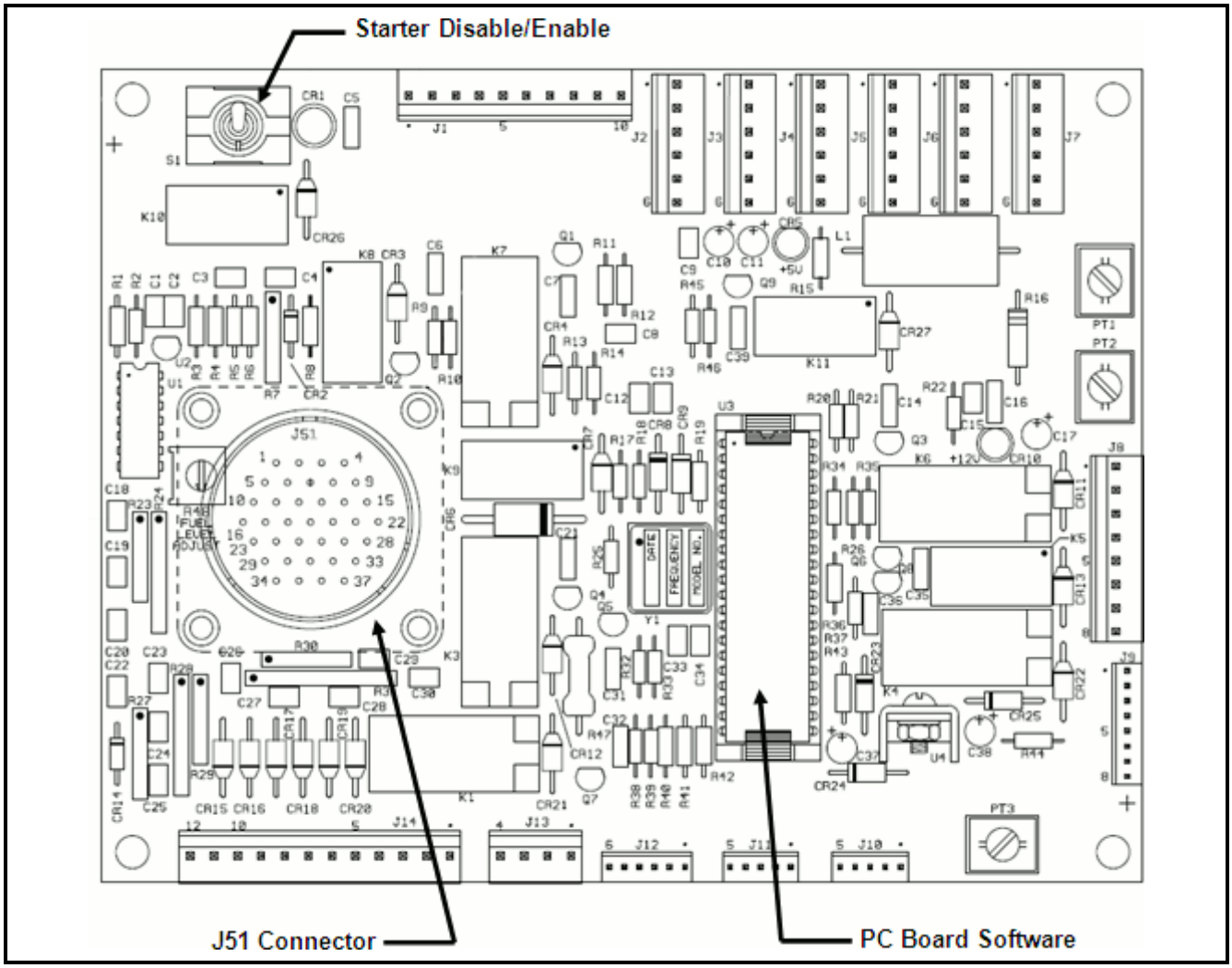


Figure 8: Engine Interface PC Board

(4) Digital Control PC Board [CTL] (A3)

The digital control PC board is the center for all communications throughout the entire control system. This board monitors the push-button switches on the control panel and issues appropriate commands to the other PC boards in the control system. The digital control PC board also controls the real time clock, monitors the over/under voltage and overload protection, controls the push-button panel indicator lights, controls the generator output meters, monitors the EF bypass switches, and communicates with the optional service tool.

EF Bypass switches (located on CTL)

The EF bypass switches, **EF1 BYPASS** for **OUTPUT 1** (or **EF2 BYPASS** for **OUTPUT 2**, if applicable), provide a means of bypassing the 28 VDC interlock circuit for the contactor when supplying power to a load bank or to an aircraft not equipped with a plug interlock system.

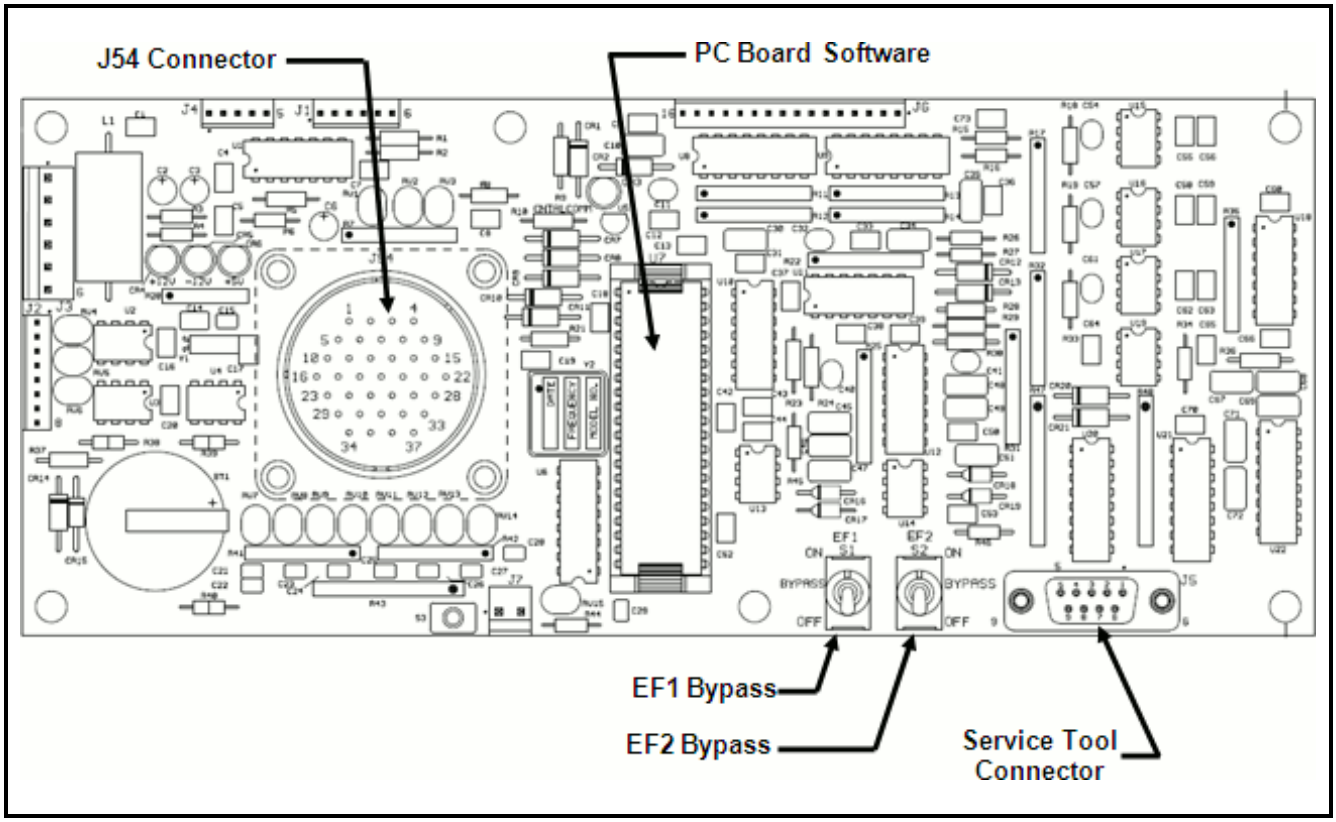


Figure 9: Digital Control PC Board

(5) Voltage regulator PC board [REG] (A4)

This voltage regulator PC board is designed to provide voltage regulation for a three-phase, four-wire, 115/200-volt, 400-Hz brushless alternator. This regulator provides field excitation power as required to meet varying alternator load conditions to hold the alternator voltage constant. In addition, the voltage regulator PC board circuitry provides line-drop compensation. Any deviation of the alternator voltage from its set, regulated level is sensed at the voltage regulator PC board. The sensing signal is compared to a reference signal, and, with associated circuitry, varies the field power supplied to the rotary exciter.

- When the machine is started, and the engine is at rated speed, the rotary exciter is excited from alternator residual magnetism through the half-wave rectifier-bridge, located on the voltage regulator PC board assembly. As the rotary exciter voltage increases, alternator excitation increases and the alternator voltage builds up. The sensing circuit of the voltage regulator PC board then compares the input voltage to a reference voltage and adjusts the field power of the rotary exciter to bring the voltage into regulation limits.

- When the alternator is loaded, its terminal voltage decreases, lowering the rectified three-phase voltage of the voltage sensing circuit. The sensing voltage is low in respect to its reference voltage, causing the voltage regulator PC circuitry to increase the power to the field of the rotary exciter. The alternator voltage increases until the voltage returns to its regulated value.

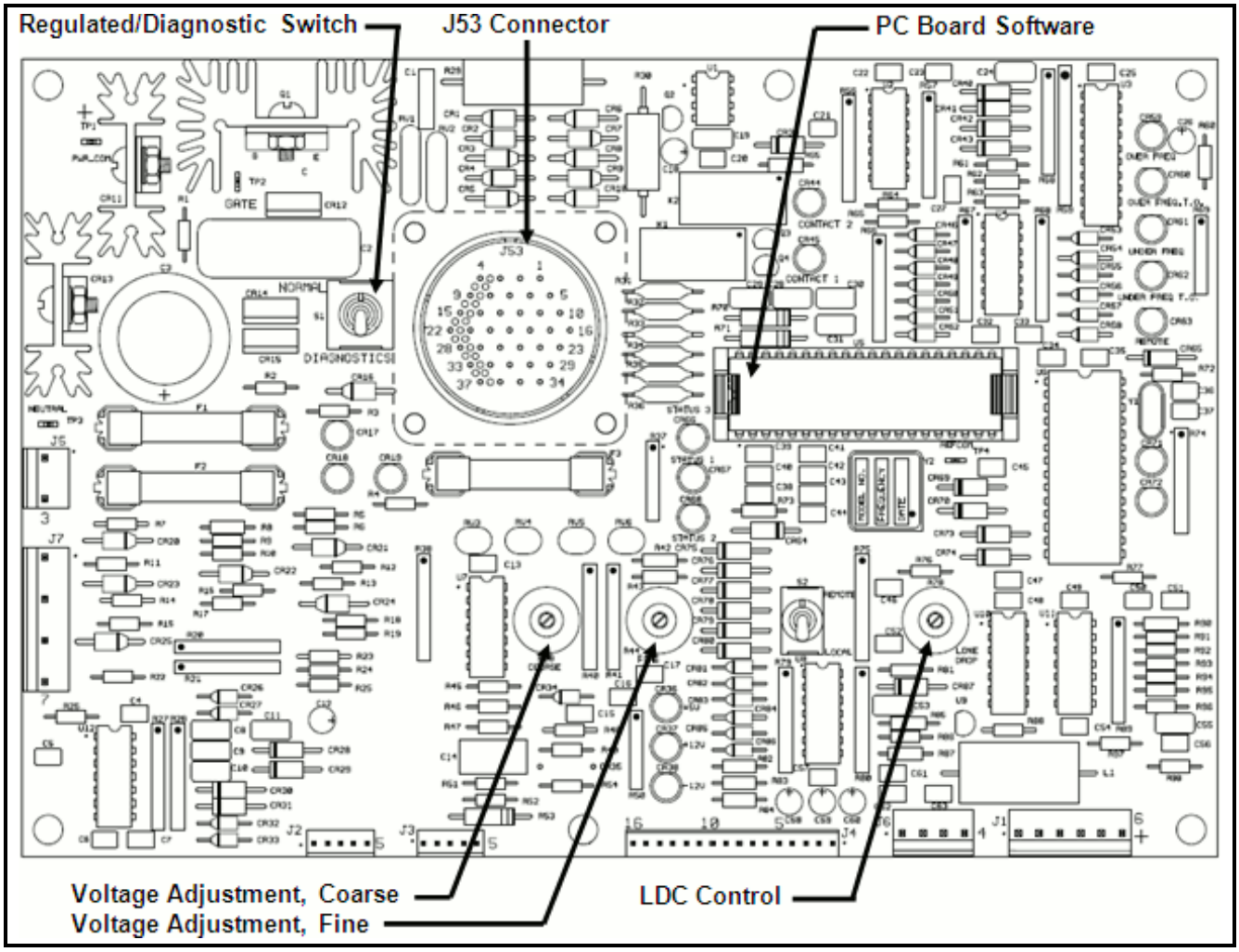


Figure 10: Voltage Regulator PC Board

- When a load is removed from the alternator, the alternator voltage rises. The rectified three-phase voltage-sensing signal increases, causing this signal to be higher than the reference signal. The associated voltage regulator circuitry causes the field power of the rotary exciter to decrease, lowering the alternator voltage until the voltage returns to regulated value.

The line-drop voltage compensation circuit consists of a current transformer on each phase of the load circuit, and fixed resistance in parallel with each current transformer. The current transformers detects the magnitude of current flowing through the power cables from the alternator to its load and feeds a signal into the voltage regulator PC board. The PC board processes this signal to change the output voltage proportional to the current draw. The regulator output increases slightly so that the alternator output voltage is equal to the regulated voltage plus the voltage drop in the lines. The line-drop compensation potentiometer may be adjusted to match exactly the voltage drop of the power cables carrying the load current.

The under/over frequency protection, EF signal, and lost neutral detection are also monitored by the REG and will signal the CTL when a fault has occurred. The CTL issues the appropriate command that corresponds to the fault.

Regulated-diagnostic switch (located on the REG)

When the **REGULATED/DIAGNOSTIC** switch is in the **REGULATED** (down) position, the generator output voltage is regulated by the PC board for 115/200 VAC output to an aircraft. When this switch is placed in the **DIAGNOSTIC** (up) position, 12 VDC is applied to the generator exciter with the engine running at rated RPM, in order to check the operation of the generator. This is done to determine if a particular power output malfunction is caused by a defective generator or by a defective voltage regulator. When this switch is in the MAINTENANCE position, no current is supplied to the generator exciter. In this condition, a low-level, unregulated voltage of approximately 30 VAC will be produced at the generator output terminals due to the residual magnetism of the exciter.

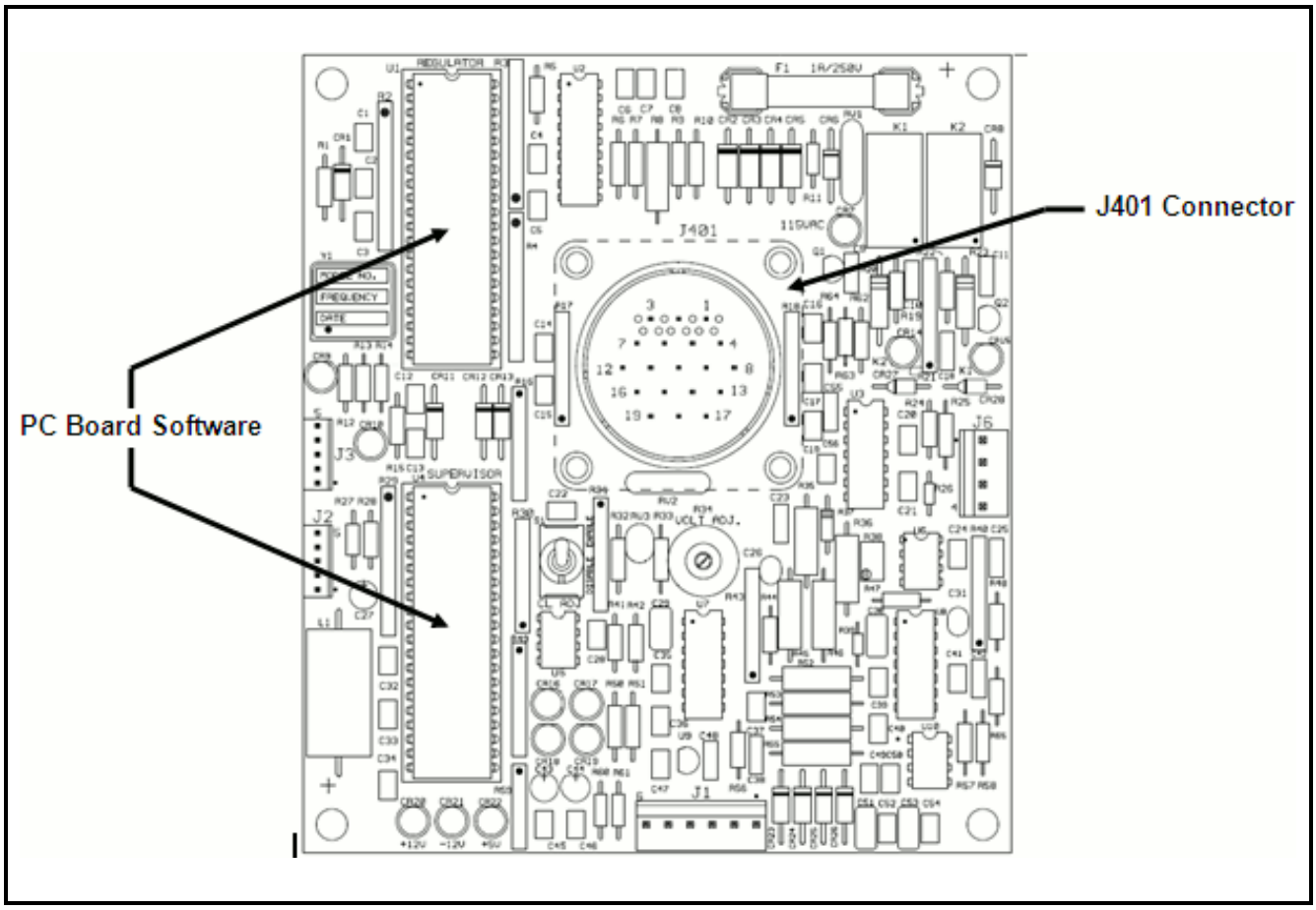


Figure 11: Transformer-Rectifier PC Board

(6) Transformer-Rectifier PC Board [TRB] (A404) *[Optional with TR]*

The TRB PC Board is only used when the optional 28.5 VDC transformer-rectifier assembly is installed. The TR monitors the output voltage, output current, controls the input and output contactors, and monitors all fault events associated with the DC output. When a fault event does occur the TRB relays this information to the CTL. The CTL will issue the command to the system that fits the fault event.

(7) +5, -12 VDC Power Source (PS1)

Supplies the internal power distribution of +5 VDC and –12 VDC into the control system.

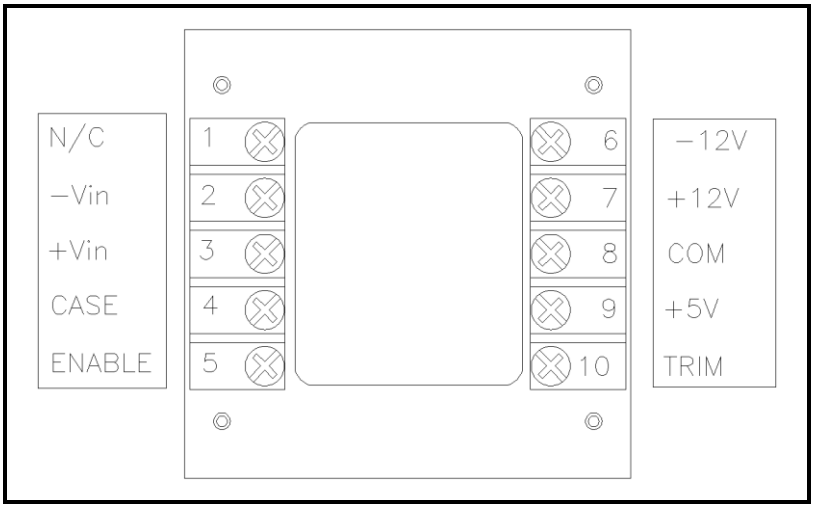


Figure 12: Control System Power Source

(8) Circuit Breakers (CB1, CB4, CB7)

Breaker Number	Breaker Name	Rating (Amps)	System Protected
CB4	Engine	10	12 VDC engine electrical and fault circuits
CB7	Control	5	12 VDC control system
CB1	Marker Lights	10	12 VDC lighting system

9) Power Module Panel Assembly

The power module panel assembly sometimes referred to as the contactor panel, is located at the rear of the machine under the control box. The panel assembly provides a means of connecting and disconnecting generator output to and from the aircraft.

a) Load contactor (K1 and K201)

Each load contactor contains a magnetic operating coil and four sets of contacts. The three larger contacts conduct three-phase AC generator output. A small contact set is connected to the Digital Control PC Board (CTL) to activate the protective monitor circuit. Three-phase, 400-Hz generator output power is distributed to the load contactor by 2/0 cables that pass through current transformers.

b) Current transformers (CT1-CT3 and CT4-CT6)

On each individual output a set of current transformers are used to monitor and control the line-drop compensation, ammeter, and overload circuit.

(1) Line-Drop Compensation

The current transformers detect the magnitude and power factor of current flowing from generator to load. They feed a signal to the voltage regulator that interprets the signal and alters the exciter field current as required to maintain a constant predetermined voltage at the load.

(2) Ammeter

The current transformers convert a current signal to a voltage signal, which is sent to the Voltage Regulator PC Board (REG). The ammeter is really a voltmeter graduated and numbered in amperes to show current proportional to the voltage signal received.

When there is overload on the output for more than 5 minutes (load exceeding 326 amperes per output or 125% of rated load), the main overload sensing circuit sends signals the load the contactor circuit to open the load contactor.

(3) Overload, No 1 and/or No. 2 output

On each individual output the current transformers converts a current signal to a voltage signal. The voltage signal is sent to the ammeter and to the overload monitoring circuit for that output. The overload monitoring circuit will open the contactor when the output current reaches 125% of the normal rated output current. The monitoring circuit monitors each individual output, as well as, the overall current for a dual output machine.

The following is a list of overload module characteristics:

- At 125% load the module will function in 5 minutes.
- At 150% load the module will function in 30 seconds.
- AT 200% load the module will function in 10 seconds.

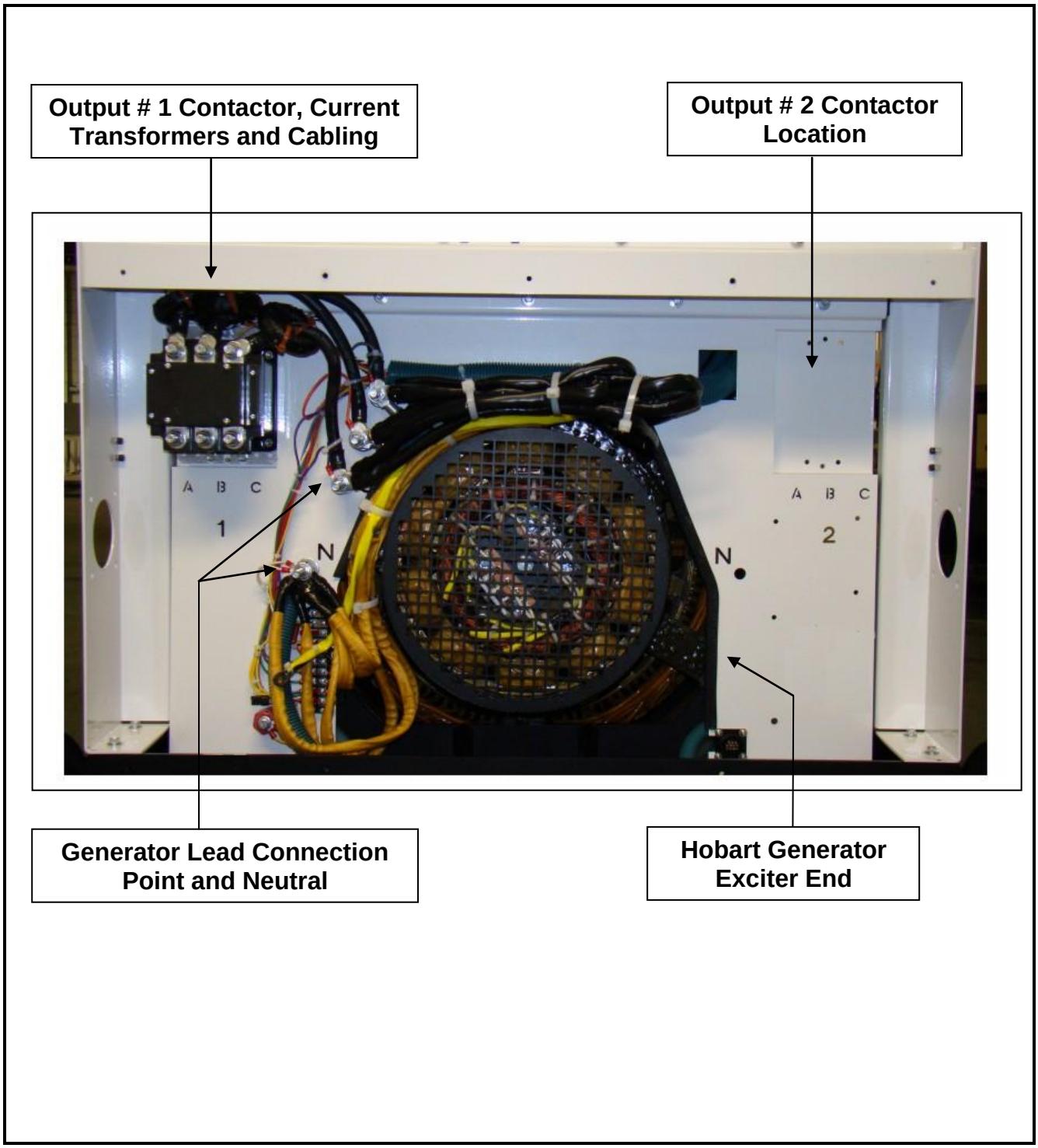


Figure 13: Output Power Module Components

10) Cold Weather Starting System (BH1)

The intake air heater, located on the intake manifold, is used for starting the engine at very cold temperatures and reduces the white smoke associated with a cold start. This cold weather starting system is fully automatic once engaged by the operator (Chapter 1, Section 3). The intake air heater (or grid heater) is energized or de-energized from a power relay controlled by the ECM. The amount of time the air intake heaters stay on, in the preheat phase, is a function of the intake manifold temperature at start up. (The pre-heat time increases with colder intake manifold temperatures). The maximum duration of the pre-heat phase is around 30 seconds. During cranking, the intake air heater is turned off to allow maximum current to be used by the starter.

CAUTION

Never use an ether start system in conjunction with the air intake heater.

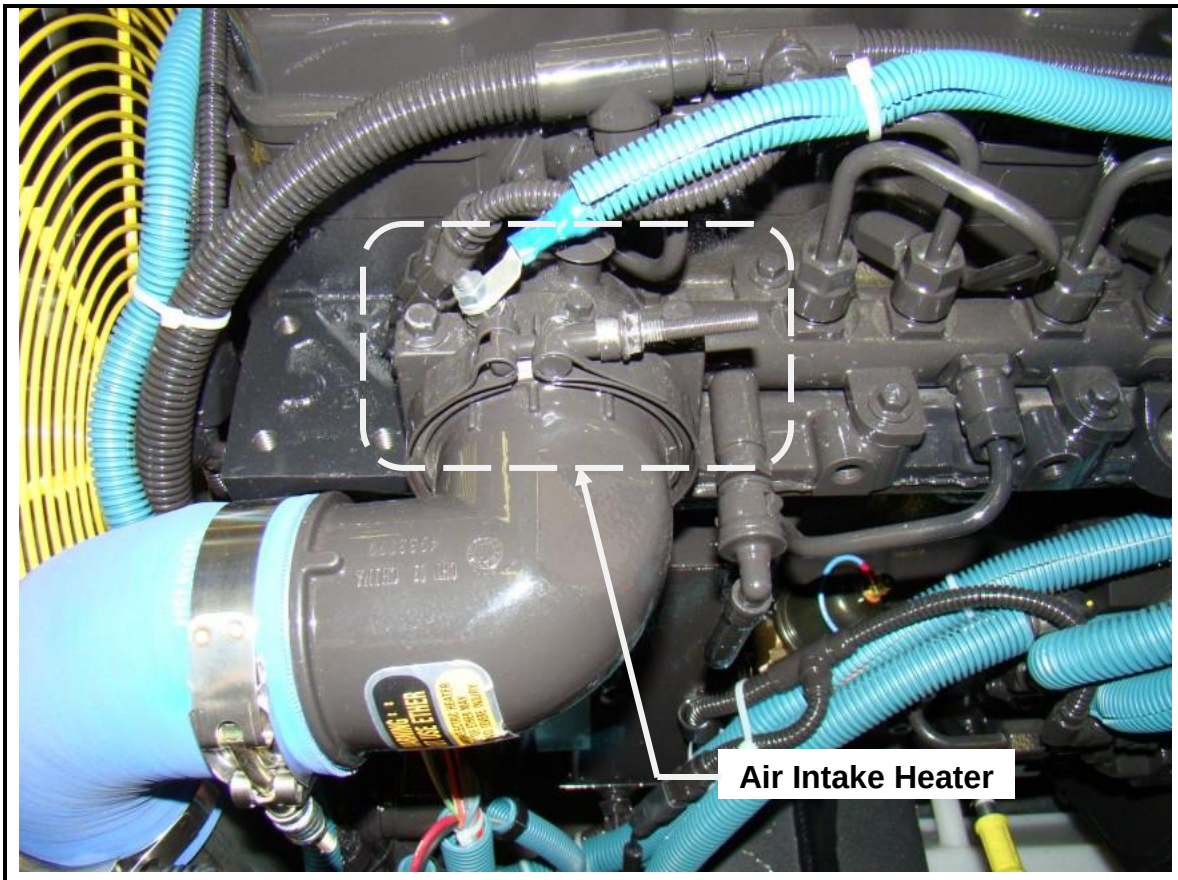


Figure 14: Air Intake Heater

11) Transformer-Rectifier (T-R) Assembly

The T-R provides a regulated output voltage of 28.5V DC. Input power is provided to the DC components from the 115/200 volt, 400 Hz generator set, through an input contactor. The output contactor provides DC power to the load. If during DC operation, AC power is required, the DC output voltage will no longer be regulated once the AC output contactor is closed. The AC voltage regulator will take over regulating the AC output voltage. The DC voltage will drop during full load applications when the simultaneous operation is used.

a) Transformer Assembly (T401)

This transformer assembly steps down the generator's output (115/200 VAC, 3 phase, 400 Hz) to 25 VAC. The smaller voltage is rectified by the six diode rectifiers, located on the heat sink assembly.

b) Heat Sink / Diode Assembly (CR402-CR407)

This assembly rectifies the AC voltage from transformer assembly, providing unfiltered 28.5V DC. A DC shunt connected to the heat sink assembly measures the DC output current.

c) Input Contactor (K401)

The input contactor applies the generator output power to the input of the transformer assembly.

d) Output Contactor (K402)

The output contactor connects the output of the 28.5 VDC power supply to the output cables. The contactor is located on the right side under the T-R Assembly.

e) DC Inductor / Filter Assembly (L401)

The DC inductor filters the raw 28.5 VDC from the diode assembly and provides low ripple 28.5 VDC output.

f) Pre-Load Resistors (R402-R404)

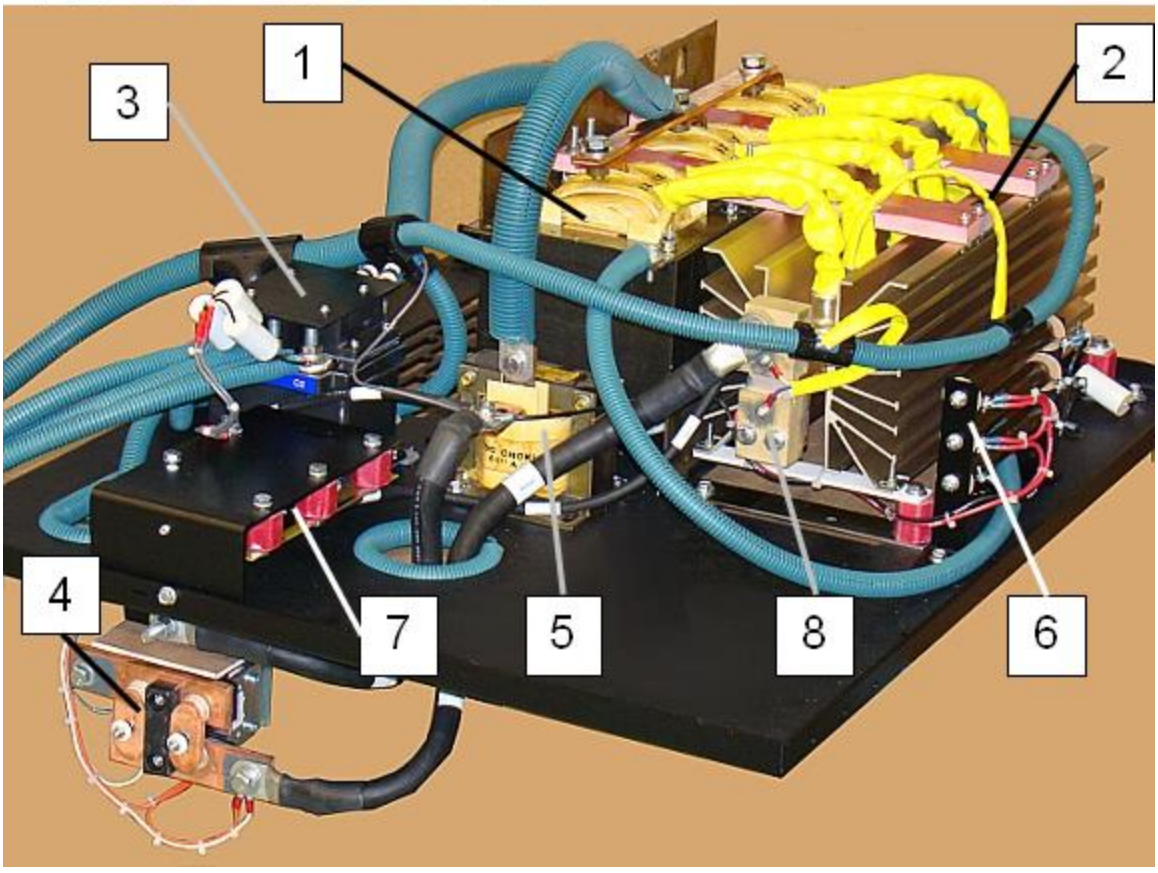
The three 10-ohm, 100-Watt pre-load resistors provide a minimum output load on the DC output.

g) Capacitor PC Board (A401)

The DC capacitor PC board works with the DC inductor as a filter to produce a low ripple 28.5 VDC output voltage.

h) Control Interlock Kit (Optional)

This optional assembly is used for applications requiring a safety interlock signal being sent back from the aircraft before closing the output contactor to delivery power to the load. See Chapter 4, Section 3 for details of the assembly and Chapter 5 for schematics and connection diagrams.



1. Transformer Assembly (T401)
2. Heat Sink / Diode Assembly (CR402-CR407)
3. Input Contactor (K401)
4. Output Contactor (K402)
5. DC Inductor / Filter Assembly (L401)
6. Pre-Load Resistors (R402-R404)
7. Capacitor PC Board (A401)
8. Shunt (R401)

Transformer-Rectifier Components
Figure 15

Section 2 Preparation for Use, Storage, or Shipping

1) Preparation for Use

a) Inspection/Check

Inspect the unit thoroughly prior to operation.

(1) Remove blocking, banding, ties, and other securing material.

(2) Inspect exterior for shipping damage such as broken lights, damaged sheet metal, etc.

(3) Open all canopy doors and inspect interior for foreign material such as rags, tools, shipping papers, etc.

(4) Check fuel, coolant, oil hoses and connections for visible leaks. Visually inspect the compartment floor and ground surface under the unit for signs of leakage. Correct any leaks by tightening hose clamps, tube fitting, etc., as required.

(5) Check security of generator set retaining components.

(6) Check the fuel level. Press the **LAMPS** pushbutton switch to energize the fuel gauge when the engine is stopped. Fuel is supplied from a customer-furnished source.

NOTE: For recommended fuel specifications, refer to the Engine Manufacturers Operation and Maintenance Manual provided with this manual.

(7) Check the engine coolant. Remove the radiator cap to check coolant level. Coolant level should be at the bottom of the filler neck.

CAUTION	Be sure the cooling system antifreeze solution is adequate to protect below the lowest temperature expected.

NOTE: For antifreeze protection, use a solution of 50% permanent antifreeze (Ethylene glycol) and 50% clean water.

Lubricating oil capacity (w/ filter)	11.6 quarts (11 liters)
Coolant capacity system	20 quarts (18.9 liters)

Figure 1: Engine Oil and Coolant Capacities

(8) Check the engine lubricating oil level. The oil gauge rod has H high mark and L low-level marks to indicate the operating lubrication oil supply. Oil level should be kept as near the high mark as possible, without going over it. See Figure 1 for capacity.

CAUTION	**NEVER** operate the engine with oil level below the **L** level mark or above the **H** level mark.

NOTE: See the Engine Manufacturer's Operation Maintenance Manual for oil recommendations.

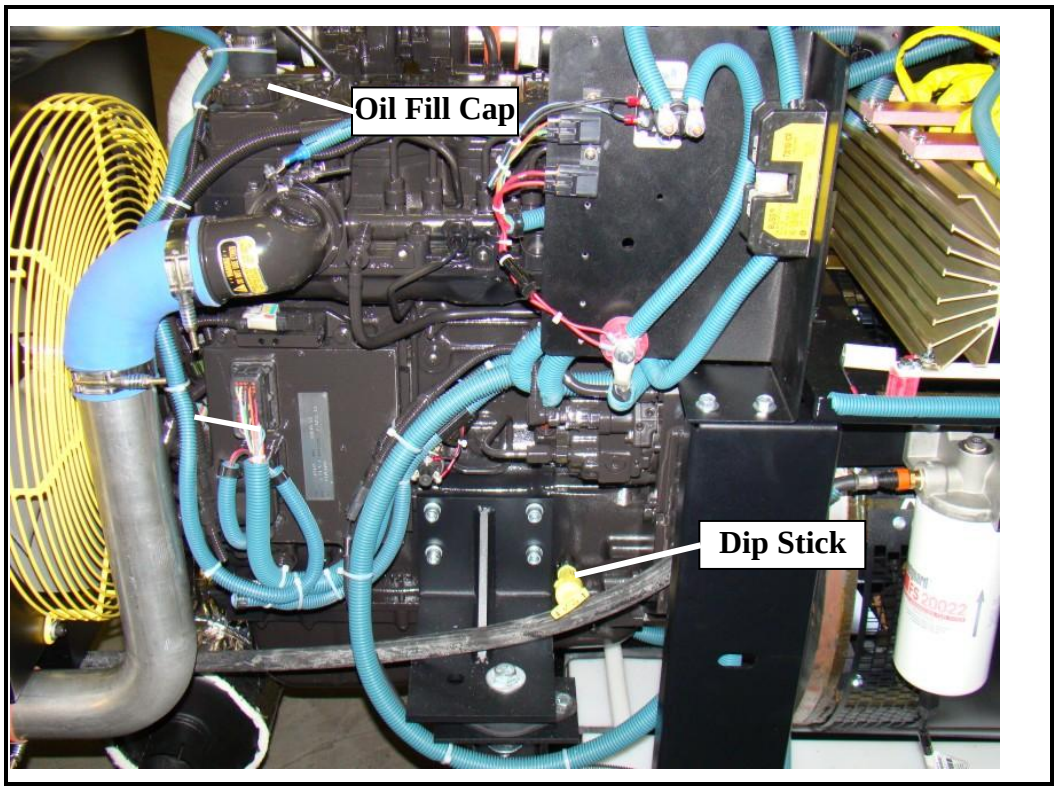


Figure 2: Oil Fill and Oil Level Check Locations

(9) Check the batteries. Inspect the batteries for proper connection of the terminals and check the electrolyte level (if possible). Service or replace if necessary.

b) Installing Three-Phase AC Output Cables

The generator set may be shipped without aircraft cables. The output cables connect to the load contactors, which are located on the power module assembly (left side of the unit beneath the engine control panel).

The conductor size recommended for AC output cables is 2/0 AWG. Use No. 12 size for control (E and F) terminals. Large cables (A, B, C, and N) should be equipped with terminals having at least a 3/8-inch diameter mounting hole. Mounting hole in small leads (E and F) should be at least 1/4-inch diameter.

To install AC output cables proceed as follows:

(1) Open the control box door of the generator set and remove the lower panel.

(2) Remove the Plexiglas cover in front of the power module assembly.

(3) Remove the cover panel on the cable tray covering the cable clamps.

(4) Loosen the screws on the cable clamps.

(5) Route the cables through cable clamps, and up to the load side of the load contactor(s).

(6) Connect the phase cable terminal lugs to the appropriate terminal studs on the contactor(s): cable lug A to terminal stud A, B to B, and C to C.

(7) Connect the cable's neutral terminal lug securely to the neutral (ground) stud on the power module assembly.

(8) Connect the E and F cables to the E and F studs on the power module assembly.

(9) Tighten the clamp screws securely, but avoid damage to the cable insulation.

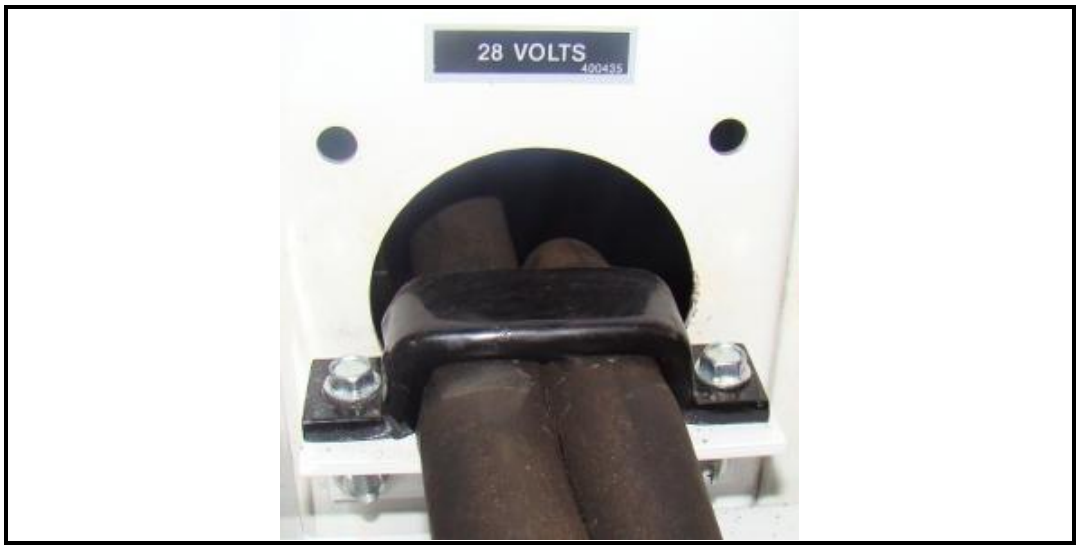
(10) Replace the Plexiglas cover panel and lower panel and close the canopy door.

c) Installing the DC Output Cable (optional)

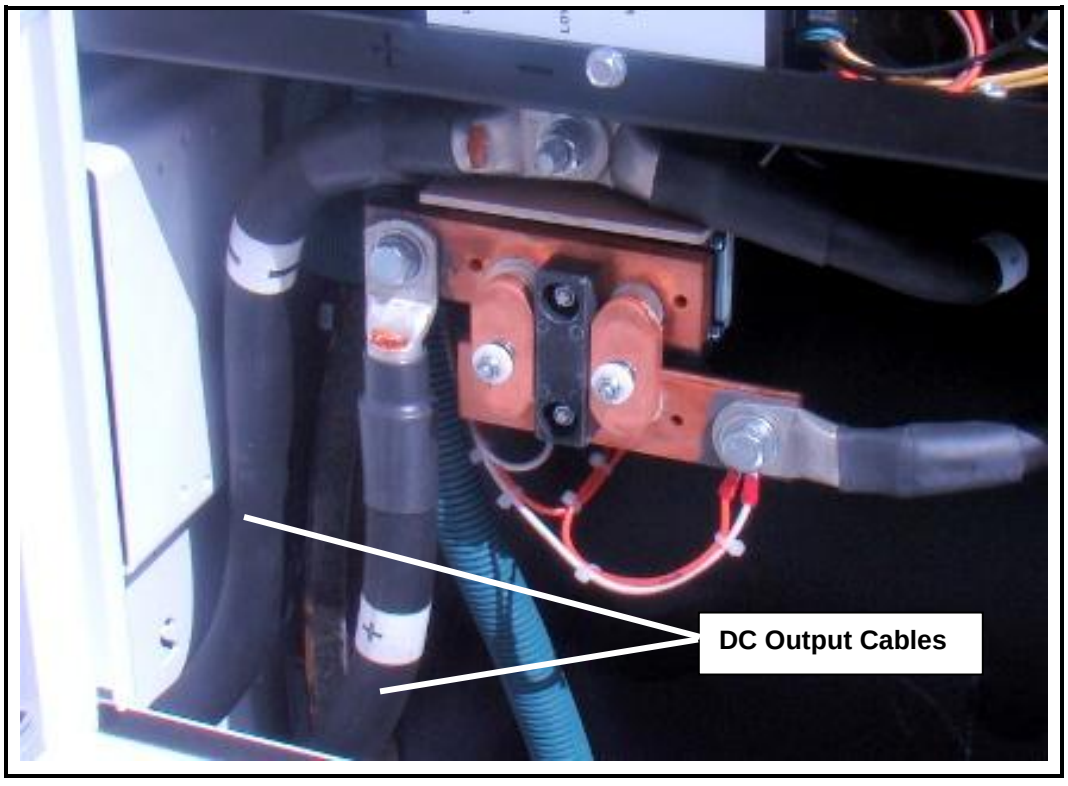
(1) The DC output cable is not normally supplied unless specifically ordered. For normal aircraft service, use cable assembly MS90347 with 4/O size cables having a positive and negative connection.

(2) The output cable is extended through the canopy via the supplied hole and bracket in the frame assembly (See Figure 3).

(3) The cables will be connected to the output contactor, located under the TR assembly on the right side (See Figure 4).



DC Cable and Clamp
Figure 3



Output Cable Connections
Figure 4

2) Preparation for Storage

When a generator set is to be stored or removed from operation, special precautions should be taken to protect the internal and external parts from rust, corrosion, and gumming in the engine fuel system.

a) General

Pull all circuit breakers and/or disconnect battery negative terminal.

(1) The unit should be prepared for storage as soon as possible after being removed from service.

(2) The unit should be stored in a building which is dry and which may be heated during winter months.

(3) Moisture-absorbing chemicals (Hobart Part No. 76A1354-001) are available for use where excessive dampness is a problem; however, the unit must be completely packaged and sealed if moisture-absorbing chemicals are to be effective.

b) Temporary Storage

When storing the unit for 30 days or less, prepare as follows:

(1) Lubricate the unit completely in accordance with instructions in Section 2-2. This will include changing engine oil, and all filter elements.

(2) Start the engine and operate for about two minutes so that all internal engine components will be coated with new oil.

NOTE: Do not drain the fuel system or crankcase after this run.

(3) Make certain the cooling system antifreeze solution is adequate to protect below the lowest temperatures expected during the storage period. Be sure the solution is thoroughly mixed.

(4) Clean the exterior of the engine. Dry with clean rags and compressed air.

(5) Seal all engine openings. Use a waterproof, vapor proof material that is strong enough to resist puncture damage from air pressures.

c) Long Time Storage (Over 30 Days)

To protect the generator and other electrical components, the complete unit should be packaged using moisture proof packaging material and sealing material. Place containers of moisture-absorbing chemicals (Hobart Part No. 76A-1354-001) in the unit before packaging. The unit may be stored for long periods with no special preparation if it is possible to operate the engine once each week. When starting once a week proceed as follows:

(1) Make certain the cooling system is adequately protected.

WARNING

ENSURE adequate ventilation before starting the engine.

(2) Start the engine and operate under full load until coolant temperature has reached at least 176ºF (80ºC).

(3) While the engine is running, ensure that normal operating controls are in good working condition before shutdown and storage. If weekly operation is not possible, contact the nearest engine manufacturer distributor for instructions.

3) Preparation for Shipment

a) Disconnect battery negative terminal before shipping.

b) During long shipments, vibration, jolting, etc may loosen the generator set retaining hardware.

CAUTION

When shipping the unit, provide sufficient retaining materials to ensure the generator set cannot roll out or off the vehicle in which it is being transported.

NOTE: It is suggested that strong banding be used to secure the generator set, or a strong steel bar be either welded or bolted across the front of the generator set frame.

Section 3 Operation

1) General

This section contains information and instructions for the safe and efficient operation of the equipment. Operating instructions are presented in step-by-step sequence of procedures to be followed in supplying 400-Hz power.

NOTE: Read ALL of the operating instructions before attempting to operate the equipment.

WARNING

Ear protection equipment may be necessary when working close to this equipment.

2) 400 Hz. Operating Procedure

a) Pre-start Inspection

(1) Be sure the fuel shutoff valve on the unit is open.

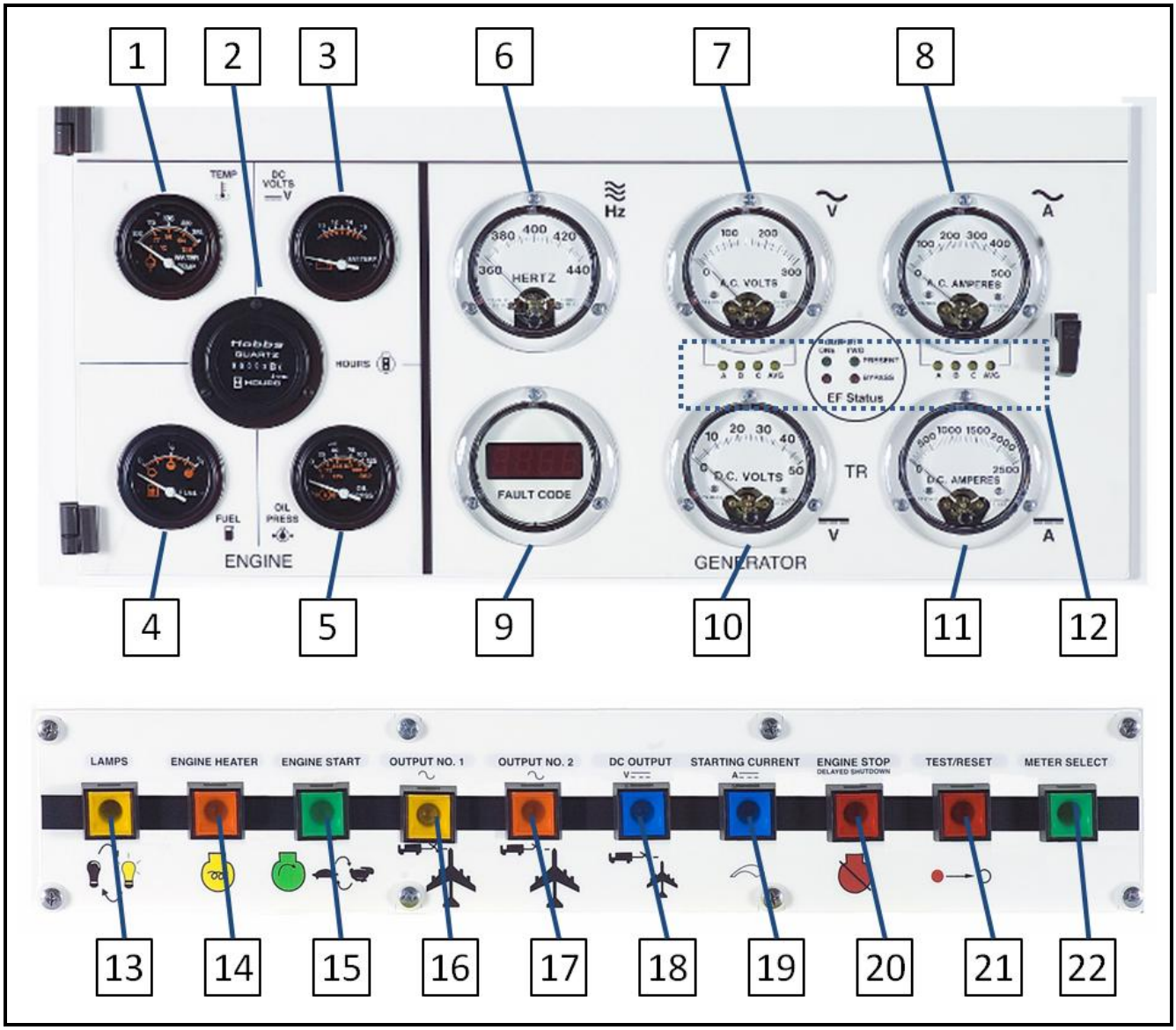
(2) Ensure 12 VDC power is available to the engine starting system.

(3) Check the engine and generator compartments to make certain they are free of rags or other foreign materials.

(4) Make certain there is sufficient lubricating oil and coolant in the engine.

(5) Check that all circuit breakers are reset.

(6) Make certain the "**STARTER ENABLE/DISABLE"** switch is enabled, and the **"FREQUENCY ADJUST"** switch is disabled.



1. Engine Coolant Temperature Gauge (M24)
2. Running Time Meter (M4)
3. Battery Voltmeter (M5)
4. Fuel Gauge (M13)
5. Oil Pressure Gauge (M25)
6. Frequency Meter (M3)
7. AC Generator Voltmeter (M2)
8. AC Generator Ammeter (M1)
9. Fault Code Meter (M6)
10. DC Voltmeter *[Optional with TR]*
11. DC Ammeter *[Optional with TR]*
12. Front LED Display (A5)

13. Panel Light Switch (S74)
14. Air Intake Heater Switch (S79)
15. Engine Start Switch (S24)
16. AC Output No. 1 Switch (S75)
17. AC Output No. 2 Switch (S275)
18. DC Output Switch (S430) *[Optional with TR]*
19. DC Starting Current Switch (S431) *[Optional with TR]*
20. Engine Stop Switch (S76)
21. Test/Reset Switch (S77)
22. Meter Selector Switch (S3)

Figure 1: Operator Controls

b) Normal Engine Starting Procedures

Engine starting procedures are outlined below. The engine's operating controls and monitoring instruments are illustrated in Figure 1.

CAUTION	Refer to operating instructions in the engine manufacturer's operation manual, when starting engine for the first time.

NOTE: The engine manufacturer's operation manual is provided with this manual.

(1) If illumination is required, press "**LAMPS"** push-button switch one time. Pressing this button switch also activates the fuel gauge.

(2) On days when the ambient temperatures are below 60° F, press the **"ENGINE HEATER"** push-button to engage the air intake heater prior to starting the engine. The light in the button will illuminate when the intake heater is engaged (if the light does not illuminate, the engine is ready to start) and will go off when the intake heater is disengaged, thus signifying the engine is ready to start.

CAUTION	Never use an ether start system in conjunction with the air intake heater.

(3) Press the green **"ENGINE START"** push-button switch and hold until engine starts. The engine will start at idle speed, and the green light in the **"ENGINE START"** push-button switch will flash to indicate that power is available to the engine's ECM circuit.

CAUTION	Do not attempt to bring to rated speed for at least 5 seconds after engine starts. Damage to the starter and flywheel will result.

CAUTION	If the engine fails to start, the control system will automatically disable the starting motor and indicate a low oil pressure fault. The emergency stop switch must be pressed to reset the control system and allow another starting attempt. If the engine fails to start after four attempts, an inspection should be made to determine the cause. If the engine fires sufficiently to disengage the starter gear, but does not start, allow the starting motor to come to a complete stop before attempting to engage the starter again, then press the start pushbutton switch.

(4) Check oil pressure to make certain that it is normal and observe all other engine instruments for normal operation.

(5) Allow engine to idle and warm for **3 - 5 minutes** before bringing it up to rated speed.

CAUTION	To eliminate the possibility of wet stacking (See Appendix A), DO NOT allow the engine to idle for long periods.

c) Failed Starting Procedure

CAUTION	To prevent damage to the starting motor, do not engage the starting motor for more than 30 seconds. Wait two (2) minutes between each attempt to start.

In the event that the engine fails to start, the circuitry must be reset before the next attempt. To do this:

(1) Push the red "**EMERGENCY STOP/RESET BUTTON"** on the control box door to the right of the control panel.

(2) Pull the red "**EMERGENCY STOP/RESET BUTTON"** back out before the next attempt to start the generator set.

d) Power Delivery

(1) Press **"ENGINE START"** pushbutton switch a second time to bring engine from idle speed to rated speed. The ECM will immediately increase engine speed to 2000 RPM and maintain it. The voltage build-up will occur automatically. In addition, the green indicating light in the **"ENGINE START"** push-button switch will glow continuously.

(2) Observe generator instruments. The frequency meter should indicate exactly 400 Hz. With the **"METER SELECT"** pushbutton switch set to read any line-to-neutral position, (A-N, B-N, or C-N), the voltmeter should read 115 volts. With the **"METER SELECT"** pushbutton switch set to any line-to-line position, (A-B, B-C, or C-A), the voltmeter should read 200 volts.

(3) The final step in delivering power is closing one or both of the load contactors. When the instruments indicate satisfactory frequency and voltage values, close either load contactor (or both load contactors) by momentarily pressing the load contactor(s) (**"OUTPUT NO. 1"** or **"OUTPUT NO. 2"**) pushbutton switch. The yellow or orange indicating light of the pushbutton switch that is pressed will glow continuously, indicating that the load contactor is closed and power is available at the aircraft.

(4) Early in the power delivery run it is recommended that the operator check output voltage and current in each of the three phases. Use the **"METER SELECT"** pushbutton switch to select the either the line-to-line or line-to-neutral voltage. If the load is changing, observe the instruments until load conditions stabilize.

CAUTION	**NEVER** press the test/reset pushbutton switch while power is being delivered. The contactors will open and power to the aircraft will be suddenly interrupted.

(5) A condition of over-voltage, under-voltage, under-frequency, over-frequency, or overload in the output circuit will automatically open the load contactor and display a fault code to signal the operator which of the above faults caused the protective monitor system to operate. After the fault has been corrected, press the "**TEST/RESET**" push-button switch to reset the protective relay system. Proceed with power delivery by operating the load contactor pushbutton switch.

WARNING	**NEVER** disconnect the output cable while power is being delivered. Output contactors must be open prior to removal of the cable from the aircraft.

CAUTION	The generator set must be shut down so that the failed power delivery problems can be diagnosed. Only licensed technicians should work on this generator set.

e) Failed Power Delivery

If the contactor indicating light goes out approximately two seconds after the output pushbutton switch is released, and the fault code meter shows an **EF1** or **EF2** fault code, this indicates that the aircraft is not supplying the 28.5 VDC interlock signal to the plug interlock circuit. Correct the condition and again press the output pushbutton switch.

The "**REGULATED/DIAGNOSTIC"** switch (located on the voltage regulator PC board) must be set to "**NORMAL**" for power delivery.

If the aircraft (or load bank) does not have the 28.5 VDC signal, set the **EF Bypass ON/OFF** switch (located on the digital control PC board) to the "**ON**" position.

See "Load Contactor Operating Circuits" in Section 2-4 for other for additional troubleshooting procedures.

f) Discontinue Power Delivery with Unit Shutdown

(1) Normal conditions

a Push the "**OUTPUT"** (No. 1 or No. 2) pushbutton switch to open the output load contactor. The indicating light (yellow or orange depending on the contactor used) on that switch will go OFF immediately to indicate that the load contactor has opened and power is no longer being delivered to the aircraft. The engine will remain at rated speed.

b Push the red **"ENGINE STOP"** pushbutton switch once to bring the engine down to idle speed. This will begin the automatic shutdown sequence to shut off the engine, gauges, lights, etc., after approximately 3 - 5 minutes.

c Disconnect output cable from aircraft after engine is at idle speed only.

(2) Emergency conditions

a Depress the "**EMERGENCY STOP BUTTON**" located on the control box door to the right of the control panel. When pushed this button instantly shuts the generator set off. Pull the button back out to reset it before restarting the generator set.

CAUTION	Do not use the "**EMERGENCY STOP BUTTON**" button as a normal shutdown device. Damage to the engine turbo charger may result without proper cooling time. Use the "**ENGINE STOP**" push-button for all normal engine shutdowns.

3) DC Operating Procedure (optional)

This section describes the operation of the optional DC unit. The DC output voltage value, which is controlled by a potentiometer on the Transformer-Rectifier Board (TRB), need only be set once. The voltage level will remain the same for all future operations, even when the unit is shut down or the battery is disconnected. It may, however, be changed as often as desired.

Note: The DC output voltage is only regulated when operating DC alone without an AC output. If AC and DC are operated together, only the AC voltage is regulated.

a) Normal Power Delivery

(1) Connect the output cable plug connector to the aircraft receptacle. Be sure connector is mated fully and securely.

(2) The engine should be running at rated speed (2000 RPM) and generating 115/200 VAC. If not, reference the engine starting procedure above.

(3) Press "**DC OUTPUT**" push button to close the DC output contactor. The blue "**DC OUTPUT**" lamp glows to indicate that DC power is being delivered to the aircraft.

b) Current Limiting Power Delivery

If current limiting is required for starting an aircraft, set the current limit as follows:

(1) Press the "**STARTING CURRENT**" push button to activate and view the present current limiting value. Continue to hold the button down to increase the setting.

(2) Each time the "**STARTING CURRENT**" push button is pressed the current limiting will be viewed and increased by 100 A until it reaches the maximum setting of 2500 A. At that time the current limiting will reset to the beginning and start the 100 A increments again. Set the current limit to the desired setting.

c) Discontinue Power Delivery

(1) Press "**DC OUTPUT**" push button to open the DC output contactor. The blue "**DC OUTPUT**" lamp turns off to indicate that DC power has been removed from the aircraft.

(2) Disconnect the output cable connector from the aircraft receptacle and store properly in the GPU's cable tray.

4) Simultaneous AC and DC Operation

If both 28.5 VDC and 400-Hz AC power must be delivered at the same time, the operation of the controls remains the same. However, the DC output voltage will not be regulated when the AC voltage contactor is closed and is supplying power.

When both AC and DC are being used and a fault condition occurs, the system's response to the fault is given priority over all operations.

Chapter 2 Service and Troubleshooting

Section 1 Maintenance Inspection/Check

1) General

To make certain the generator set is always ready for operation, it must be inspected and maintained regularly and systematically so that defects may be discovered and corrected before they result in serious damage to components, or failure of the equipment.

WARNING

STOP operations at once if a serious or possibly dangerous fault is discovered.

2) Maintenance Schedule

a) General

A periodic maintenance schedule should be established and maintained. A suggested schedule is provided in Figure 1 on the following pages. It may be modified, as required to meet varying operating and environmental conditions. It is suggested that generator set and vehicle inspections be coordinated as much as possible.

b) Maintenance Schedule Check Sheet

It is strongly recommended that the customer use a maintenance schedule check sheet such as the one in engine manufacture's operation manual. The check sheet will provide a record and serve as a guide for establishment of a schedule to meet the customer's maintenance requirements for his specific operation.

c) Time Intervals

The schedule is based on both hours of operation and calendar intervals. These two intervals are not necessarily the same. For example, in normal operation the oil change period, based on hours of operation, will be reached long before the three months calendar period. The calendar period is included to make certain services are performed regularly when the equipment is stored, or being operated infrequently. Lubricating oil standing in engines that are stored, or used very little, may tend to oxidize and may require changing although it is not dirty. Perform all services on whichever-comes-first basis.

d) Identification of Interval Periods

Each interval period is identified by a letter A, B, C, etc. For example, services under B schedule should be performed at the end of each 250 hours of operation, or every three months, BR service is performed during the BREAK IN period (first 50-150 hours) and AR service is performed AS REQUIRED.

Hourly Interval	AR	50-150	10	250	500	1000	1500	2000
Calendar Interval		**Once**	**Daily**	**3 Mo.**	**6 Mo.**	**1 Yr.**	**1.5 Yr.**	**2 Yr.**
Symbol	**AR**	**BR**	**A**	**B**	**C**	**D**	**E**	**F**
Engine								
Change Air Cleaner Cartridge	X							
Check Coolant Hose and Clamps	X							
Check Crankcase Oil Level			X					
Drain Fuel PreFilter Elements			X					
Check Coolant Level			X					
Check for Leaks and Correct		X	X					
Check Air Cleaner Indicator			X					
Check Exhaust System	X		X					
Charge-Air-Cooler (CAC) and Piping				X				
Change Lubricity Fuel Filter Element		X			X			
Check Fuel Pump				X				
Check Radiator Core and Hoses				X				
Check Oil Pressure and Record				X				
Change Crankcase Oil		X			X			
Change Oil Filter Element		X			X			
Check Engine and Generator Mounts		X			X			
Check Coolant, Additive-Concentration		X			X			
Check Fan Hub and Drive Pulley						X		
Check Hose Clamps on Air Intake Side	X					X		
Check Belts Conditions and Tensioner						X		
Check and/or Adjust Valve Clearance						X		
Check Water Pump		X				X		
Steam Clean Engine		X					X	
Clean Fuel System							X	
Check Alternator							X	
Check Cranking Motor							X	
Check Vibration Damper								X
Check Cooling and CAC systems								X

Maintenance Schedule
Figure 1 (Sheet 1 of 2)

Hourly Interval	AR	50-150	10	250	500	1000	1500	2000
Calendar Interval		**Once**	**Daily**	**3 Mo.**	**6 Mo.**	**1 Yr.**	**1.5 Yr.**	**2 Yr.**
Symbol	**AR**	**BR**	**A**	**B**	**C**	**D**	**E**	**F**
Engine (continued)								
Flush and Change Coolant								X
Check Fan Mounting				Spring & Fall				
Clean Cooling System				Spring & Fall				
Check Hoses				Spring & Fall				
Clean Electrical Connections				Spring & Fall				
Check Thermostats and Seals				Fall				
Electrical (12 VDC System)								
Check All Lights			X					
Check Alternator Charging Rate			X					
Check Battery and Fluid Level				X				
Clean Battery Terminals	X			X				
Check Wiring and Connections					X			
Check All Engine Meters			X					
Electrical (400-Hz System)								
Check E-F By-Pass Operation				X				
Check Output Cable and Connectors			X					
Check Volt, Amp & Frequency Meters			X					
Check and/or Adjust Output Voltage	X				X			
Inspect Wiring and Connectors					X			
Clean and Inspect Generally					X			

Maintenance Schedule
Figure 1 (Sheet 2 of 2)

3) Inspection/Check

a) General

See Section 2-2 for detailed maintenance procedures.

See Section 2-3 for adjustment and test procedures.

b) "AR" Checks and Operations (As Required)

(1) Engine

a Change Air Cleaner

Replace the air filter when the fault code meter shows the "air" code. These filters should not be washed because washing breaks down the material inside the filters.

b Check and tighten, as required, all coolant hose clamps, air intake hose clamps and exhaust clamps. Check all coolant hoses, air intake hoses and exhaust pipes for leaks.

(2) Electrical System (12 VDC) – Check Battery Terminals

Anytime the compartment doors are opened for any reason, visually check battery cable connectors and battery posts. If corrosion is observed, disconnect cables and clean battery posts and connectors with a wire brush or special battery post-cleaning tool. Coat posts and connectors with a light film of petroleum lubricant before reconnecting cables.

(3) Electrical (400 Hz System) -- Check Output Voltage

Check the output voltage and be sure it is set for 115 VAC ± 1 V. Adjustment can be made using the fine adjustment located on the Voltage Regulator PC Board (REG).

c) "BR" Checks and Operations (Break-In Period, Once After 50-150 hrs.)

The following procedures are precautionary measures taken on most new engines. If a problem occurs with any of the following issues, be sure to recheck it after the next 50-150 hours.

(1) Engine

a Check for leaks and correct. This involves an overall inspection of the engine and may require some maintenance if leaks are found. Refer to the engine manufacturer's operations manual for assistance.

b Change all fuel filter elements. Metal shavings from the new fuel tank can clog the filter.

c Change crankcase oil. New engines often release metal shavings more frequently. Therefore, the crankcase oil must be changed as a precautionary measure.

d Change oil filter element. The oil filter should be changed with the oil.

e Check engine and generator mounts to ensure they are properly installed and they have not worked loose. (Torque is set at 122 N-m, 90 ft-lb.).

f Check coolant additive concentration. Refer to the engine manufacturer's operations manual for assistance.

g Steam clean the engine to free it of oil and dirt to prevent uneven engine cooling "hot spots". The oil and dirt can also fall into the engine and fuel system when covers are removed during repair work.

h Inspect the water pump weep hole for indication of a steady leak. If a steady flow of coolant or oil is observed, replace the water pump with a new or rebuilt unit. Refer to the engine manufacturer's operations manual for assistance.

d) "A" Checks and Operations (10 Hours or Daily)

(1) Engine

a Check Crankcase Oil Level

CAUTION	
	DO NOT overfill. **DO NOT** operate the engine with oil level below the lower bar or above the upper bar on the dipstick.

(i) Check oil level daily with oil gauge dipstick.

(ii) Oil level should not be checked until 3 to 5 minutes after engine shutdown. Keep oil level as near the upper bar as possible.

b Drain Fuel Lubricity Filter/Pre-Filter Element

The life of the fuel pump and injectors can be extended if the operator drains about a cup of fuel from the fuel pre-filter element to remove water and sediment before starting the engine each day.

CAUTION	
	BE SURE to prime and bleed the fuel system after draining the filters, replacing filter element, or if the fuel tank has run empty. Failure to do so can cause engine-starting problems.

(i) Provide a container for catching drained fuel.

(ii) Open the drain valve on the fuel/water filter by turning it counterclockwise.

(iii) Drain the filter until clear fuel is visible.

(iv) Tighten the drain valve.

(v) Safely dispose of drained fuel.

(vi) Purge air from fuel system if necessary.

c Check Coolant Level

Check coolant level daily or at each fuel fill interval. Investigate for cause of any coolant loss.

WARNING	
	Cooling system is pressurized. To avoid personal injury, DO NOT remove radiator cap when engine is hot.

d Check for Leaks and Correct

At each daily start-up, check for coolant, fuel, and oil leaks. Coolant leaks may be more noticeable when components are cold. Observe pumps, hoses, fittings, gasket connections, etc., for signs of leakage. Correct as required.

Fuel Pre-Filter and Drain
Figure 2

e Check Fault Code Meter

At each daily start-up, observe the fault code meter on the control panel. If the display shows “air”, change the air filter. See Section 2-4 for other fault codes.

f Check Exhaust System

Visually inspect muffler and exhaust pipes for rust and signs of approaching failure. Listen for any gasket or joint leaks.

WARNING

A leaking and defective exhaust system could be a fire hazard.

(2) Electrical System (12 VDC)

a Check All Lights

Check all indicating lights to be sure they will operate when they should. If any light fails to operate, check both the lamp and its protective circuit breaker. Figure 5 lists all lamps with their location and part number. Figure 6 lists all circuit breakers.

b Check Engine Battery Voltage

Observe the 12 VDC engine voltmeter each time the engine is started to be sure the alternator is functioning correctly and charging the batteries. If the batteries need to be replaced, be sure the replacements meet the specifications for Cold Cranking Amps (CCA) and Reserve Capacity.

c Check the operation of all the engine meters.

(3) Electrical (400 Hz System)

b Check Output Cables and Connector

Check the output cable and plug connection for damaged insulation and contacts each time the connector is detached from the aircraft.

b Monitoring Instruments

Check operation of voltmeter, ammeter and frequency meter each time the unit is started.

e) "B" Check and Operations (250 Hours or 3 Months)

(1) Engine

a Prevent Diesel Engines Wet Stacking

All diesel engines operated for extended periods under light load may develop a condition commonly referred to as wet-stacking. This condition results from the accumulation of unburned fuel in the exhaust system. It is recognizable by fuel oil wetness around the exhaust manifold, pipes, and muffler along with an excessive amount of soot.

Wet-stacking is common, and can be expected in diesel engines operated under light loads. Light loads do not allow the engine to reach the most efficient operating temperature for complete combustion of fuel and will also increase the fuel consumption rate. The unburned fuel collects in the exhaust system to create the wet condition known as wet-stacking.

To alleviate wet-stacking in lightly loaded engines, it is recommended that the machine be connected to a load bank after each 250 hours of use and operated under full rated load for one hour. This will burn away and evaporate the accumulation of fuel and soot in the exhaust system. This clean-out procedure should be considered as a regular maintenance operation for machines operated under light loads.

b Charge-Air-Cooler and Piping

Inspect the charge-air-cooler for dirt and debris blocking the fins. Check for cracks, holes, or other damage.

Inspect the pipes and hoses for leaks, holes, cracks, or loose connections. Tighten the hose clamps if necessary.

c Check and record oil pressure

After each oil change, check and record oil pressure at idle speed after oil has warmed to approximately 140º F. Record oil pressure under identical conditions at each oil change interval. A comparison of pressure at idle speed with previous readings will give an indication of progressive wear of oil pump, bearings, shafts, etc. Investigate any abnormal change in pressure readings.

d Check Radiator Core and Hoses

Inspect the radiator core for dirt and debris blocking the fins. Clean as necessary. Check for cracks, holes, or other damage.

e Check Fuel Pump

Inspect the fuel injection pump mounting nuts for loose are damaged hardware.

(2) Electrical (12 VDC system)

NOTE: The battery furnished with this generator set is MAINTENANCE FREE.

Check battery terminals and clean if necessary.

(3) Electrical (400 Hz System)

a Check the operation of the E-F bypass system.

f) "C" Checks and Operations (500 Hours or 6 Months)

(1) Engine

a Check Engine and Generator Mounts

CAUTION	An unstable or loosely mounted engine can create hazardous environment and may damage equipment.

(i) Engine mount bolts must be torqued to 122 N-m (90 ft-lb.).

(ii) Generator mount bolts must be torqued to 122 N-m (90 ft-lb.).

b Change oil and oil filters

c Change all fuel filters.

d Check Coolant Additive Concentration

The cooling system protective liquid (nitrite-, amine- and phosphate free) provides effective protection against corrosion, cavitation, and freezing. See engine manufacturer's operation manual for ordering and mixture details.

(2) Electrical (12 VDC system)

a Wiring

Inspect all cables and leads for worn or damaged insulation.

b Connections

Inspect connectors for damaged or corroded condition.

(3) Electrical (400 Hz System)

a Protective Monitoring Circuits

Check operation of all protective monitoring circuits to make certain they will function if a fault should occurs in the output circuit. Procedures for testing these circuits are contained in the Adjustment/Test section of this manual.

b Inspect Wiring and Connections

Check all cables, leads, and wiring for broken, worn and damaged insulation. Check all connections for tightness.

c Clean and inspect generally

g) "D" Checks and Operations (1000 Hours or 1 Year)

(1) Engine

a Check Fan Hub and Drive Pulley

Inspect for loose bolts or worn features. Tighten bolts and replace parts if necessary. Refer to the engine manufacturer's operations and maintenance manual for assistance and the most update to date information.

b Check Hose Clamps on Air Intake Side

Be sure that all clamps are properly secured to prevent leaks and all hose are in good condition.

c Check Belt Condition and Tensioner

Refer to the engine manufacturer's operations and maintenance manual for assistance and the most update to date information.

d Check and/or Adjust Valve Clearance

Refer to the engine manufacturer's operations and maintenance manual for assistance and the most update to date information.

e Check Water Pump

Inspect the water pump weep hole for indication of a steady leak. If a steady flow of coolant or oil is observed, replace the water pump with a new or rebuilt unit. Refer to the engine manufacturer's operations manual for assistance.

h) "E" Checks and Operations (1500 Hours or 1.5 Year)

(1) Engine

a Steam Clean Engine

There are several reasons why the engine exterior should be kept clean. Dirt on the outside will enter fuel and oil filter cases and rocker housings when covers are removed, unless dirt is removed first. A clean engine will run cooler and develop fewer hot-spots. Steam cleaning is one of the most satisfactory methods of cleaning and engine; however, there are some **CAUTIONS** to be observed:

WARNING

Exercise care to avoid injury and damage to eyes and skin.

CAUTION

1. If a cleaning compound is used, select one that is free from acid and will not remove paint.
2. Protect (or remove) all electrical accessories, such as voltage regulator, alternator, and electrical wiring.
3. Seal all openings. DO NOT use a flammable solvent.
4. **DO NOT** use mineral spirits or solvents on a hot engine.
5. Remove or protect bottom panel of unit (belly pan) to protect insulation.

b Clean Fuel System

See engine manufacturer's operation manual for instructions.

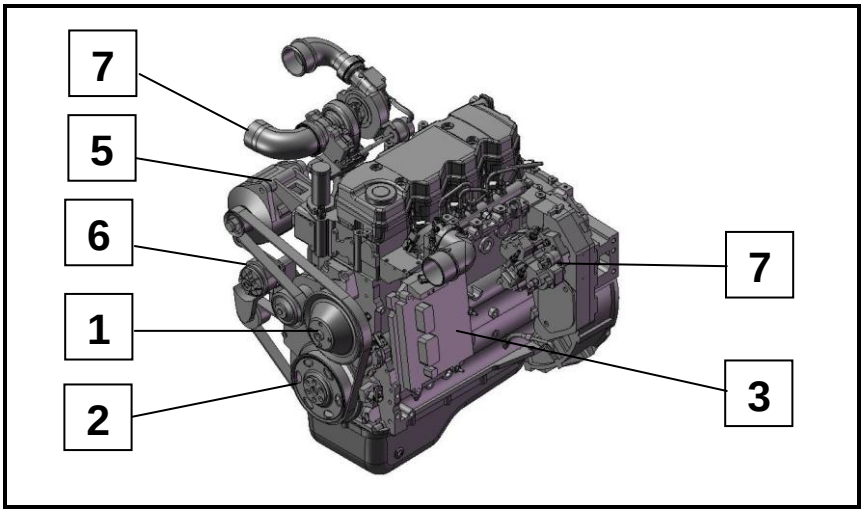
c Check Alternator and Cranking Motor.

The alternator and cranking motor on this particular engine require no periodic lubrication.

i) "F" Checks and Operations (2000 Hours or 2 Years)

(1) Engine

a Check Vibration Damper.



1. Fan Pulley
2. Vibration Damper
3. Engine Control Module (ECM)
4. Exhaust Outlet
5. Alternator
6. Belt Tensioner
7. Fuel Pump

Engine Accessories
Figure 3

Check vibration damper for looseness, wobble, chunking and streaking. Also verify the hub bolts are tightened to the engine manufacturer's specifications.

Refer to the engine manufacturer's operations and maintenance manual for assistance and the most update to date information.

b Check Charge-Air-Cooler and Radiator Systems

(i) Check for damaged hoses and loose or damaged hose clamps.

(ii) Check the radiator for leaks, damage, and build up of dirt in the fins. Clean or replace as necessary.

c Flush cooling system and change coolant.

j) Seasonal Maintenance Checks Spring/Fall (Engine)

(1) Check Fan Mounting

a Check fan to be sure it is securely mounted.

b Check for fan wobble and/or broken/cracked blades.

c Check fan hub and crankshaft pulley for secure mounting.

(2) Check cooling system each spring and fall. Clean if necessary.

(3) Check All Hoses.

In addition to daily checks of hoses for leaks, inspect hoses thoroughly each time the cooling system is cleaned and serviced.

Inspect for signs of deterioration and collapse. Inspect for cracks and cuts. Inspect for cutting and deformation caused by hose clamps. Replace hoses as required.

(4) Check thermostat and seals each fall when cooling system is serviced.

k) Lamps Circuit breakers, and Fuses

(1) Check all lamps daily

(2) Check circuit breakers and fuses as required.

(3) The lamp chart lists all lamps with their location and identifying trade number in table below.

(4) The circuit breaker chart lists all circuit breakers with their location, size, and type.

(5) The fuse chart lists all fuses with their location, size, and type.

Item Protected	Location	Schematic Identifier	Quantity	Type
Engine Air Intake Heater	Engine Electrical Panel	F110	1	125 A, 300 VAC
REG Load Contactor Circuit	REG Board	F2	1	MDL 1 A, 250 V
REG Diagnostics	REG Board	F3	1	MDL 1 A, 250 V
REG Field Voltage Circuit	REG Board	F1	1	MDL 5 A, 250 V
TRB Load Contactor Circuit	TR Board	F1	1	MDL 1 A, 250 V
ECM Protection		F101	1	5 A
ECM Protection		F102	1	30 A
Starter Solenoid		F112	1	2 A, 250 V (Fast Blow)

Fuse Identification Chart
Figure 4

Light Identification	Location	Lamp (Bulb) as per Lamp Industry Trade Number or Description
Engine Start Indicator	Switch Panel	1815
Engine Stop Indicator	Switch Panel	1815
No. 1 Load Contactor Indicator	Switch Panel	1815
No. 2 Load Contactor Indicator	Switch Panel	1815
Test/Reset Indicator	Switch Panel	1815
Pre-heater Indicator	Switch Panel	1815
Clearance Lights (optional)	Canopy Top	57
Engine Gauge Lights	Inside Each Gauge	Chapter 4, Section 3, Fig. 6
Generator Gauge Light Strip	Around Meter	Chapter 4, Section 3, Fig. 6

Lamp Identification Chart
Figure 5

Item Protected	Location	Quantity	Size
Engine Circuit and Instrument Panel	Inside Control Box	1	10 A
Controls	Inside Control Box	1	5 A
Marker Lights (optional)	Inside Control Box	1	10 A

Circuit Breaker Identification Chart
Figure 6

Section 2 Maintenance Procedures

1) General

A suggested maintenance schedule is provided in Section 1 of this Servicing Chapter. Each step of the schedule is also covered in general in Section 1. This Section covers maintenance in more detail, where necessary.

Item	Maintenance Required
Engine Oil	Check oil level daily or after every 10 hours of use. Change oil and the oil filter after the first 50 to 150 hours of use, then at 500 hour or 6 month intervals thereafter. Engine oil capacity is approximately 11.6 quarts (11 liters).
Fuel Water Separator	Drain filters daily. Change the filter elements every 500 hours or after 6 months of use, whichever comes first.
Coolant	Check coolant level daily. Service and maintain coolant system according to Section 2-2, paragraph 6. Engine coolant capacity is approximately 20 quarts (18.9 liters)
Coolant hoses and connections	Check coolant hoses and connections daily for leaks.
Air Cleaner	Change air cleaner filter as required when the fault code display on engine control panel shows the “Air” code.
Fan Belt	Check fan belt condition and tension every 1000 hours or 1 year of use.
Alternator	Alternator bearings are sealed and require no periodic lubrication.
Starter	Starter motor bearings are sealed and require no periodic lubrication.
Water Pump	The water pump is packed at assembly and requires no periodic lubrication.
Fan Hub	The fan hub is lubricated at assembly and requires no periodic lubrication.
AC Generator	Periodic cleaning – no lubrication or adjustment required
Generator Controls	No periodic maintenance is required. Adjustments are covered in Section 2-3.

Figure 1: Lubrication and Maintenance Chart

WARNING

STOP operations at once if a serious or possibly dangerous fault is discovered.

2) Engine Lubrication

a) General

Proper lubrication is one of the most important steps in good maintenance procedure. Proper lubrication means the use of correct lubricants and adherence to a proper time schedule. Lubrication points, frequency of lubrication, and recommended lubricants are indicated in Figures 1 and 2.

This section incorporates the engine manufacturer's engine lubrication recommendations from their "Operation and Maintenance Manual."

Lubrication schedule

Time schedules indicated on the Lubrication Chart, Figure 1, are approximate and based on average operating conditions. It may be necessary to lubricate more frequently under severe operating conditions such as: low engine temperatures, high oil temperatures, or intermittent operation. However, time intervals should not exceed those indicated in the chart without careful evaluation.

b) Oil specification

The engine lubricating oil that is recommended by the engine manufacturer is identified by an API (American Petroleum Institute) classification designation. The manufacturer does not recommend any specific brand of lubricating oil.

The use of quality lubricating oil, combined with appropriate lubricating oil drain and filter change intervals, are important factors in extending engine life.

Oil Type	Use oil specification API CF-4, HT/HS Viscosity 3.7cP minimum. Oil recommended for the diesel engines in this application is API Class CCMC. Refer to the manufacturer's operation manual.	
Capacity	Approximately 11.6 quarts (11 liters)	
Oil Filter Replacement Part Number	Hobart: 286897-029 Cummins: LF9370	
Lube Oil Viscosity Required as per Ambient Temperatures	**VISCOSITY**	**AMBIENT TEMPERATURE CONDITIONS**
	SAE 15W40 (Preferred)	0ºF (-18ºC) and above for most climates
	SAE 10W30	-10ºF to +50ºF (-23ºC to +10ºC) Winter conditions
	SAE 5W30	-20ºF to +50ºF (-29ºC to +10ºC) Arctic Conditions
	SAE 0W30	-20ºF and below to +50ºF (-29ºC and Below to +10ºC)
Synthetic Oils	See the engine manufacturer's operations manual for usable synthetic oils and instructions.	

c) **Changing engine oil**

Change the oil once after the first 50 - 150 hours of use and then every 500 hours of engine operation thereafter. The generator set is equipped with an hour meter to record actual engine operating time.

The ideal time to change engine oil is soon after a power delivery run, when the engine is at operating temperature. If lubricating oil is drained immediately after the unit has been run for some time, most of the sediment will be in suspension and will drain readily.

Change the oil filter element each time the oil is changed.

CAUTION

- High ash oils may produce harmful deposits on valves that can cause valve burning.
- Do not use solvents as flushing oils in running engines.
- Always use clean containers, funnels, etc.

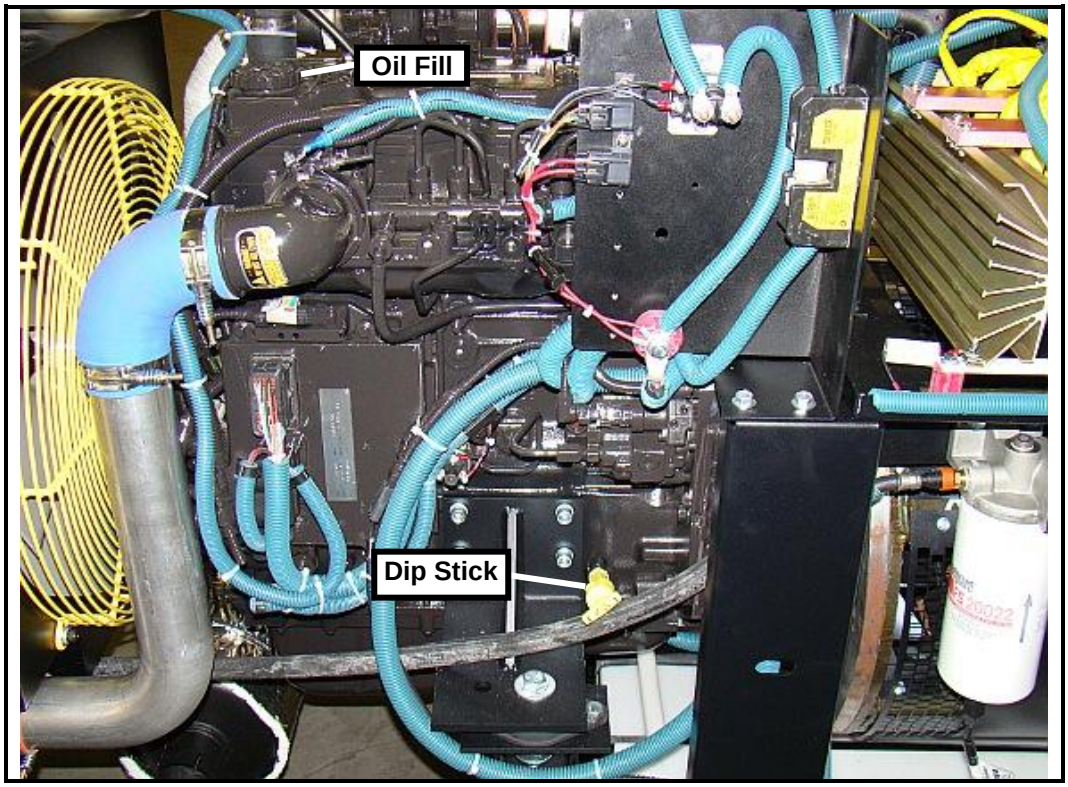


Figure 2: Oil Fill and Check Locations

Change oil as follows:

(1) Provide an open container for catching the old oil below the oil drain plug. Container capacity must be greater than 30 quarts (28.4 liters).

(2) The oil drain tube can be attained though a hole in the access panel underneath the generator set.

(3) Open drain plug located in oil pan.

(4) While oil is draining, change the oil filter element. See instructions below.

(5) Provide a container for catching spilled oil from the filter.

(6) Remove the oil filter by twisting counter-clockwise and inspect it.

(7) NOTE: The gasket can stick to the filter head. Make sure it is removed before installing a new filter.

(8) Fill the new filter with clean lubricating oil before installation.

(9) Apply a light coating of lubricating oil to the gasket-sealing surface and install the filter. DO NOT over tighten the filter.

(10) Clean the drain plug and install when engine oil has completely drained. Torque the drain plug to 50 foot-pounds (68 Nm).

(11) Refill the engine with new, clean oil that meets engine manufacturer's recommendations.

CAUTION

Remember to close the drain plug valve and install the new oil before starting the engine.

(12) Start engine and check oil pressure at once. Allow engine to idle for 5 minutes, check for leaks, than stop the engine.

(13) After the engine has been stopped for about 5 minutes, recheck the oil level. Add oil, if required, to bring the level up to the high bar on the oil dipstick.

CAUTION

If bearing metal particles are found on the element or in the shell, the source should be determined before a failure.

CAUTION

Determine source of moisture, internal leaks, defective seals, gaskets, etc.

Symbol	Name	Specification	Notes
1	Grease, General Purpose	MIL-G-3545	Excludes those of sodium or soda soap thickness.

Lubricants Chart

e) Engine Accessories Lubrication

(1) Alternator

Most alternators contain sealed bearings and require no periodic lubrication, however, check to make certain there are no lubrication points on your particular alternator.

(2) Starter

Most starting motors are lubricated at assembly and should be re-lubricated only when the starter is removed and disassembled, however, inspect the starter to make certain it has no lubrication points.

(3) Water Pump

The water pump is packed at assembly and requires no periodic lubrication. Replace pump if signs of lubricant leakage are found.

(4) Fan Pulley

The fan hub is also lubricated at assembly and requires no periodic lubrication. Replace hub if lubricant is leaking.

3) Servicing the Air Cleaner

A definite time schedule for cleaning or changing the air cleaner cannot be determined because of varying operating conditions. Unfasten the three metal latches on the end of the air cleaner housing to access the air cleaner filter. It may be inspected either at prescribed service intervals or at any time deemed necessary.

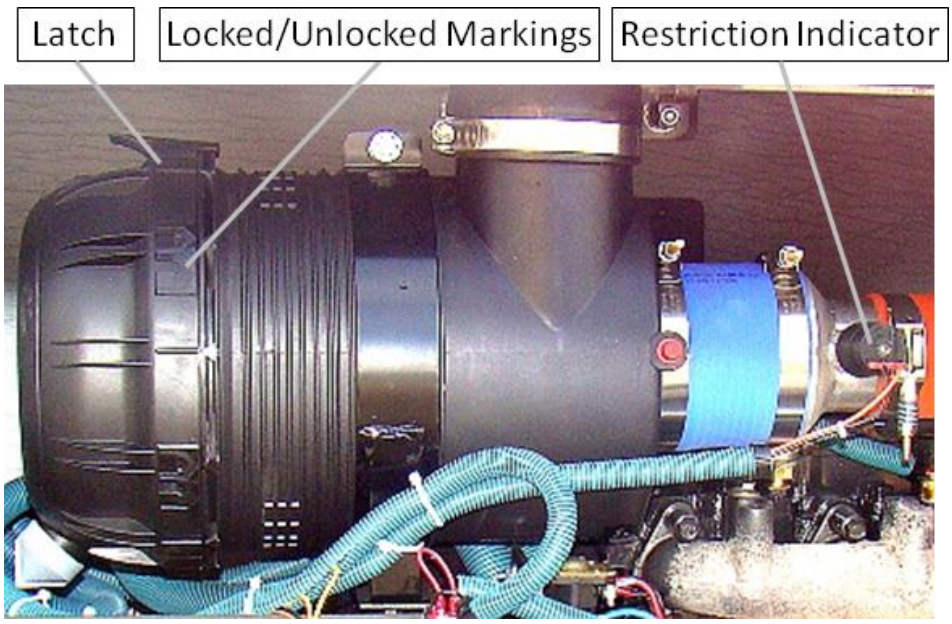
Replacement air filter part number: Hobart: 290941 Inspect regularly. Replace when the fault code meter indicates an "Air" code.	

Figure 3: Air Cleaner Assembly

a) Inspecting the Air Cleaner

(1) Make periodic checks of air cleaner inlet screen for obstructions. If any obstructions are present, remove them.

(2) Check outlet connection for proper seal.

b) Changing the Air Filter

(1) Lift the latch and rotate the back cover to the unlocked position (counterclockwise as viewed from the rear). The cover has padlock symbols to show the locked and unlocked positions.

(2) Remove the end cover of housing.

(3) Pull out air filter elements and replace.

(4) Replace end cover on housing, making certain that the filter is centered in the housing.

(5) Replace the end cover and rotate it to the locked position.

c) Disposal

Normal trash pick-up is should be acceptable. **NEVER** burn the air filter for disposal.

4) Engine Fuel

a) How to select Fuel—Quality

The quality of fuel oil used in the diesel engine is a major factor in engine performance and life. Fuel oil must be clean, completely distilled, stable and non-corrosive.

CAUTION	Due to the precise tolerances of diesel injection systems, it is extremely important that the fuel be kept clean and free of dirt or water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.

CAUTION	The use of low lubricity fuels can shorten life and/or damage the engine's fuel pump. The engine manufacturer recommends only diesel fuel.

Use commercially available diesel fuel with less than 0.5% sulfur content. If the sulfur content is higher than 0.5%, oil change intervals should be reduced (See engine manufacturer's operation manual).

In general, fuels meeting the properties of ASTM designation D 975 (grades 1-D and 2-D) have provided satisfactory performance. For more information regarding the selection of fuel to use, refer to publication "Engine Requirements—Lubricating Oil, Fuel, and Filters" available from authorized engine manufacturer's service outlets.

b) Cold Weather Operation

In cold weather, diesel fuel will form wax crystals, which can restrict flow and clog filters. Fuel oil suppliers approach this problem several ways. Some provide a specially refined product, while others may use flow-improving additives or winter blends. Winter blended fuel will likely contain kerosene or 1-D fuel, which provide good cloud point temperatures, but result in a lighter fuel with a lower heat content. These fuels may be used, but they may result in reduced engine power and/or fuel consumption.

In most cases, adequate resistance to cold can be obtained by adding an additive. For further assistance contact the nearest engine manufacturer's service representative.

5) Engine Fuel System

The fuel system consists of five primary components: fuel tank, lubricity filter, primary fuel filter, fuel lift pump, and the fuel return line. The following are maintenance procedures for each of these items.

a) Fuel Tank

Be sure that no foreign objects are permitted in the fuel tank. The fuel tank must be removed and flushed out if objects are found in the Fuel Water Separator or Lubricity Additive Filter.

b) Fuel Water Separator or Lubricity Additive Filter

A lubricity fuel filter, which is also a fuel/water separator, is mounted in the generator compartment above the fuel tank outlet. The filter's function is to add a lubricant to the fuel to help prolong the engine seals and fuel pump life when fuels other than diesel are used (i.e. jet fuel). The filter also removes foreign material and removes both free and emulsified water from the fuel before it enters the fuel lift pump. Daily draining of the filter is required.

Replacement Filter Element:

- Hobart: 286897-031
- Cummins. FS20022

Drain the water daily.

Replace the filter after every 500 hours of operation.

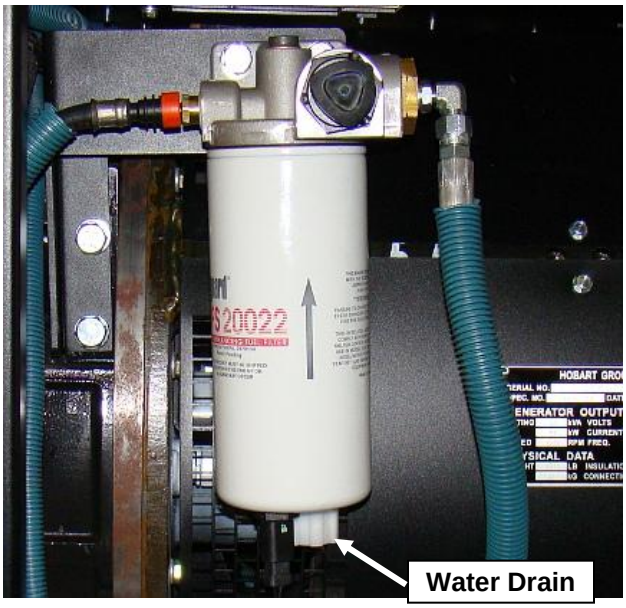


Figure 4: Lubricity Filter

To drain the water:

(1) Open drain valve

(2) Drain accumulated water and contaminants.

(3) Close drain valve.

The lubricity filter must be changed after every 500 hours of operation in order for the fuel filter to continue adding the proper amounts of the lubricity additive into the fuel system.

To change the lubricity filter:

CAUTION	When installing new element, do not over tighten it; mechanical tools may distort or crack filter head.

(1) Place a pan underneath the fuel filter to catch spilled fuel.

(2) Shut off fuel valve.

(3) Drain off some fuel by opening the drain valve.

(4) Undo fuel filter with commercial tool and spin off.

(5) Clean any dirt from the filter carrier rim

(6) Apply a light film of oil or diesel on the rubber seal on the new filter.

(7) Fill new filter with diesel fuel.

(8) Screw in the new fuel filter “snug”.

(9) Check that the cartridge is seated correctly against the gasket and tighten with a final half turn.

(10) Make sure that all rags, or absorbent sheets, are clear of moving engine parts and cannot be drawn in to the radiator fan.

(11) Open fuel valve.

(12) Start the engine and check for leaks. Correct as necessary with the engine off.

c) Primary Fuel Filter

A primary fuel filter is mounted above the engine starter in the engine compartment. The filter’s function is to remove foreign material from the fuel before it enters the fuel lift pump.

Change the fuel filter after every 500 hours of operation.

Replacement fuel filter part number: • Hobart: 286897-036 • Cummins: FF5612 Change the fuel filter after every 500 hours of operation.	

Figure 5: Primary Fuel Filter

The fuel filter must be change after every 500 hours of operation.

To change the fuel filter:

(1) Shut off fuel valve.

(2) Place a pan underneath the fuel filter to catch spilled fuel.

(3) Undo fuel filter with commercial tool and spin off.

(4) Catch any fuel.

(5) Clean any dirt from the filter carrier rim

(6) Apply a light film of oil or diesel on the rubber seal on the new filter.

CAUTION	When installing new element, do not over tighten it; mechanical tools may distort or crack filter head.

CAUTION	Make sure that all rags, or absorbent sheets, are clear of moving engine parts and cannot be drawn in to the radiator fan.

(7) Fill new filter with diesel fuel. Screw in the new fuel filter "snug". Check that the cartridge is seated correctly against the gasket and tighten with a final half turn.

(8) Open fuel valve.

d) Fuel Pump

The fuel pump supplies high pressure to the fuel system so the diesel fuel can circulate freely. This engine is equipped with a common rail fuel system that is under very high pressure. DO NOT attempt to crack fuel lines.

WARNING	**DO NOT** attempt to crack fuel lines. This engine is equipped with a common rail fuel system that is under very high pressure. Failure to follow this guideline could result in injury or death.

e) Fuel Return

The fuel return is a fuel line (tube) that takes unused fuel from the engine, and delivers it to the fuel tank. No maintenance is required.

6) Engine Cooling System

a) General

Cooling system service requires more than maintaining the proper coolant level in the radiator and protecting the system against freezing. Water should by clean and free of any corrosive chemicals such as chloride, sulfate, and acids. It should be kept slightly alkaline with a pH value in the range of 8.0 to 9.5. Any water, which is suitable for drinking, can be used in the engine when properly treated as described in engine manufacturer's operation manual. The engine manufacturer's representative should be consulted regarding the selection of satisfactory brand, permanent-type antifreeze for use in the cooling system.

b) Radiator Cap

(1) General

A pressure relief valve is built into the radiator cap. It is designed to open at a pressure of approximately 15 psi (103.4 Kpa).

WARNING	When removing cap from a very hot radiator, do not turn cap past safety stop until the pressure or steam has escaped.

(2) Removal

To remove, turn the cap to the left (counterclockwise) to the safety stop. When all pressure is released, press down on the cap and continue to turn until the cap is free to be removed.

CAUTION	Allow engine to cool before adding coolant.

CAUTION	Do not attempt to repair the valve in a radiator cap in case of failure. Replace with a new cap.

(3) Installation

When installing the cap, be sure it is turned clockwise as far as it will go so that the pressure retaining valve will be functional.

c) Coolant

The preparation and maintenance of the coolant solution is important to engine life and is completely covered in the engine manufacturer's operation manual. For information regarding coolant specifications, testing equipment, antifreeze, etc., refer to engine manufacturer's operation manual that accompanies the equipment manufacturer's manual or consult the local engine manufacturer's representative.

CAUTION

Never use soluble oil in the cooling system.

(1) General

A permanent type antifreeze is recommended for use in the cooling system.

CAUTION

1. **DO NOT** use methanol or alcohol as antifreeze.

2. **DO NOT** mix brands or type of antifreeze. A solution containing two or more types of antifreeze is impossible to test accurately.

(2) Selecting antifreeze

a Select a permanent type antifreeze known to be satisfactory for use with chromate corrosion resistor.

b When it is not known if the antifreeze is satisfactory for use with chromate resistor, check with local engine manufacturer's representative for a list of compatible antifreezes.

(3) Checking antifreeze solution

Check the solution with a reliable tester when in doubt about antifreeze protection.

d) Draining the Cooling System

To completely empty the cooling system requires draining the engine block (if furnished) and the radiator assembly. Both drain valves (radiator and block drain), can be opened/closed at the same time but they do not need to be. Follow these steps to drain the cooling system:

(1) Remove radiator cap.

(2) Place a drain pan with at least a 40 quarts (28.4 liters) capacity under radiator to catch coolant.

(3) Place the radiator drain hose that comes off the two radiator drain valves, into the drain pan.

(4) Open the radiator drain valves.

(5) Allow the system to drain completely.

NOTE: Be sure the drain valves do not clog during draining.

(6) When the system is completely drained, close the drain valves and replace engine drain plug.

e) Flushing the Cooling System

Flushing the cooling system should be a yearly maintenance procedure. By flushing the system, clean water is forced through the engine block to remove expired coolant and other contaminants.

f) Cleaning the Radiator Core

Blow out accumulated dirt from the radiator core air passages, using water. Bent or clogged radiator fins often cause engine overheating. When straightening bent fins, be careful not to damage the tubes or to break the bond between fins and tubes.

NOTE: Direct the water in a reverse direction to normal air flow. Normal flow on this installation is from the engine compartment out ward.

g) Filling the Cooling System

The preparation and monitoring of coolant in liquid-cooled engines is especially important because corrosion, cavitation, and freezing can lead to engine damage. For coolant system protection details see the engine manufacturer's operations manual.

(1) Install coolant

a Remove radiator cap. Be sure that both radiator drain valves are closed.

b Pour coolant into radiator very slowly until it reaches the bottom of fill neck. Allow time for trapped air to escape from the system then continue filling until the coolant level remains at the bottom of the fill neck.

c Start the engine and bring up to rated speed and allow the thermostat to open. Add coolant as trapped air escapes from the system and the coolant level falls.

d Continue to check coolant level until all trapped air escapes. Add coolant if needed to fill to the bottom of fill neck. Install radiator cap.

(2) Inspection/Check

a Check system for evidence of leaks.

b Inspect all hoses. Install new hoses as necessary. Tighten hose clamps as required.

c Check the condition of fan and water pump belts. Replace belts if necessary.

NOTE: It is good practice to attach a card, indicating the cooling system contents and date serviced, to the radiator filler neck.

h) Thermostat

The thermostat should be checked each fall, or as required. Refer to engine manufacturer's operations manual for recommended instructions.

7) Engine Drive Belt

a) General

The engine cooling fan, alternator, and water pumps are driven by one serpentine belt, which must be replaced if worn or damaged.

b) Preparation for Belt Check and Adjustment

All driven assemblies must be securely mounted in operating position before checking belt tension.

c) Checking Belt Tension

CAUTION	Checking the tension and changing the serpentine belt should only be performed with the engine off.

Check belt tension every 1000 hours, or once year, whichever comes first. A belt that is too tight is destructive to bearings of the driven part. A loose belt will slip and cause inefficient operation of the part being driven as well as wear to the belt.

CAUTION	Inspect and replace the belt if it has unacceptable cracks, is frayed, or has pieces of material missing.

Belt tension may be checked by hand. To do so, manually depress the belt with an index finger to determine the amount of belt deflection obtained. When a force is applied at a point halfway between pulleys on the longest span of a belt, there should be no more than 1/2 inch of deflection attained.

Refer to the engine manufacturer's operation manual for checking belt tension and changing worn belts.

8) Generator Maintenance

The 400 Hz generator requires no maintenance or service other than periodic cleaning. The unit is brushless and has bearings that are permanently lubricated and sealed.

a) Cleaning

The generator may be cleaned by careful use of compressed air and/or a good, SAFE commercial cleaner. Steam cleaning of the generator is not recommended because the use of steam and harsh chemical compounds may result in damage to insulation and other generator components.

CAUTION	Do not use a flammable solvent. Be sure the unit is completely dry before operating.

b) Adjustment

The generator itself requires no adjustment. Adjustment procedures for generator controls are covered in Section 2-3.

Section 3 Adjustment/Test

1) General

These adjustments and test procedures are applicable to testing and adjusting the generator set after major repair, major parts replacements, or overhaul.

IMPORTANT	In order to perform most of the following test, a load bank with an EF interlock circuit is required. However, if no EF interlock is available on a load bank, see special procedure in the EF Bypass section for testing the EF circuit.

2) Testing the 400 Hz. Generator Set

a) Pre-operational Test Procedures

(1) Connect cables from the generator output terminals to a load bank. Use cables of the same size and length as those to be used in service. Be sure the generator output N cable is grounded.

(2) Check engine oil level. Oil should be at the high bar on the dipstick.

(3) Check radiator coolant level.

(4) Check tension of drive belt.

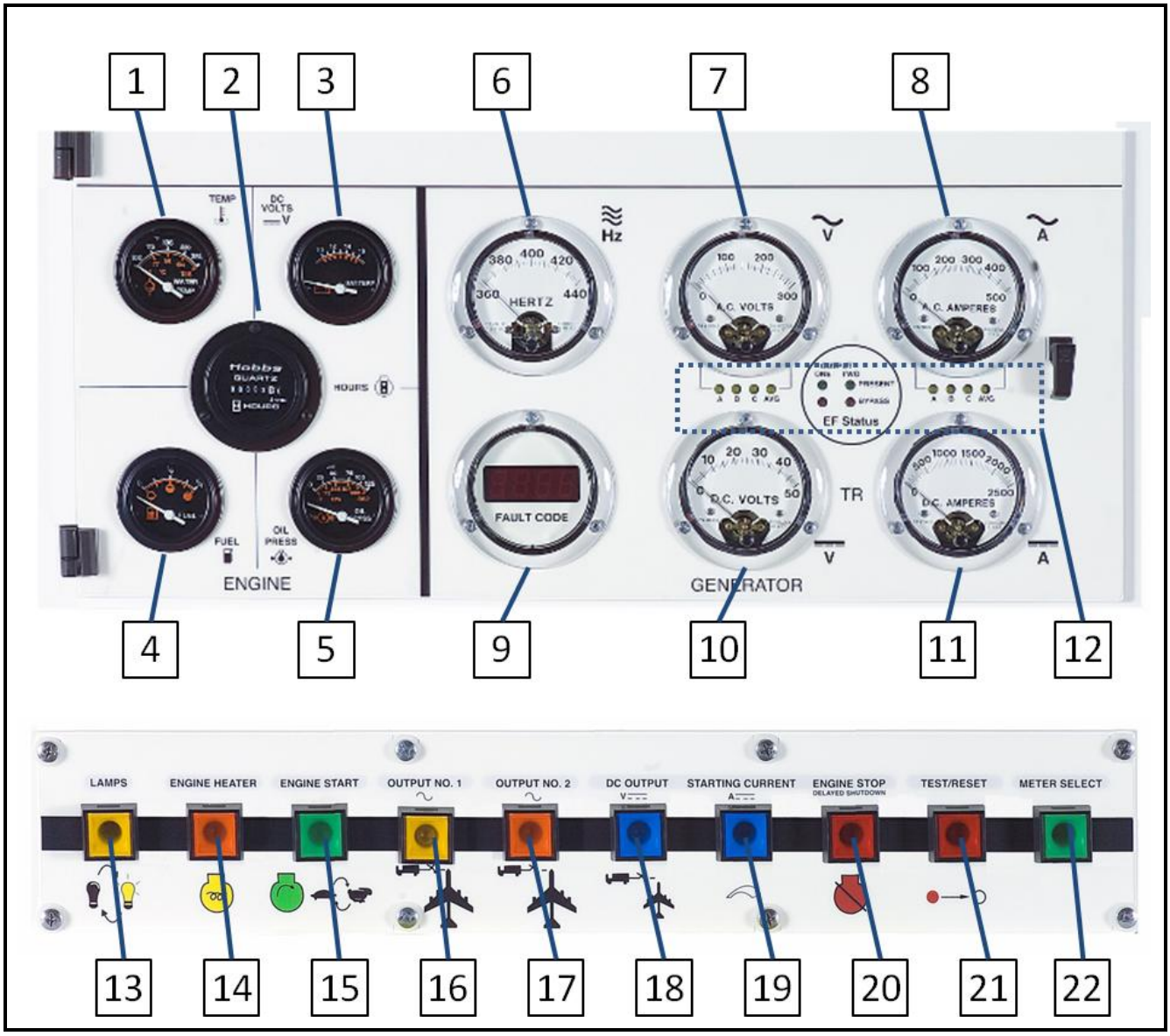
(5) Inspect for oil, fuel and coolant leaks.

(6) If the setting of the output voltage coarse adjustment potentiometer on the voltage regulator has been disturbed, set it at center position (halfway between full clockwise position and full counterclockwise position).

(7) Check control panel lights circuit breakers by pressing panel "**LAMPS**" push button switch. If panel lights operate, the circuit breaker, switch, and lamps are good.

(8) Check fault indication lights by pressing "**TEST/RESET**" push button switch. If fault code display lights up, the control circuit breaker is good.

(9) Make a general inspection of all wiring, and terminals. Inspect the equipment to be certain no damage will result from starting the engine.



1. Engine Coolant Temperature Gauge (M24)
2. Running Time Meter (M4)
3. Battery Voltmeter (M5)
4. Fuel Gauge (M13)
5. Oil Pressure Gauge (M25)
6. Frequency Meter (M3)
7. AC Generator Voltmeter (M2)
8. AC Generator Ammeter (M1)
9. Fault Code Meter (M6)
10. DC Voltmeter *[Optional with TR]*
11. DC Ammeter *[Optional with TR]*
12. Front LED Display (A5)

13. Panel Light Switch (S74)
14. Air Intake Heater Switch (S79)
15. Engine Start Switch (S24)
16. AC Output No. 1 Switch (S75)
17. AC Output No. 2 Switch (S275)
18. DC Output Switch (S430) *[Optional with TR]*
19. DC Starting Current Switch (S431) *[Optional with TR]*
20. Engine Stop Switch (S76)
21. Test/Reset Switch (S77)
22. Meter Selector Switch (S3)

Figure 1: Operator Controls

b) Operational Test Procedures

(1) Start the engine in accordance with instructions in Section 1-3.

(2) Check operation of engine instruments; ammeter, coolant temperature indicator, oil pressure gage and hour meter.

(3) Check engine idle speed. Should be 1000 +/- 25 RPM.

NOTE: A stroboscope may be required for this check.

(4) Again check for oil, fuel, and coolant leaks and correct any leaking condition
.

(5) Position switches and controls for automatic voltage regulation and power delivery as follows:

a Place regulated-diagnostic switch in "**REGULATED**" position.

b Place EF Bypass switches in "**BYPASS / OFF**" position.

c If the output voltage coarse adjustment potentiometer on the voltage regulator has been disturbed, place the knob at mid-range position.

(6) Bring the engine up to rated speed, which also energize the generator, by pressing the "**ENGINE START**" push button switch a second time. If the engine comes up to rated speed and a 115 V voltage value appears on the voltmeter, the engine ECM and excitation circuits are functioning.

(7) After generator overhaul or repair, the Regulated/Diagnostic switch must be placed in the "**DIAGNOSTIC**" position for 3 to 5 seconds to re-magnetize the exciter. Then return the switch to the "**REGULATED**" position after voltage has built-up.

(8) Observe frequency meter. If engine speed is properly set, frequency should read 400 Hz.

(9) Observe voltmeter. Use output fine voltage coarse adjustment potentiometer to adjust voltage to 115 V AC.

(10) Check adjustable voltage range.

a Observe voltmeter and turn output voltage coarse adjustment potentiometer to full clockwise position. Maximum voltage should be 134 volts or higher.

NOTE: If voltage should decrease when regulator potentiometer is turned clockwise, it indicates that internal wiring in the voltage regulator is incorrect. Replace complete voltage regulator assembly.

b Observe voltmeter and turn regulator potentiometer knob to full counterclockwise position. The minimum voltage should be 95 volts or lower.

(11) Position load bank switches, etc., to apply a light load to the generator.

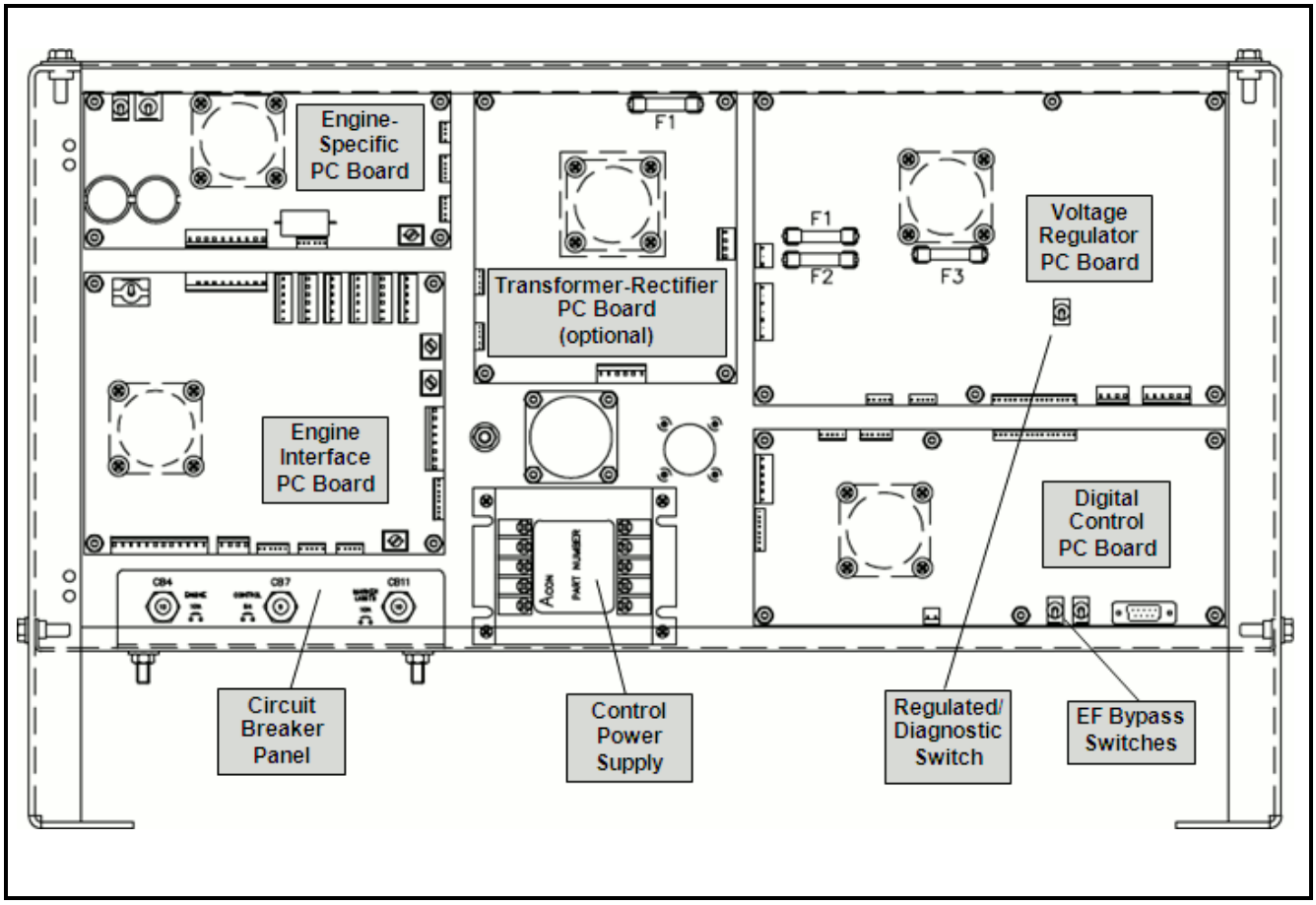


Figure 2: Control Box Interior Components

c) Testing the No. 1 Output Circuit

(1) Place EF Bypass switch in "**BYPASS / OFF**" position turn the EF signal "**ON**" on the load bank. Then press the yellow No. 1 load contactor push button switch to close contactor, which is indicated when its internal indicating light glows.

(2) Place EF switch on the load bank in the off position. The No. 1 load contactor should open immediately, and the indicating light within the push button switch should go off. The fault code display should also read "**EF 1**", indicating an EF warning. This is because the interlock circuit of the control PC board is not receiving 28.5 VDC signal from an outside source. It indicates that the No. 1 interlock circuit is OPEN, as it should be when the interlock circuit is not receiving a 28 VDC signal. Reset the fault by pressing the "**TEST/RESET**" push button.

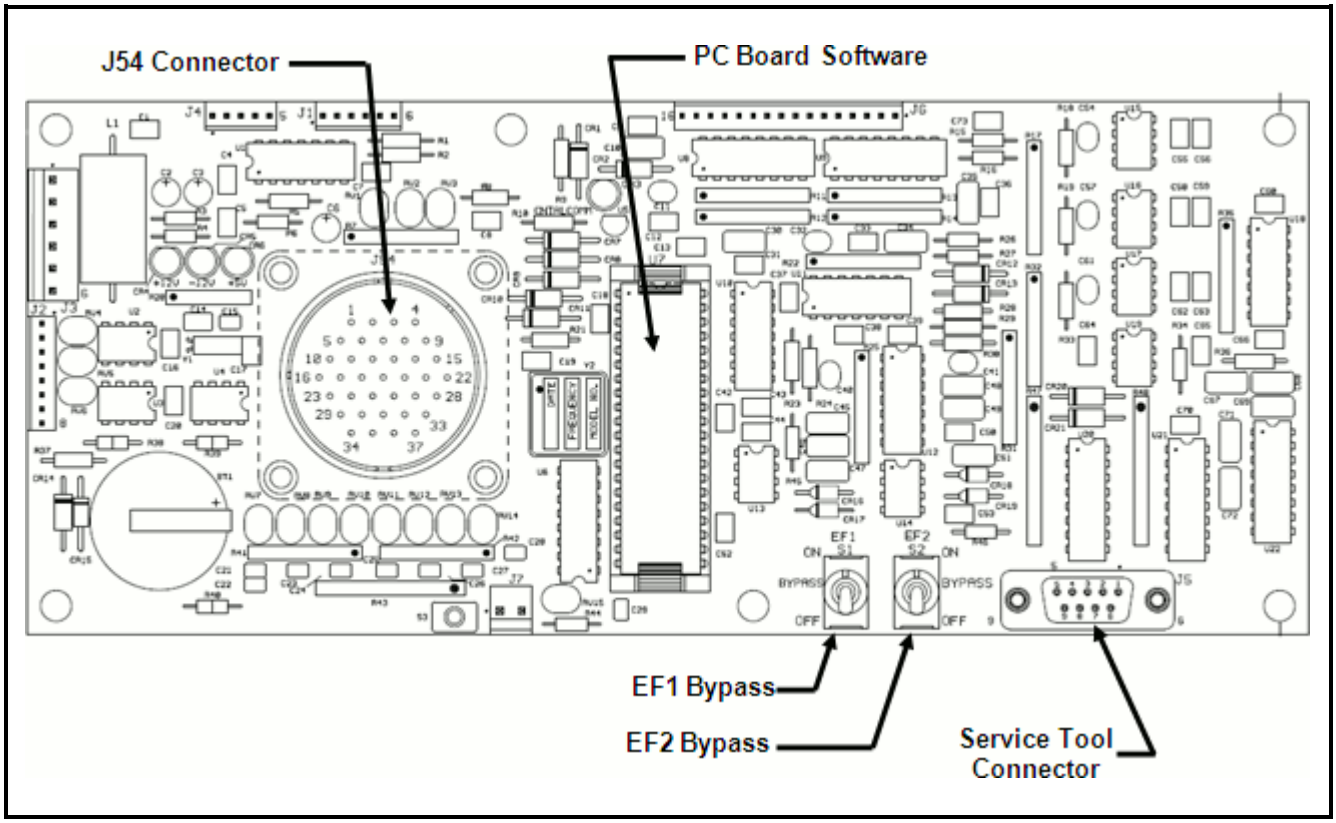


Figure 3: Digital Control PC Board

(3) Verify that when the EF Bypass switch is in the "**BYPASS / ON**" position or the "**BYPASS / OFF**" position that the appropriate LED indication on the control panel display is correct.

(4) Place EF bypass switch in "**BYPASS / ON**" position. Press the No. 1 load contactor push button switch. The No. 1 contactor power indicating light within the push button switch should glow and remain on when the push button switch is released. This indicates that EF bypass switch is functioning correctly. The corresponding LED should also indicate the bypass mode.

(5) Place the No. 1 EF bypass switch to "**BYPASS / OFF**" position. The No. 1 load contactor should open at once and the yellow indicating light within the No. 1 load contactor push button switch should go off and the fault code display should also read "**EF 1**", indicating a EF warning. The corresponding LED should also indicate the EF present mode. Reset the fault by pressing the "**TEST/RESET**" push button.

(6) Proceed to step 12.

(Steps 8 - 11 are only required if EF interlock system is not available on a load bank.)

(7) Connect a source of 24 V-DC power (two twelve-volt batteries connected in series) to terminals N, F (or E) at the output terminal panel. Connection polarity is important. Connect plus (+) to terminals E or F, and minus (-) to terminal N.

(8) Verify that when the EF Bypass switch is in the "**BYPASS / ON**" position or the "**BYPASS / OFF**" position that the appropriate LED indication on the control panel display is correct during the following steps 9 and 10.

(9) Place the No. 1 EF bypass switch to "**BYPASS / OFF**" position. Press the No. 1 contactor operating push button switch. The No. 1 contactor power on indicating light, within the push button switch, should glow and remain on when the push button switch is released. This indicates that the load contactor is closed and the plug interlock circuit is functioning properly.

(10) Disconnect the 24 V-DC power source and the No. 1 load contactor should open immediately, and the indicating light within the push button switch should go OFF. The fault code display should also read "**EF 1**", indicating an EF warning. This is because the interlock circuit of the control PC board is not receiving 28.5 VDC signal from an outside source. It indicates that the No. 1 interlock circuit is OPEN, as it should be when the interlock circuit is not receiving a 28 VDC signal. Reset the fault by pressing the "**TEST/RESET**" push button.

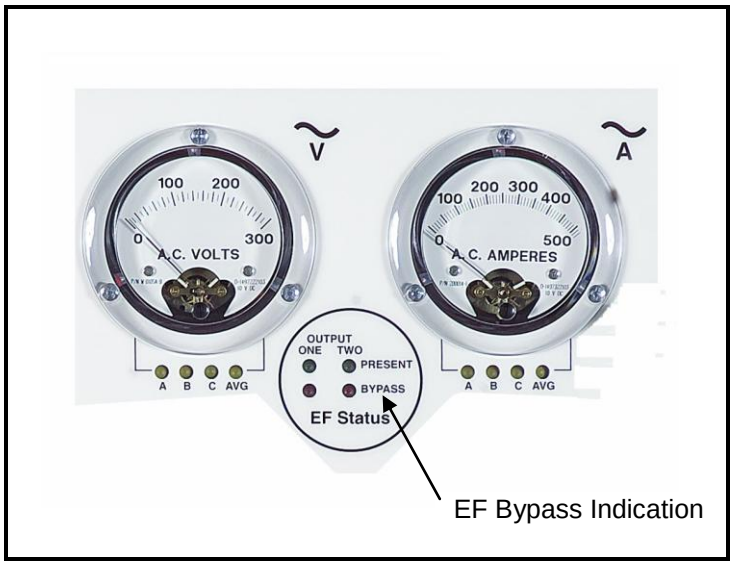


Figure 4: EF Bypass Indication

(11) In EF bypass mode, apply 1/3 to 1/2 load at the load bank and allow the unit to run for 15 to 30 minutes. Observe operation of all monitoring instruments.

(12) Increase load at the load bank to full load.

(13) Check operation of the engine ECM by observing the frequency meter when generator is switched from no load to full load, and vice versa. Use the No. 1 contactor control push button switch to apply and remove load several times. Steady-state frequency droop should be no more than 1 Hz.

(14) Follow instructions in Paragraph 3 to set voltage regulator line-drop compensation for the length and size of cable being used.

(15) Check voltage regulator, at intervals, from no load to full load. Observe and note voltage at various loads. Steady-state voltages should vary no more than +/- 1% from normal output voltage.

(16) Operate the No. 1 output circuit of the unit no less than 10 minutes under full load. The overload protection MUST NOT trip.

(17) Operate the No. 1 output circuit of the unit at 125% load (325 amperes) for 5 minutes immediately following the full load run. The overload device MUST trip within 5 minutes, and the fault code display should read "**70.18**" indicating an overload condition in "**OUTPUT NO 1**" (Reference fault chart in Section 2-4).

(18) Reset the fault by pressing "**TEST/RESET**" push button.

d) Testing the No. 2 output circuit

(1) Repeat steps (1) through (18) in the previous section "**Testing the No. 1 Output Circuit**" for testing the No. 2 output circuit.

e) Testing and checking meters, switches, protective monitoring circuits, and fault code display

(1) Check accuracy of AC voltmeter

a Open door of control box and connect a master voltmeter of known accuracy to terminals of the AC voltmeter.

b Compare the unit's voltmeter reading with master meter. Error must not exceed 2% of full scale.

(2) Check accuracy of AC ammeter

a Connect a master ammeter of known accuracy to the AC ammeter.

b Compare the unit's ammeter reading with master meter under various loads. Error must not exceed 4% of full scale.

(3) Check operation of the "**METER SELECT**" switch.

a In any LINE-TO-NEUTRAL position, the voltmeter reading should be 115 volts when the LED under the voltmeter indicates one of the 3-phase being checked.

b In any LINE-TO-LINE position, voltmeter reading should be 200 volts when the LED under the voltmeter indicates two of the phases being checked.

(4) Check accuracy of frequency meter

a Connect a master frequency meter of known accuracy to the terminals of the frequency meter.

b Compare meter readings. Error must not exceed 1% of full scale.

NOTE: Make all protective system tests with the unit operating under a load for the following steps. (Reference Chapter 2, Section 4, for all fault codes)

(5) Check operation of over-voltage circuit and fault code display.

a With the unit running at a normal load, adjust the coarse adjustment potentiometer on the voltage regulator clockwise to increase voltage until the over-voltage sensing circuit actuates the protective monitor. After the protective monitor is activated, the load contactor will open and the fault code display will display fault "**70.16**". At 125 volts, the circuit will trip after a 1-second time delay. At higher values of voltage, time delays for over voltage trips are as follow:

- At 140 volts, the circuit will trip within 160 milliseconds.
- At 180 volts, the circuit will trip within 50 milliseconds.

b If the load contactor does not open under the conditions described in step (a), refer to the Troubleshooting Chart in Section 2-4.

c Return unit to normal operating conditions by adjusting coarse adjustment potentiometer (turning it counterclockwise) and pressing "**TEST/RESET**" button switch to clear the fault code.

(6) Check operation of under-voltage circuit and fault code display.

With the unit running at a normal load, adjust the coarse adjustment potentiometer on the voltage regulator counterclockwise to decrease voltage until the under-voltage sensing circuit actuates the protective monitor. After the protective monitor is activated, the load contactor will open and the fault code display will display fault "**70.17**". Follow the following steps below to activate the under-voltage protective monitor. A stopwatch is required for this check.

a With the unit running at normal load, use the output voltage coarse adjustment potentiometer on the voltage regulator to reduce the voltage to 104 volts. The load contactor should NOT open.

b Reduce voltage in increments of 1 volt, with a time delay of 7 seconds between steps. At a setting of 100 volts, the load contactor will open and the under voltage light will glow after a 7-second time delay.

c If the load contactor does not open under the conditions described, refer to the Troubleshooting Chart in Section 2-4.

d If the under voltage circuit performs satisfactorily, return unit to normal operation by adjusting output voltage coarse adjustment potentiometer for normal output voltage, pressing the "**TEST/REST**" push button switch to clear the fault code.

(7) Check under-frequency circuit and fault code display.

At some frequency value 380 Hz or less, after 7 seconds, the frequency condition should signal the under-frequency circuit protective monitor to OPEN the load contactor and display "**70.23**" on fault code display. To check the under-frequency protective components, proceed as follows:

a While the unit is operating normally under load, set the frequency adjust switch to "**TEST**". Rotate the frequency adjust potentiometer to adjust frequency to 400 HZ.

b Reduce frequency in steps of 1 Hz, with a time delay of 7 seconds between steps.

c If the protective circuit opens the load contactor and displays fault "**70.23**" on the fault code display after 7 seconds, at 380 Hz or less, all components of the system are functioning properly.

d If the load contactor is not opened at 380 Hz or less after 7 seconds, refer to Troubleshooting Chart in Chapter 2, Section 4.

e Return unit to normal operating condition by setting the frequency adjust switch to "**NORMAL**" and pressing "**TEST/RESET**" button switch to clear fault code.

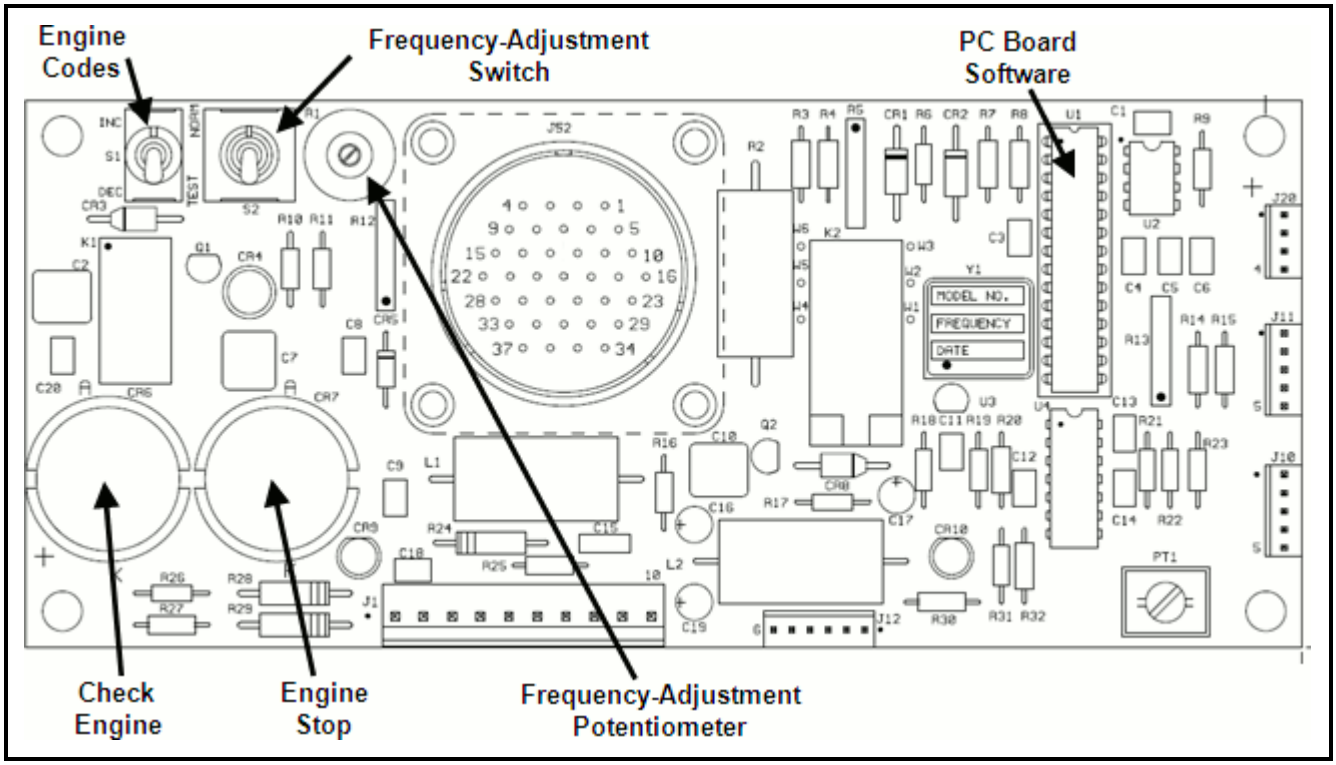


Figure 5: Engine Specific PC Board

(8) Check over-frequency circuit and fault code display.

At some frequency value 420 Hz to 440 Hz, after 5 seconds, the over frequency sensing circuit should signal the over-frequency circuit protective monitor to OPEN the load contactor and display "**70.22**" on fault code display.

At any frequency value exceeding 440 Hz, the over-frequency circuit should immediately signal the protective monitor to OPEN the load contactor and display "**70.22**" on fault code display...

To check the under frequency protective components, proceed as follows:

a While the unit is operating normally under load, set the frequency adjust switch to "**TEST**". Rotate the frequency adjust potentiometer to adjust frequency to 400 HZ.

b Increase frequency in steps of 1 Hz, with a time delay of 5-7 seconds between steps.

c If the protective circuit opens the load contactor and displays fault "**70.22**" on the fault code after 5 seconds at 426 Hz, all components of the system are functioning properly.

d If the load contactor is not opened at 426 Hz after 5 seconds, refer to Troubleshooting Chart in Chapter 2, Section 4.

e Return unit to normal operating condition by setting the frequency adjust switch to "**NORMAL**" and pressing "**TEST/RESET**" button switch to clear fault code.

NOTE: If the generator is operating under load at this point, open the contactors. There will be no further need for the load bank in the following checks.

f) Testing for engine ECM faults

(1) Set the starter enable/disable switch to "**DISABLE**". "**DISABLE**" will prevent the engine from starting, but will still supplying 12 VDC to the control system, while checking the ECM faults.

(2) Press the green "**ENGINE START**" push button switch. Although the engine is not running, the green light in the "**ENGINE START**" switch will flash to indicate that power is available to the engine ECM.

(3) If no active codes are recorded, both the "Engine Stop" and "Check Engine" lamps will come on and stay on.

If active codes are recorded, both lamps will come on momentarily and then begin to flash one code of the recorded faults.

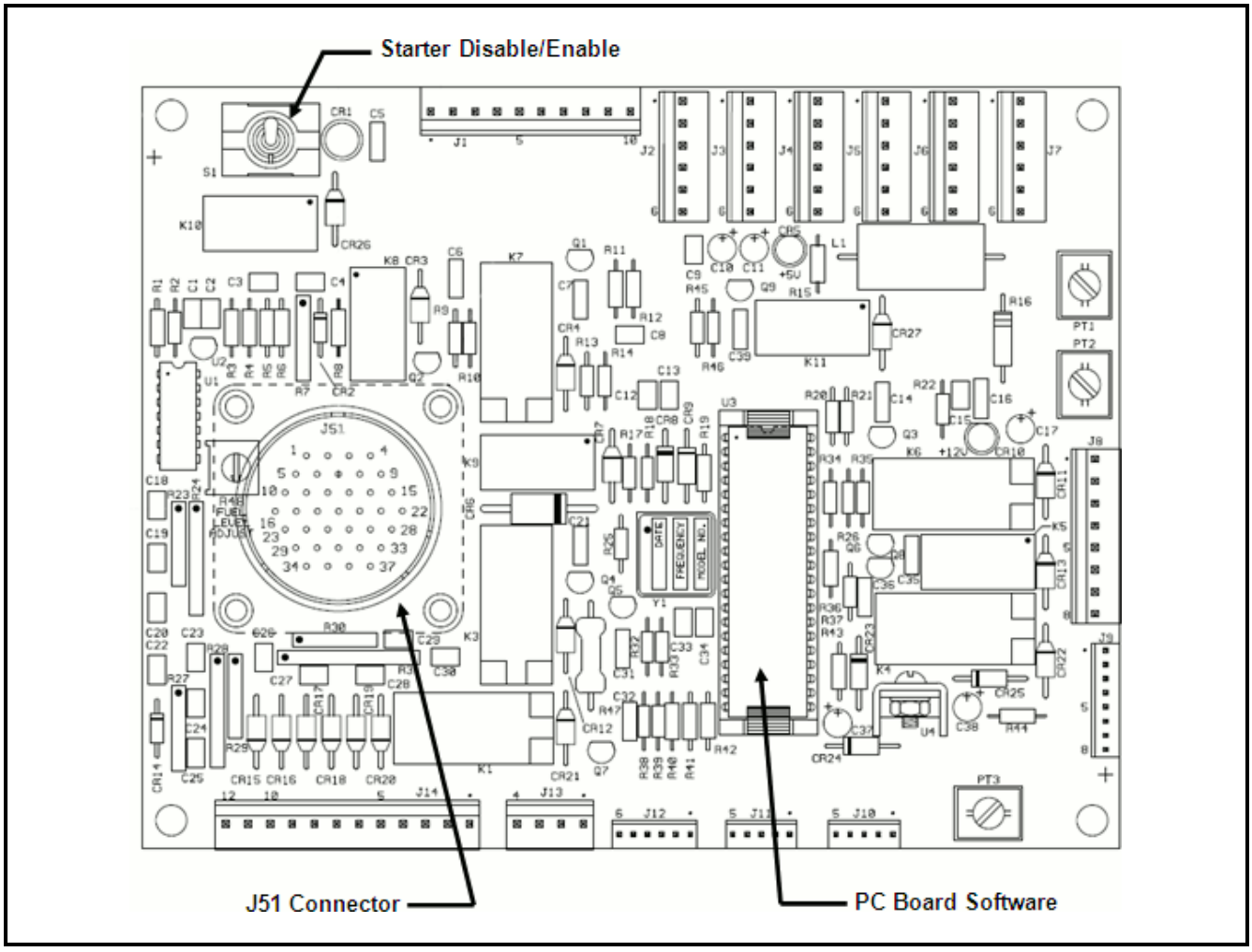


Figure 6: Engine Interface PC Board

(4) The fault code will flash in the following sequence:

First, a “Check Engine” (yellow) lamp will flash. There will be a short 1- or 2-second pause after which the number of the recorded fault code will flash in the “Engine Stop” (red) lamp. There will be a 1- or 2-second pause between each number. When the number has finished flashing in the red lamp, the yellow lamp will appear again. The fault code will repeat in the same sequence.

The lamps flash each fault code 3 times before advancing to the next code. To skip to the next fault code, move the Engine Codes Switch momentarily to the UP position. You can go back to the previous fault code by momentarily moving the Engine Codes Switch to the DOWN position. If only one fault is recorded, the QSB control system will continuously display the same fault code when the Engine Codes Switch is moved to either the UP or DOWN position.

(5) See engine manufacture’s manual for code meanings.

g) Re-checking the entire unit after testing

(1) With the engine running at normal rated speed, check the entire unit for vibration and for any parts that may have become loosened during the above checks. Tighten any loose hardware as required.

(2) Check engine oil pressure at rated speed (2000 RPM). The oil pressure gage should indicate at least 44.9 psi (3.1 bar) when engine is hot. Also at rated speed, check the engine coolant temperature. The temperature gage should indicate in the range of 180° to 190° F (82º to 88º C), depending upon operating conditions.

WARNING

If a metal sounding rod is used to detect bearing noises, exercise extreme care to avoid injury from moving components.

(3) Check 400 Hz generator bearings. Use a stethoscope or metal sounding rod to listen for unusual noises. If using a metal rod, place on end on the generator housing and hold the other end near the ear. Hold the rod with three fingers and use the index finger and thumb to form a sounding chamber between the rod and the ear. Do NOT allow the rod to touch the ear. Listen for grinding or pounding sounds, which would indicate a defective bearing. An engine noise may be telegraphed to the generator and misinterpreted as a generator noise. Contact the equipment manufacturer if in doubt of bearing serviceability.

3) Generator Set Adjustment

a) Generator Adjustment

The 400 Hz generator is a brushless type requiring no adjustments of any kind.

b) Adjust 400 Hz voltage regulator.

When a voltage regulator is first put into service, or when output (generator-to-aircraft) cables are changed, the regulator may require adjustments of output voltage value and line-drop compensation. For making these adjustments, the voltage regulator has three potentiometers:

- A coarse output voltage potentiometer
- A fine output voltage potentiometer
- A line-drop compensation potentiometer

For the following adjustment, the generator set must be running at rated speed (2000 RPM), under no-load conditions. Adjust the regulator as follows:

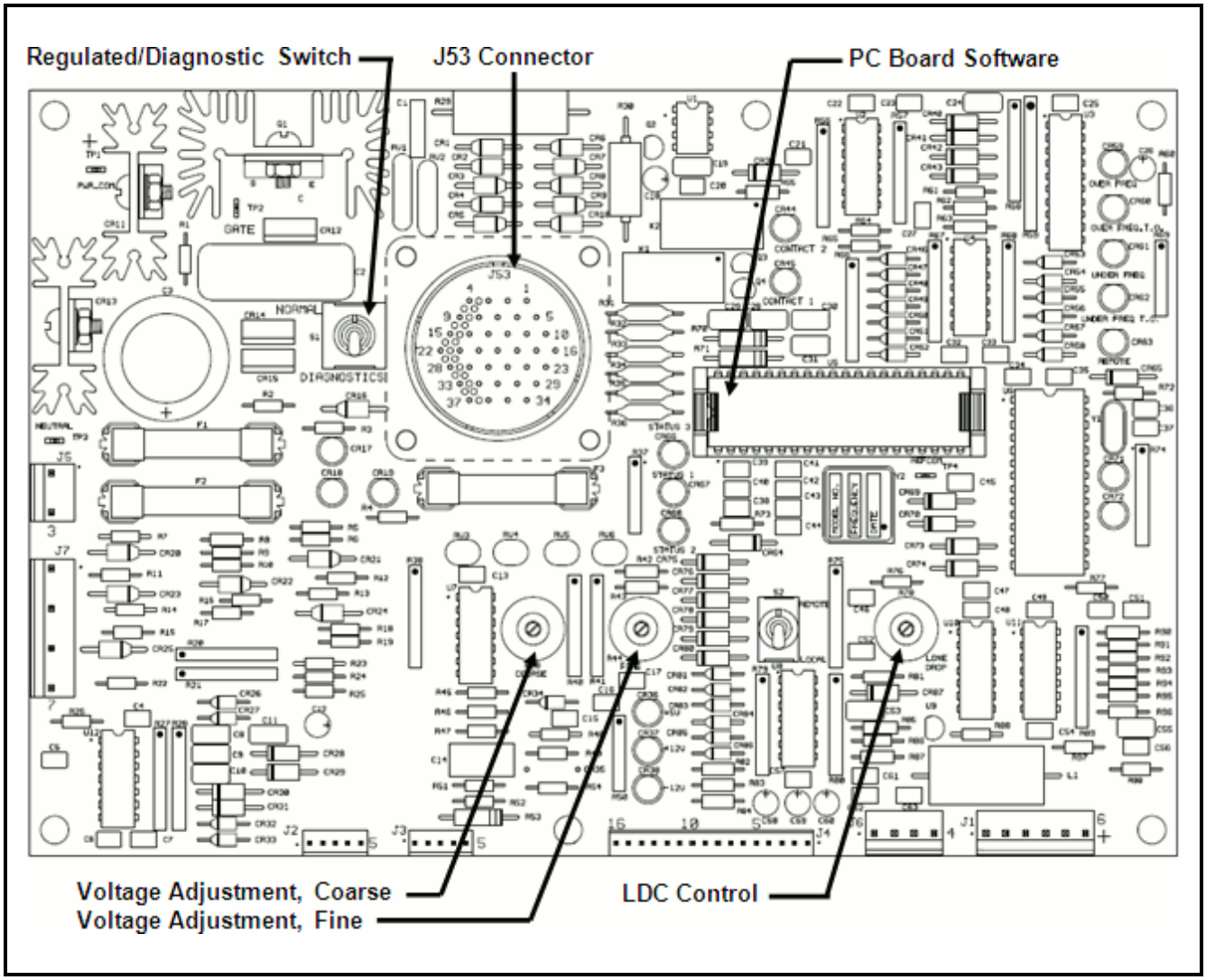


Figure 7: Voltage Regulator PC Board

(1) Output Voltage Adjustment

a Adjust Voltage Control

The output voltage, at which the generator is regulated, is adjustable by the fine voltage adjustment potentiometer. Turn the potentiometer adjustment clockwise to increase generator output voltage, and counterclockwise to decrease voltage.

Observe the output voltage as indicated by the voltmeter, located on the control panel of the generator set. Set output voltage at 115-V AC line-to-neutral (200-V AC line-to-line).

b Adjust Line-Drop Compensation

Adjustment of line-drop compensation is made with the line-drop compensation potentiometer. Turning the potentiometer knob clockwise increases the magnitude of the compensation, and turning the potentiometer knob counterclockwise decreases the magnitude (A graduated nameplate for specified cable lengths is included for quick reference.). To adjust the line-drop compensation, proceed as follows:

(i) Connect the generator set output cables to a load. Load the generator set with the largest available three-phase load of rated power factor not exceeding the maximum rating of the generator set.

(ii) Measure output voltage at the load end of the cables. If the load voltage rises or drops more than 1% at the load end of the cables, decrease or increase the line-drop compensation until the regulation is flat (115-V AC line-to-neutral and 200-V AC line-to-line).

(iii) If the line-drop compensation adjustments have affected the no-load voltage output, adjust the fine output voltage control potentiometer to the desired value.

(2) Test the Voltage Regulator

After necessary adjustments have been completed, re-test the voltage regulator as follows:

a Connect a voltmeter at the load end of the generator output cables.

b Operate the generator set at no-load and observe voltage reading.

c Operate the generator set under load and observe voltage reading.

d Voltage under load and no load should vary no more than 1% at the load end of the cables.

c) Basic Engine Adjustments

Adjustment procedures applicable to the diesel engine are included in the engine manufacturer's operation manual, which is referenced in Chapter 5. Refer to the engine operation manual for detailed information on the following engine adjustments.

NOTE: A stroboscope is required for engine idle speed checks.

Engine idle speed is programmed at the factory. If adjustment is required, contact the local engine distributor. The recommended idle speed is 1000 RPM, +/- 25 RPM.

The speed limiting adjustment is also set and sealed at the factory. Speed should be limited to approximately 2350 RPM. If adjustment is required, contact your local engine distributor.

d) Engine Accessories Adjustment

Alternator and fan belt adjustment: Refer to Section 2-1 and engine manufacturer manual.

4) Generator and Exciter Test

The generator fields and exciter stator may be tested with a Kelvin bridge. This is a double-bridge type instrument required for the very low resistance's encountered in this test. It is understood that zero (0) resistance indicates a **SHORT CIRCUITED** condition. An infinite resistance reading indicates an **OPEN** CIRCUITED condition.

a) Disconnect generator stator leads at the output module panel.

b) Disconnect the two black exciter field leads from terminal block mounted on output module panel.

c) Check resistance and compare to values.

Test Connection	Resistance (Ohms)
Generator Stator Phase A to N (G1)*	0.0026
Generator Stator Phase B to N (G1)*	0.0026
Generator Stator Phase C to N (G1)*	0.0026
Exciter Stator Field (L2)	29
A - B, B - C, C - A Exciter Armature (G2)	0.041
Generator Revolving Field (L1)	2.1
***NOTE:** The two leads of a phase must be connected when test is made. Take readings when unit is cold and in an ambient temperature of 70 ºF (21ºC.).	

Figure 8: Generator and Exciter Test Readings

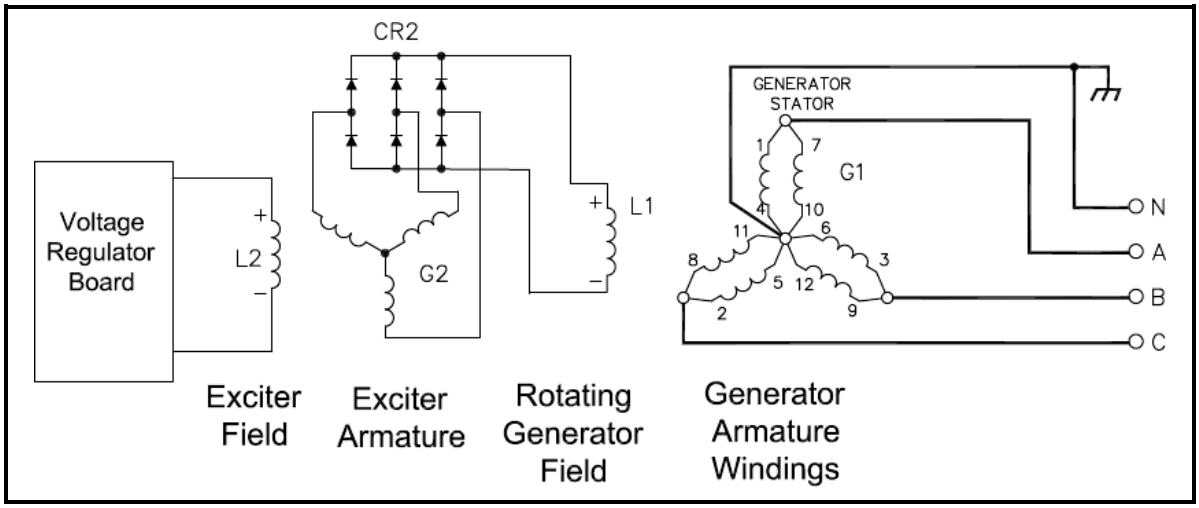


Figure 9: Generator Connections

5) Diode Test

Test values for diodes are not given here because they could be misleading. Test values may vary even between diodes of the same part number, rating, and manufacturer. General instructions for testing diodes are as follows:

a) Disconnect exciter windings from diode lead(s).

b) Use a good quality ohmmeter. An instrument, which indicates 50 ohms at the center of the scale, is preferable.

NOTE: Make certain the battery is in good condition and the pointer is adjusted to zero when the test lead points are shorted together.

c) Hold one ohmmeter lead point on the threaded end of the diode. Hold the other lead point on the wire terminal end. Observe and note the indicated resistance. Now reverse the lead connection on the diode. Again observe and note the ohmmeter indicated resistance. Generally speaking, if an infinite or very high resistance was indicated with the leads connected one way and a low, readable resistance was indicated with the leads connected the opposite way, the diode may be considered good.

6) Testing the Transformer-Rectifier (for units with the DC option)

The 28.5-VDC transformer-rectifier is an optional add-on to the GPU. The following test procedures may be used for testing the T-R following repair, or for just checking performance.

a) Preparation for Testing

(1) Connect the T-R to a load bank.

(2) Start the GPU per the operating procedures in Chapter 1, Section 3.

b) Operational Test Procedure

(1) Power Delivery

a Press "**DC OUTPUT**" push button to close the DC output contactor. The blue "**DC OUTPUT**" lamp will glow indicating that DC power is being delivered to the load bank.

b Observe the DC voltmeter on the control panel, under no load for accuracy. It should indicate approximately 28.5 VDC.

c With the GPU connected to a load bank, place a 600 A load on the GPU. Observe the DC voltmeter and ammeter for accuracy.

(2) Discontinue Power Delivery

Press "**DC OUTPUT**" push button to open the DC output contactor. The blue "**DC OUTPUT**" lamp will not glow indicating that DC power has been removed from the load bank.

(3) Current Limiting / Soft Starting Control

a Press the "**STARTNG CURRENT**" push button to activate the current limiting and set the limit to 1500 A.

b Press the "**DC OUTPUT**" push button to close the contactors to apply the load to the load bank. Observe the ammeter, the current should stay below 1500 A.

c Discontinue the power delivery.

(4) Over-Voltage Protection

a Press "**DC OUTPUT**" push button to close the DC output contactor. The blue "**DC OUTPUT**" lamp will glow indicating that DC power is being delivered to the load bank.

b Adjust the voltage adjustment potentiometer on the TRB PC Board to range of 32-34 VDC.

c With 7 to 9 seconds after the trip voltage is reached, the contactor will open and an over-voltage fault will be indicated on the fault code meter, which will read "**70.28**"

d Reset the voltage back to 28.5 VDC.

(5) Under-Voltage Protection

a Press "**DC OUTPUT**" push button to close the DC output contactor. The blue "**DC OUTPUT**" lamp will glow indicating that DC power is being delivered to the load bank.

b Adjust the voltage adjustment potentiometer on the TRB PC Board to less than 20 VDC.

c With 7 to 9 seconds after the trip voltage is reached, the contactor will open and an under-voltage fault will be indicated on the fault code meter, which will read "**70.29**"

d Reset the voltage back to 28.5 VDC.

(6) Overload Protection

a Press the "**STARTNG CURRENT**" push button to activate the current limiting and set the limit to 1500 A.

b Press "**DC OUTPUT**" push button to close the DC output contactor. The blue "**DC OUTPUT**" lamp will glow indicating that DC power is being delivered to the load bank.

c The contactor should open in 30 seconds. The fault code meter will read "**70.30**"

d Discontinue power delivery and let the cables cool for 2-3 minutes.

e Press the "**STARTNG CURRENT**" push button to activate the current limiting and set the limit to 2000 A.

f Press "**DC OUTPUT**" push button to close the DC output contactor. The blue "**DC OUTPUT**" lamp will glow indicating that DC power is being delivered to the load bank.

g The contactor should open in 10 seconds. The fault code meter will read "**70.30**"

h Discontinue power delivery and let the cables cool for 2-3 minutes.

(7) Temperature Overload Protection

a Press "**DC OUTPUT**" push button to close the DC output contactor. The blue "**DC OUTPUT**" lamp will glow indicating that DC power is being delivered to the load bank.

b Remove one wire from the thermostat switch located on the right side of the T-R heat sink. This will open the switch, thus simulating an over temperature fault. The fault code meter will read "**70.44**"

(8) Silicon Diodes

a Shut the GPU completely down removing all power from the system.

b Disconnect diode leads.

c Use a good quality ohmmeter, place one ohmmeter lead on the threaded end of the diode and the other lead on the diode lead and the record value.

d Reverse the ohmmeter leads and record the value.

e The diode may generally be considered good if one reading is infinite or very high and the other reading is extremely low.

(9) Control Interlock Kit (Optional)

a With the output cable sitting in the cable tray, start the GPU and bring the engine to rated speed.

b Close the output contactor by pressing the "**DC OUTPUT**" push button. The output contactor should open immediately with an "**EF3**" warning displayed on the fault code meter.

c Using a 28 VDC power source, apply a 28 VDC signal to the control socket of the output cable (small socket).

d Close the output contactor by pressing the "**DC OUTPUT**" push button. The output contactor should stay closed.

e Remove the 28 VDC power source and the contactor should open with an "**EF3**" warning.

7) Adjusting the Transformer-Rectifier (for units with DC option)

The T-R is design to be adjustment free. No adjustments required, other than periodically checking the output voltage and adjusting the TRB PC board potentiometer as necessary.

Section 4 Troubleshooting Procedures

1) General

The Troubleshooting Chart and Fault Code Chart located in this section cover the common faults and malfunctions that you may find during operation or maintenance of this equipment. The charts may not list all faults and malfunctions that may occur. If a fault of malfunction is not listed in the chart, start looking for the cause at the source of power in the affected circuit. Refer to the schematic and connection diagrams in Chapter 5. Test the circuit systematically until the source of the malfunction is isolated.

The Fault Code Chart is arranged under two headings: Commands and Faults. Commands display the operation mode at the time a fault code is triggered.

WARNING	Exercise extreme care to avoid contact with high voltage leads and components. High voltage can kill!

CAUTION	Maintenance personnel must be very careful when performing terminal-to-terminal checks to be certain the proper terminals are being used, especially when using jumper leads. Damage to electrical components may result from the application of improper voltage and current.

2) Equipment for Troubleshooting

A good quality multi-scale voltmeter is the only instrument required for troubleshooting. At least two jumper leads with alligator, or similar clips, will be required. The engine electrical system may be used as a 12 VDC power source.

3) Parts Replacement

To lessen end item down time and to get a faulty machine back on line as quickly as possible, the black box concept of parts replacement is reflected in the Troubleshooting and Fault Code Chart. For example, if a component on a control box board is defective, the quickest way to remedy the situation is to replace the complete board and send the old to stock. Some of the assemblies that tend to lend themselves to this concept are:

- Voltage regulator Board (REG)
- Control board (CTL)
- Engine Specific Board (ESB)
- Engine Interface Board (EIB)
- LED Board (LED)
- 28.5 VDC Transformer-Rectifier Board (TRB) *[optional]*

4) Normal Operation

The system specifications, which are listed in Section 1-1, provide useful information when troubleshooting abnormal operation. In particular, the Protective System Specifications and the Normal Operating Characteristics provide information about how the generator set should be operating.

5) Check Connections and Leads

ALWAYS make a check of connections and leads to a component suspected of being faulty. With the exception of a few instances, we will assume that connections and wiring have always been checked first and that power has not been lost as a result of defective wiring or connections.

6) Engine Troubleshooting

When troubleshooting the engine, remember that the ability of the engine to start and run properly depends upon the following:

- An adequate supply of 12 VDC power reaching a good starter and starter button
- An adequate supply of air, compressed to a sufficiently high pressure
- The injection of the correct amount of clean fuel at the proper time

7) Illustrations

Illustrations, Figures 1, 2, 3 and 4, are referred to throughout the Troubleshooting Chart

8) Connection and Schematic Diagrams

All connection and schematic diagrams for generator, engine, lights, and all controls are located in Chapter 5.

9) GPU Control Monitoring

The GPU control system performs complete diagnostic testing and continuous monitoring of all critical circuits and operating electrical values. If the control system senses a problem with one of the circuits or if any of the electrical values exceeds its safe operating limit, the control system will shut the GPU down, or may allow the GPU to continue operation depending on the severity of the condition.

a) Commands

The ongoing operations conducted by the GPU are driven by the list of commands in Table 1. The control board communicates these commands to all of the boards in the GPU. The first half of the fault code identifies the command that was present when the fault occurred.

Commands

01. \ 39.	Self-Test Mode
40.	Engine Start Mode
50.	Engine Idle Mode
70.	Engine Run Mode
80.	Engine Shutdown Mode
90.	Engine Stop Mode
99.	System Off Mode

Operating Commands
Table 1

(1) Self-Test Mode

When power is first applied to the control circuit, the GPU performs complete self-diagnostics of the internal circuitry. During this self-test, the GPU will perform the commands listed in the enclosed charts. When a fault is detected during the self-test, the current **COMMAND** and detected **FAULT** are displayed on the fault code display.

(2) Engine Start Mode

When the **ENGINE START** push-button is activated, the engine's starter and the engine's ECM will be energized.

(3) Engine Idle Mode

When the engine has been started, the engine will begin in the idle mode. The **ENGINE START** push-button will flash indicating the engine is in the idle mode.

(4) Engine Run Mode

After the engine has been warmed up properly in the Engine Idle Mode, pressing the **ENGINE START** push-button again brings the GPU up to rated speed. The **ENGINE START** push-button light no longer flashes, but instead becomes continuously illuminated. The GPU is now ready for aircraft loading.

(5) Engine Shutdown Mode

When shutting the GPU down, pressing the **ENGINE STOP** push-button starts the 3-5 minutes delayed shutdown period. The **ENGINE STOP** push-button flashes and the engine returns to idle speed. The shutdown period is required to cool the engine's turbocharger.

(6) Engine Stop Mode

After the 3-5 minutes delayed shutdown period, the engine stops running.

(7) System Off Mode

The power is removed from the GPU's entire control system.

b) Faults

Faults result when any of the fault limits are exceeded, when an internal problem occurs, or under certain conditions that would cause injury to personnel or damage to an aircraft or the GPU. Faults are also stored in memory as event records. The fault limits and conditions are preset at the factory.

Faults

.01 \ .09	Warning (no operation changes)
.10 \ .39	Run Mode (minor fault)
.40 \ .59	Idle Mode (moderate fault)
.60 \ .79	Stop Mode (major fault)
.80 \ .99	Special Configuration (reserved)

Fault Codes
Table 2

(1) Warning

Warning faults have no effect on the operation of the GPU. An example is an intake air restriction fault due to a dirty filter. Although the GPU continues to operate, the fault appears on the fault code display. Pressing the **TEST/RESET** pushbutton or shutting down the GPU resets the fault.

(2) Run Mode

Run mode faults remove power form the aircraft but do not change the operating speed of the engine. An example is an over voltage fault. Although the contactors open and remove power from the aircraft, the engine remains at rated speed, and the fault appears on the fault code display along with the command. Pressing the **TEST/RESET** pushbutton or shutting down the GPU resets the fault.

(3) Idle Mode

Idle mode faults remove power from the aircraft and drop the operating speed of the engine to the idle setting. A possible example (depending on customer configuration) is a high temperature fault. The contactors open and remove power from the aircraft, the engine drops to its idle speed, and the fault appears on the fault code display along with the command. Pressing the **TEST/RESET** pushbutton or shutting down the GPU resets the fault.

(4) Stop Mode

Stop mode faults remove power form the aircraft and shut the engine down. An example is a low oil pressure fault. The contactors open and remove power from the aircraft, the engine shuts down, and the fault appears on the fault code display along with the command. Pressing the **TEST/RESET** pushbutton or shutting down the GPU resets the fault.

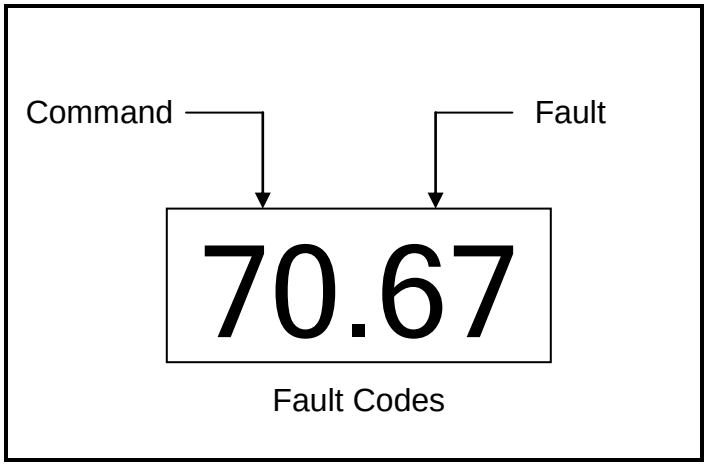
(5) Special Configuration

These fault codes are reserved for special customer configurations. Contact the factory for information.

c) Fault Code Display

The numbers that appear in the **FAULT CODE** display are used for troubleshooting the GPU. The first two digits represent one-half of the fault code and the last two digits represent the other half.

- The first two digits on the left side of the Fault Code represent the **Command**.
- The two digits on the right side of the Fault Code represent the **Fault** Condition.



Fault Meter Display
Figure 1

d) Operation Monitoring

While applying power to an aircraft, the GPU continually monitors all critical circuits and operating electrical values.

During 400 Hz AC and 28.5 VDC (if supplied) operations, the GPU continually performs Command 70 (Engine Run Mode). When a fault is detected during operation, this **Command** and the detected **Fault** are indicated in the **FAULT CODE** display.

By referencing the Command and Fault Code chart, the GPU state and exact fault can be determined. When the fault is reset and the GPU restarted, the GPU may often detect the fault again revealing additional information. This method yields a high degree of troubleshooting accuracy.

Fault meter display example shown above: If the engine shuts down with the above fault code, 70.67, the engine ceases operation due to high coolant temperatures in the engine. The 70 represents the command the GPU was executing at the time of the fault and shutdown (Command 70 indicates an Engine Run Mode command.). The 67 represents the fault code that indicates the action taken by the control system upon faulting (Fault 67 indicates a Stop Mode fault which shuts the GPU down.).

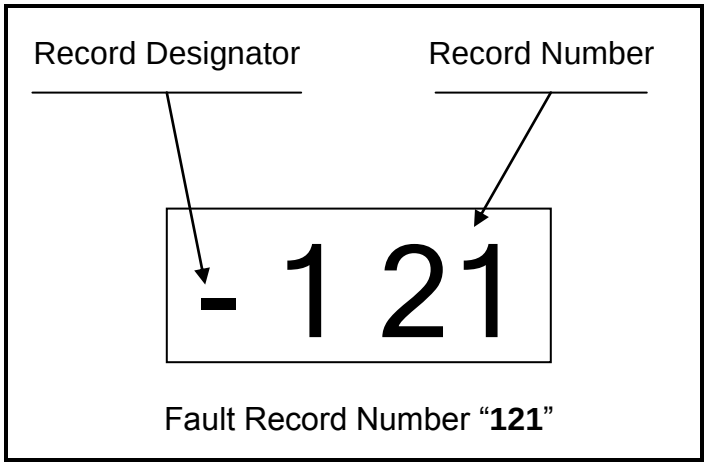
e) Extracting Fault Code Information

In the event the GPU fault code history information is required for troubleshooting, all fault codes stored in the control system's memory (i.e. data records) can be extracted and viewed on the Fault Meter Display (starting with the last fault code and scrolling backward through all previous fault codes). The following are the procedures for extracting the fault code information:

(1) Pull the **EMERGENCY STOP** button out.

(2) Press the **LAMPS** pushbutton to turn on the control box lights.

(3) Press the **TEST/RESET** pushbutton and hold for 2 to 3 seconds until the data record number appears on the display (See Figure 2).

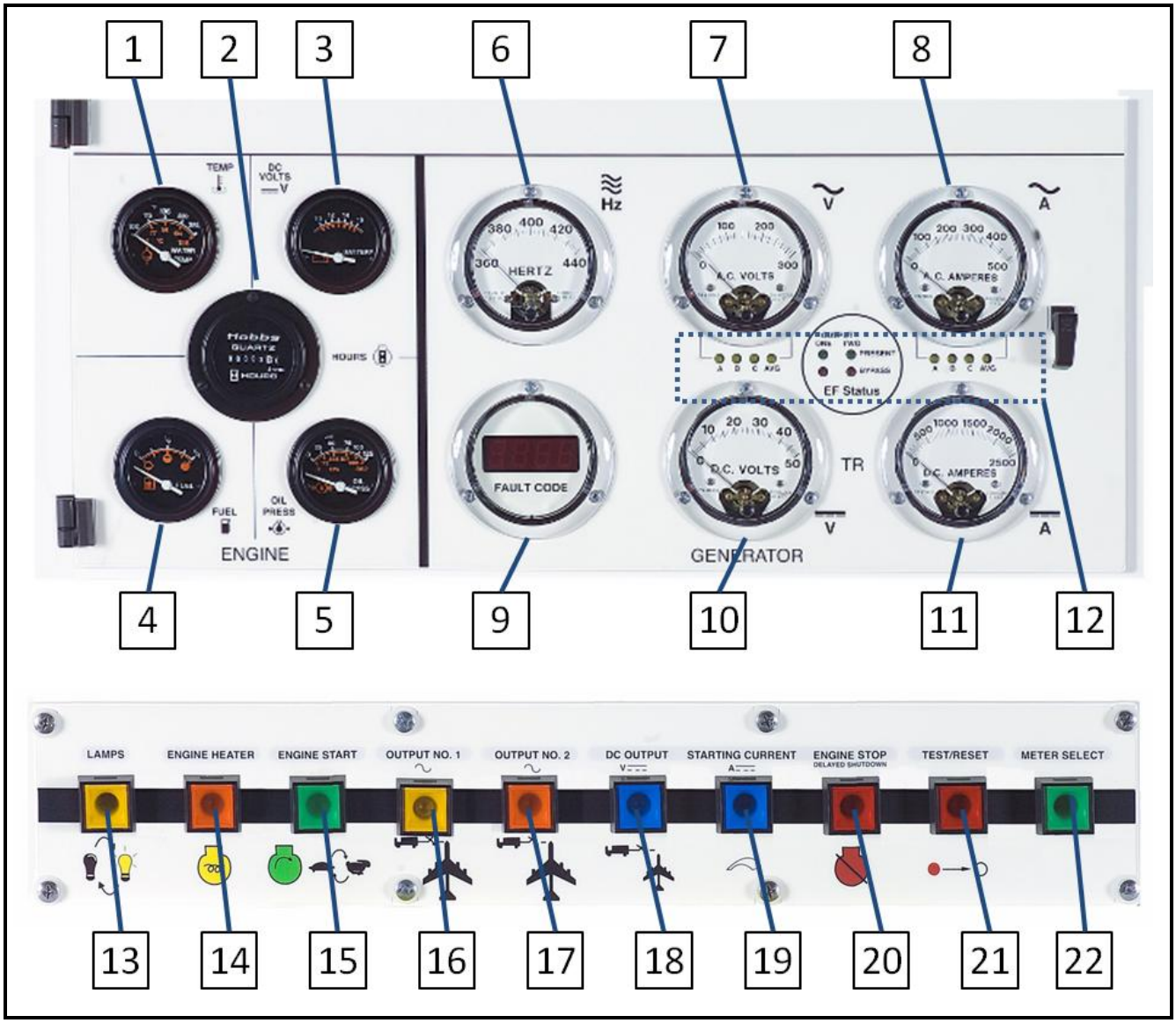


Fault Meter Display (Fault Record Number)
Figure 2

(4) Release the **TEST/RESET** pushbutton. The display alternates between the fault record number (See Figure 2) and the fault code (See Figure 1).

(5) To continue scrolling backward through the previous fault codes, press and release the **TEST/RESET** pushbutton again. The previous fault record number and fault code are displayed as described in Step 4.

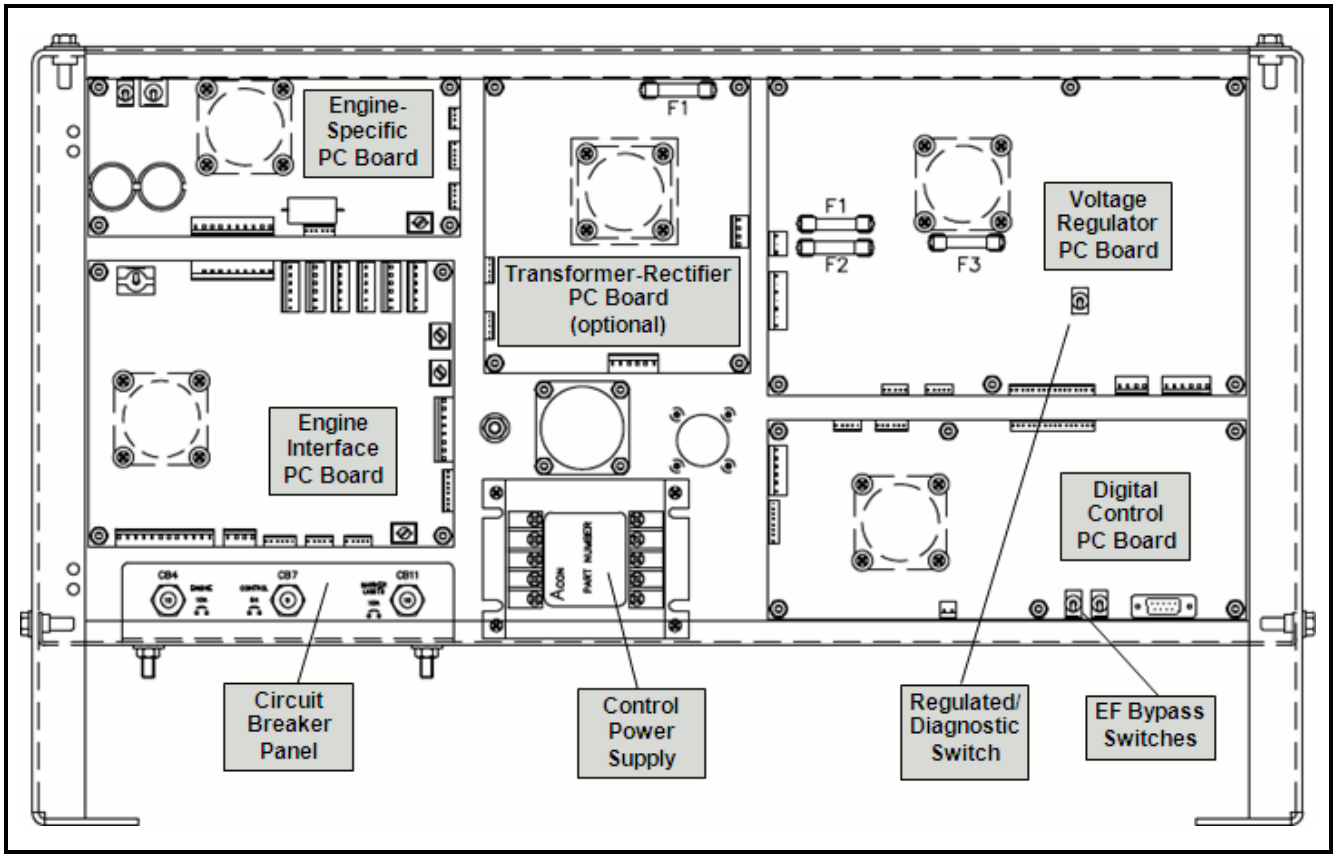
(6) Repeat Step 5 to continue scrolling backward. Once the first fault record is reached, the scrolling stops. To begin again, press the **LAMPS** pushbutton to turn off the control box lights and repeat Steps 2 through 5.



1. Engine Coolant Temperature Gauge (M24)
2. Running Time Meter (M4)
3. Battery Voltmeter (M5)
4. Fuel Gauge (M13)
5. Oil Pressure Gauge (M25)
6. Frequency Meter (M3)
7. AC Generator Voltmeter (M2)
8. AC Generator Ammeter (M1)
9. Fault Code Meter (M6)
10. DC Voltmeter *[Optional with TR]*
11. DC Ammeter *[Optional with TR]*
12. Front LED Display (A5)

13. Panel Light Switch (S74)
14. Air Intake Heater Switch (S79)
15. Engine Start Switch (S24)
16. AC Output No. 1 Switch (S75)
17. AC Output No. 2 Switch (S275)
18. DC Output Switch (S430) *[Optional with TR]*
19. DC Starting Current Switch (S431) *[Optional with TR]*
20. Engine Stop Switch (S76)
21. Test/Reset Switch (S77)
22. Meter Selector Switch (S3)

Figure 3: Operator Controls



Control Box Interior Components
Figure 4

Printed Circuit Board Name	Abbreviation
Engine-Specific board	ESB
Engine Interface board	EIB
Voltage Regulator board	REG
Digital Control board	CTL
Transformer-Rectifier board	TRB

10) Troubleshooting Charts

Engine Controls

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
1. The engine will not start, and the starter will not crank the engine.	**a. Emergency Stop** switch has been pressed.	• Make sure the **Emergency Stop** switch is pulled out.
	b. Battery Disconnect switch is in the **OFF** position.	• Make sure the battery disconnect switch is in the **ON** position
	c. Battery discharged or loose battery or ground connection	• Make sure the voltage across the batteries is approximately 12.8 VDC. • Check the battery terminals. • Be sure 12.8 volts DC is reaching the auxiliary solenoid input terminal.
	d. Defective auxiliary solenoid (L10)	• Check if you can hear the auxiliary solenoid activate when the start button is pressed. If not, check for voltage on the auxiliary solenoid coil (see below). • Temporarily connect a large-capacity jumper cable (No. 1/0 minimum) between the hot side of auxiliary starter solenoid and the starter input terminal. If starter does not crank engine, the starter may be defective
	e. No voltage at auxiliary solenoid coil	• Check inline fuse F112 • Check or replace the Engine Interface (EIB) board
	f. Defective starter	Remove the starter motor from engine and apply 12 VDC to test it. Replace the starter if it doesn't operate.
	g. Internal seizure	If the starter is good, attempt to hand crank the engine using a 3/4-inch square drive on the crankshaft pulley. If engine cannot be turned one complete revolution, internal seizure is indicated. Remove engine and contact the engine manufacturer and/or nearest dealer.
	h. Defective Engine Interface (EIB) board	Replace the EIB board.
	i. Defective engine start button	Measure the voltage across the switch. The voltage should read approximately 5 VDC when the switch is open and 0 V when the switch is closed. If voltage does not go to 0 V, replace the switch.
2. Engine will not start. Starter clicks on and off.	**a.** Low battery output	Check the battery and recharge or replace
	b. Loose starting circuit connections or faulty cables	Check all connections and cables. Tighten or replace as required.

Engine Controls (continued)

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
3. Engine will not start. Cranking speed is low.	**a.** Low battery output	Check the battery and recharge or replace
	b. Loose starting circuit connections or faulty cables	Check all connections and cables. Tighten or replace as required.
	c. Improper lubricating oil viscosity	Check the oil. Refer to Section 2-2. Remove and replace the oil as necessary.
4. Engine cranks but will not start. **Caution:** To prevent damage to the starting motor, do not engage the starting motor for more than 30 seconds. Wait two (2) minutes between each attempt to start.	**a.** Low fuel	Make sure there is sufficient fuel in the fuel tank. • If engine will not start, the fuel pump may be defective. • If engine starts and then stops after a short time, check fuel lines, and filters
	b. Fuel shutoff valve closed	Open the shutoff valve on the fuel tank.
	c. Plugged or defective filter	Replace fuel filters. Also, check the gaskets for leaking or damaged condition.
	d. Loose connections, damaged hoses or fuel lines between tank and fuel pump	Tighten all fittings and connections. Replace any damaged hoses or fuel links.
	e. Defective EIB board.	Replace the EIB board.
5. Engine cranks, but will not start. Over-temperature indication appears immediately.	**a.** Defective engine temperature switch	Check wiring to engine high temperature switch (S49 on schematic), which is located on top of the engine block. If wiring is correct, remove wires and check resistance between terminals C and N.O. A resistance of less than 10 ohms indicates a defective switch. Replace switch if defective.
	b. Defective EIB board (A2)	Replace the EIB board.
6. Engine is hard to start. Cranking speed is normal and the fuel supply is adequate.	**a.** Low compression, which may be caused by sticking or burned exhaust valves, worn or broken compression rings, leaking cylinder head gasket, or valve clearance adjustment.	Check the compression in accordance with instructions in the engine manufacturer's operation manual. Overhaul the engine to make repairs as necessary.
7. Engine starts but then stops after a few seconds by automatic shutdown.	**a.** Low oil pressure or defective oil pressure switch.	Restart the engine and observe oil pressure gauge. If oil pressure is 12 psi or more, disconnect wire from the normally-closed switch terminal on the oil pressure switch. Restart engine. If engine continues to run, the oil pressure switch is defective. Replace oil pressure switch. If engine stops, the EIB board might be defective.
	b. Defective EIB board (A2)	Replace EIB board.

Engine Controls (continued)

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
8. Engine either goes from rated speed to idle speed, or shuts down.	**a.** Low fuel was detected or the EIB board could be defective.	Add No. 2 diesel fuel. Replace EIB board.
9. Engine has slow response time when a load is applied.	**a.** Engine needs tune-up	Tune-up as required. Refer to engine manufacturer's operation manual.
10. Engine misses or runs unevenly.	**a.** Insufficient fuel	Check fuel system in accordance with engine manufacturer's operation manual. Repair or replace parts as required.
	b. Faulty injector	Check injectors in accordance with engine manufacturer's operation manual.
	c. Low compression pressure	Check compression in accordance with engine manufacturer's operation manual.
	d. Air in fuel system	Check all fittings to be sure they are tight and the thread sealant is still present. Tighten the fittings and add new thread sealant as required.
11. Engine lacks power	**a.** Improper engine adjustments and gear train timing	Tune-up engine in accordance with engine manufacturer's operation manual.
	b. Insufficient fuel	Check low fuel level in accordance with engine manufacturer's operation manual. Repair or replace parts as required.
	c. Insufficient inlet air due to damaged or dirty air cleaner.	Check air cleaner for plugging and/or damage.
	d. Restricted exhaust system	Check exhaust pipes for restrictions. Check muffler for clogged condition. Replace as required.
12. All panel and clearance lights are either always ON or always OFF.	**a.** Marker light circuit breaker (CB1) won't close.	Replace marker lights circuit breaker (CB1) if defective.
	b. Defective CTL board	Replace CTL board.

Generator Excitation Circuits

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
1. No (or low) generator output voltage in all phases. Generator operating at 400 Hz.	**a.** Defective generator or excitation circuit	On Voltage Regulator (REG) board (A4), place the **Regulated/ Diagnostic** switch in the **Diagnostic** position. This applies 12 VDC from battery to exciter field, which should produce an indicated output voltage of 100 +/- 20 VAC line to neutral. If voltage produced is within this range, the generator is good, and trouble may be in the voltage regulator circuit.
	b. Open fuse on Voltage Regulator (REG) board	Check the fuses on the Voltage Regulator board.
	c. Defective Voltage Regulator (REG)	Verify by swapping with a known good Voltage Regulator (REG) Board and replace if required.
	d. Defective connector at voltage regulator, or defective wiring from regulator to exciter field	Disconnect the exciter wires at the terminal strip. Using jumper leads with clip terminals, connect 12 VDC to wires. If generators produce at least 80 VAC, replace or repair the connector and wiring between voltage regulator and exciter field as required.

Load Contactor Operating Circuits

Output 1: Contactor K1, Pushbutton switch S75

Output 2: Contactor K201, Pushbutton switch S275

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
1. Load contactor will not close when the corresponding **Output** pushbutton switch is held in closed position. Generator is running at normal voltage.	**a.** Blown contactor fuse (F3) on regulator board	Check the fuse and replace if blown. If it blows again, check the contactor.
	b. Defective **Output** pushbutton switch	At rated speed, measure the voltage across the switch. The voltage should read approximately 5 VDC when the switch is open and 0 V when the switch is closed. If voltage does not go to 0 V, the switch is defective and needs to be replaced.
	c. Defective Voltage Regulator (REG) board	Measure the DC output voltage at contactor coil. If the voltage measured isn't approximately 90 VDC, replace REG.
		Replace the REG board.
	d. Defective coil in load contactor	Disconnect leads at load contactor terminals V and W. Check coil resistance between these terminals. Resistance should be approximately 600 ohms. If coil is defective, replace the contactor.

Load Contactor Operating Circuit (Continued)

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
2. Load contactor closes when the **Output** pushbutton switch is held in CLOSED position but opens immediately when the switch is released.	**a.** The plug interlock EF circuit on CTL board could be defective	Place EF Bypass switch in the **ON** position. If load contactor remains closed, proceed to step **b.**
	b. 28.5 VDC is not reaching the plug interlock EF circuit from aircraft for following reasons:	Proceed as follows to find the cause of this malfunction.
	c. Generator-to-aircraft cable connector defective or not plugged into aircraft receptacle connector	Inspect cable connector plug thoroughly for damaged E and F terminals. Be sure plug is fully mated with aircraft receptacle connector and making good contact.
	d. Aircraft rejecting power	Check aircraft on-board electrical equipment and controls.
	e. Defective contacts in switch mounted on side of contactor	Connect a jumper lead between terminals of the normally-open auxiliary switch. If the contactor now remains closed, replace the auxiliary switch or the entire contactor.
3. Load contactor opens during power delivery. No fault indicated.	**a.** A fault has developed in load contactor holding circuit.	If load contactor cannot be closed by operation of output pushbutton switch, check circuit in accordance with instructions in Trouble, Symptom, Condition 1. If the load contactor can be closed, but opens as soon as power accepted switch is released, check for trouble under Trouble 2, above.
	b. Cable accidentally disconnected from aircraft	Reconnect cable.

Protective Circuit

NOTE: Protective monitoring is not completely functional until the load contactor is CLOSED. Since it is not advisable to vary voltages for test purposes while delivering power to an aircraft, the GPU should be connected to a load bank for trouble shooting protective circuits. To avoid repetition, it will be assumed that **TEST/RESET** push-button switch has been pressed and the load contactor has been closed before commencing each test.

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
1. Load contactor opens during power delivery. Over voltage fault indicated.	**a.** Over-voltage condition may have been result of a sudden drop in load, or possible tampering with REG potentiometer, and may have been a normal action.	Press **TEST/RESET** push-button switch and resume power delivery. Observe voltmeter to be certain voltage is normal 115 VAC. Adjust to normal if necessary. If load contactor is opened again and the fault code meter indicates an over-voltage condition, proceed to step **b**.
	b. Defective CTL board	Use REG potentiometer to reduce voltage to 110 VAC. Observe voltmeter and gradually increase voltage with potentiometer. If sensing circuit CTL board opens the load contactor at any value less than 125 VAC, it is defective. Replace CTL board.
2. Load contactor opens during power delivery. Under voltage fault indicated.	**a.** Under-voltage condition may have been result of a sudden shock load, or possible tampering with REG potentiometer, and may have been a normal action.	Press **TEST/RESET** push-button switch and resume power delivery. Observe voltmeter to be certain voltage is normal 115 VAC. Adjust to normal if necessary. If load contactor is opened again and the fault code meter indicates an under-voltage condition, proceed to step **b**.
	b. Defective CTL board	Use REG potentiometer to reduce voltage to 100 VAC. Observe voltmeter and gradually decrease voltage with potentiometer. If sensing circuit CTL board functions to open load contactor at any value great than 100VAC, it is defective. Replace CTL board.

Protective Circuit (continued)

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
3. Load contactor opens during power delivery. Over frequency fault indicated.	**a.** Frequency adjust switch is enabled.	Set frequency adjust switch on the ESB board to DISABLE
	b. Defective REG board	If over-frequency faults continue after engine's ECM is proven to be good, and an over-frequency condition does not exist, replace the REG board.
4. Load contactor opens during power delivery. Under frequency fault indicated.	**a.** Frequency adjust switch is enabled	Set frequency adjust switch to DISABLE
	b. Defective REG board	If under-frequency faults continue after engine's ECM is proven to be good, and an under-frequency condition does not exist, replace REG board.
5. Load contactor opens during power delivery. Overload fault indicated.	**a.** There may have been an overload condition.	Observe the ammeter. Check for abnormal overload conditions and correct. If the load contactor opens when an overload does not exist, proceed to step b.
	b. Defective CTL board	Replace CTL board.

Generator

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
1. No (or low) voltage output	**a.** Shorted diode in exciter rectifier (CR2)	Check diodes in accordance with Section 2-3. If diodes are good, proceed to step b.
	b. Open or shorted exciter rotor winding (G2)	Use ohmmeter to check for open or shorted condition diodes in accordance with Section 2-3. If exciter rotor windings are good, proceed to step C.
	c. Open or shorted exciter field windings (L2)	Check field resistance. See Section 2-3 for normal values.
	d. Open or shorted generator rotor windings (L1)	Check resistance with ohmmeter to determine if open or short circuited diodes in accordance with Section 2-3
2. Generator operates single phase.	**a.** Open or short circuited winding in generator stator (G1)	Check stator-winding resistances. See Section 2-3 for normal values.
3. Generator overheats	**a.** Loose connection causing high resistance	Check all output connections. Look for discoloration caused by heat. Tighten or replace as required.
	b. Improper or blocked ventilation	Check for foreign material (rags, etc.) blocking airflow. Provide adequate ventilation.
	c. Generator stator windings short circuited	Check stator windings. See Section 2-3.
4. Unbalanced output	**a.** Loose connection in output circuit	Check all output connections. Discolored connectors indicate a loose connection. Tighten or replace as required.
	b. Open or short-circuited phase	Check stator windings in accordance with Section 2-3. Repair or replace as required.
	c. Defective connection in output circuit	Check the plug and receptacle connectors at aircraft. Tighten, repair, or replace as required.
	d. Break or cut in output cable assembly	Inspect the output cable for damage.
	e. Unbalanced load	Check the aircraft 400-Hz components.

T-R Controls and Components

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
1. Input AC and Output DC contactor will not close when **DC OUTPUT** push button S431 is pressed. Engine running normally, AC voltage normal, no load applied to output cable.	**a.** Defective push button switch	At rated speed, measure the voltage across the switch. The voltage should read approximately 5 VDC. Press the switch again and the voltage should go to 0 V. If voltage does not go to 0 V, the switch is defective and needs to be replaced.
	b. Fault code display indicates defective contactor: • **70.46** for input contactor • **70.31** for output contactor	Check all wire connections or replace with a known good contactor. If the above works correctly, see Step c.
	c. Defective TRB Board	Replace TRB board with a board known to be operating properly. If contactor still doesn't close, contact the factory for further information.
2. Load contactor K402 opens during power delivery. The engine is still running at rated speed or has returned to idle.	**a. Defective** load contactor. Fault Codes Display • **70.46** for input contactor • **70.31** for output contactor	Check all wire connections or replace with a known good contactor. If the above works correctly, see Step c.
	b. Contactor opening could have been normal because of an over/under-voltage condition. Fault Codes Display • **70.28** for over-voltage • **70.29** for under-voltage	Resume operation and closely observe voltmeter and fault code gauge for evidence of over/under-voltage condition. If contactor opens and no over/under-voltage condition exists, proceed to Step c.
	c. Contactor opening could have been normal because of an overload or over temperature condition. Fault Codes Display • **70.30** for overload • **70.44 or 70.45** for over temperature	Resume operation and closely observe fault code gauge for evidence of and overload or over temperature condition. If contactor opens and neither condition applies, proceed to Step d.
	d. Defective TRB Board	Replace TRB board with a board known to be operating properly. Resume power delivery. If contactor still opens, contact the factory for further information.

T-R Controls and Components (continued)

Trouble, Symptom, Condition	Probable Cause	Test, Check, and/or Remedy
2. (continued)	**e.** Interlock signal not being received from the aircraft	Be sure the output cable is properly inserted into the aircraft receptacle and try again. Verify 28 VDC is on the DC+ connection of the GPU and/or being sent from the aircraft. If aircraft is sending signal but not being received at the GPU DC+ and the cable is properly inserted into the aircraft receptacle, verify the K403 relay is operating. If K403 relay is operating, replace output cable. If all the above appears to be working, replace the TRB board.
3. STARTING CURRENT push button sets the current limit, but the system is not current limiting.	**a.** Defective push button switch	At rated speed, measure the voltage across the switch. The voltage should read approximately 5 VDC. Press the switch again and the voltage should go to 0 V. If voltage does not go to 0 V, the switch is defective and needs to be replaced.
	b. Defective TRB Board	Replace TRB board with a board known to be operating properly. If current limiting is still not operating, contact the factory.
4. STARTING CURRENT push button does not increment the current limiting values.	**a.** Defective push button switch	At rated speed, measure the voltage across the switch. The voltage should read approximately 5 VDC. Press the switch again and the voltage should go to 0 V. If voltage does not go to 0 V, the switch is defective and needs to be replaced.
	b. Defective TRB Board	Replace TRB board with a board known to be operating properly. If contactor still doesn't close, contact the factory.

10) Troubleshooting Tables

a) GPU Commands

GPU Commands		
Cmd code	**Name**	**Description**
00. _ _	Invalid Command	
01. _ _	ENGINE SELF-TEST CMD	All boards test the communication between each other.
40. _ _	ENGINE START MODE	Engine starter and engine's ECM is activated.
50. _ _	ENGINE IDLE MODE	Engine idles at approximately 1000 RPM
55. _ _	ENGINE RAMP UP	Period when engine goes from idle to rate speed
63. _ _	REG TEST OUTPUT FREQUENCY	Check for 400 Hz. output frequency
68. _ _	CTL TEST OUTPUT	Check the CTL communications
70. _ _	ENGINE RUN MODE	The engine is at rated speed and ready for aircraft load.
75. _ _	ENGINE RAMP DOWN	Period when engine goes from rated to idle speed
80. _ _	ENGINE DELAYED SHUTDOWN MODE	Allows the turbocharger to cool properly
90. _ _	ENGINE STOP MODE	Engine is brought to a complete stop
99. _ _	System Off Mode	All electrical circuits have been turned off
-- End of Command Table --		

b) Faults

Faults			
Fault code	**Name**	**Possible Cause(s)**	**Corrective Action**
Air	EIB AIR RESTRICTION FAULT	Air filter is obstructed or dirty. Bad air restriction indicator	Check for obstructions. Change air filter cartridge or air restriction indicator.
FUEL	EIB LOW FUEL WARNING	Fuel tank level is below ¼ tank.	Fill fuel tank.
_ _.00	Invalid Fault		
_ _.03	CTL MEMORY FAULT	CTL board defective	Replace the CTL board.
_ _.04	REG EF1 LOSS FAULT	EF1 voltage signal not present CTL board defective	Switch the EF1 switch to ON Check cable contacts. Replace the CTL board.
_ _.05	REG EF2 LOSS FAULT	EF2 voltage signal not present CTL board defective	Switch the EF2 switch to ON Check cable contacts. Replace the CTL board.
_ _.06	TRB EF3 LOSS FAULT	EF3 voltage signal not present TRB board defective K403 relay defective Defective Output Cable	Check cable/aircraft connection. Place a 28 VDC signal of DC+ at output cable and at GPU. Replace defective components.
_ _.16	CTL OUTPUT OVER VOLTAGE FAULT	Voltage set too high LDC set too high CTL board defective	Adjust voltage or the LDC on the REG board. Replace CTL board.
_ _.17	CTL OUTPUT UNDER VOLTAGE FAULT	Voltage set too low CTL board defective	Adjust voltage on the REG board. Replace CTL board.
_ _.18	CTL OUTPUT 1 OVERLOAD FAULT	Overload on Output 1	Reset and restart GPU.
_ _.19	CTL OUTPUT 2 OVERLOAD FAULT	Overload on Output 2	Reset and restart GPU.
_ _.20	CTL MACHINE OVERLOAD FAULT	Total overload on Output 1 & 2	Reset and restart GPU.
_ _.21	CTL OUTPUT VOLTAGE IMBALANCE FAULT	Open or broken sense line Load not balanced	Repair sensing wire. Check load imbalance and correct as required.
_ _.22	REG OUTPUT OVER FREQ FAULT	Defective engine ECM Defective REG board	Replace engine ECM. Replace REG board.
_ _.23	REG OUTPUT UNDER FREQ FAULT	Defective engine ECM Defective REG board	Replace engine ECM. Replace REG board.

Faults			
Fault code	**Name**	**Possible Cause(s)**	**Corrective Action**
_ _.24	REG CONTACTOR1 FAULT	Defective output contactor Defective REG board	Replace output contactor. Replace REG board.
_ _.25	REG CONTACTOR 2 FAULT	Defective output contactor Defective REG board	Replace output contactor. Replace REG board.
_ _.26	CTL DC OVER VOLTAGE FAULT	Defective CTL board	Replace CTL board.
_ _.27	CTL DC UNDER VOLTAGE FAULT	Defective CTL board	Replace CTL board.
_ _.28	TRB OUTPUT OVER VOLTAGE FAULT	Voltage set too high TRB board defective	Reset and restart GPU. Replace TRB board.
_ _.29	TRB OUTPUT UNDER VOLTAGE FAULT	Voltage set too low. TRB board defective	Reset and restart GPU. Replace TRB board.
_ _.30	TRB OUTPUT OVERLOAD FAULT	DC load over rating of GPU	Reset and restart GPU.
_ _.31	TRB DC CONTACTOR FAULT	Defective output contactor Defective TRB board	Replace output contactor. Replace TRB board.
_ _.32	REG EF1 VOLTAGE TOO HIGH FAULT	EF voltage being sent from aircraft on output 1 to the GPU is too high. Output cable is defective.	Reset and restart GPU. Check output cable.
_ _.33	REG EF2 VOLTAGE TOO HIGH FAULT	EF voltage being sent from aircraft on output 2 to the GPU is too high. Output cable is defective.	Reset and restart GPU. Check output cable.
_ _.34	TRB AC CONTACTOR FAULT	Defective input contactor. Defective TRB board	Replace input contactor. Replace TRB board.
_ _.40	CTL ID FAULT	Defective CTL board	Replace CTL board.
_ _.41	TRB ID FAULT	Defective TRB board Defective or missing ID resistor	Replace TRB board. Replace or install ID resistor.
_ _.42	ESB ID FAULT	Defective ESB board	Replace ESB board.
_ _.43	REG ID FAULT	Defective REG board	Replace REG board.
_ _.44	TRB HEATSINK OVERTEMP FAULT	Obstructed cooling air path Defective thermal switch	Clear air obstruction. Replace switch.
_ _.45	TRB TRANSFORMER OVERTEMP FAULT	Obstructed cooling air path Defective thermal switch	Clear air obstruction. Replace switch.
_ _.46	TRB INPUT CONTACTOR FAULT	Defective input contactor. Defective TRB board.	Replace input contactor. Replace TRB board.
_ _.47			

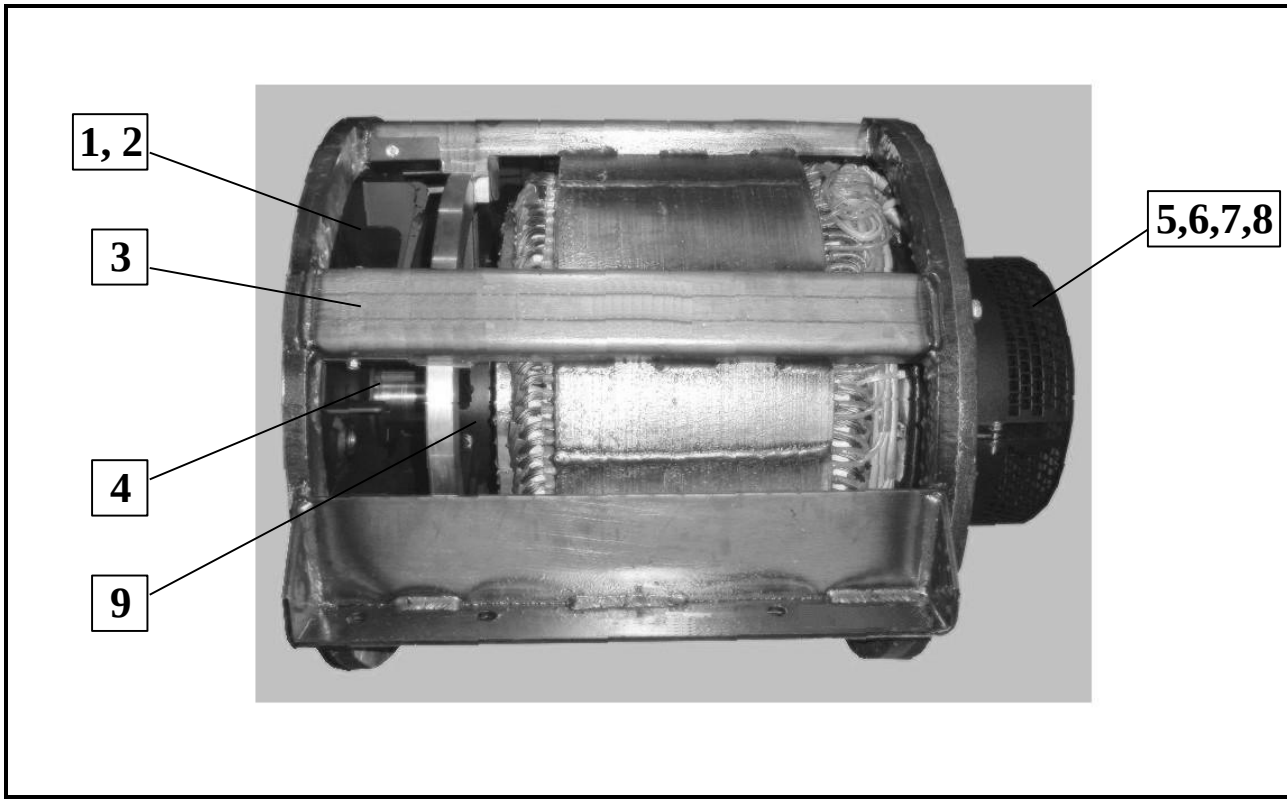
Faults			
Fault code	**Name**	**Possible Cause(s)**	**Corrective Action**
_ _.48	GEN ID FAULT	The REG board cannot find the generator. Defective REG board	Check for ID R2 on TB1. Check for broken wire on ID R2 on TB1. Replace REG board.
_ _.49	CTL POWER MODULE ID FAULT	Call Factory	Call Factory
_ _.50	TRB SELF-TEST FAULT	TRB board defective	Replace TRB board.
_ _.55	EIB LOW FUEL FAULT	Fuel tank level is below $^{1}/_{8}$ tank.	Fill fuel tank.
_ _.60	CTL COMM FAULT	Defective CTL board	Replace CTL board.
_ _.61	EIB COMM FAULT	Defective EIB board	Replace EIB board.
_ _.62	ESB COMM FAULT	Defective ESB board	Replace ESB board.
_ _.63	REG COMM FAULT	Defective REG board	Replace REG board.
_ _.64	TRB COMM FAULT	Defective TRB board	Replace TRB board.
_ _.66	EIB LOW ENGINE COOLANT FAULT	Engine coolant level is too low. Engine is loosing coolant.	Refill radiator. Check for leaks and replace defect components.
_ _.67	EIB ENGINE OVERTEMP FAULT	Engine is over-heated. Coolant level is too low. Radiator is dirty or obstructed. Defective EIB board Defective temperature switch	Let engine cool then restart. Check coolant level and add. Clean radiator. Replace EIB board. Replace switch.
_ _.68	EIB LOW OIL PRESSURE FAULT	Engine oil level is too low. Defective EIB board. Defective oil pressure switch.	Check oil level and add. Replace EIB board. Replace switch.
-- End of Fault Table --			

Chapter 3 Overhaul/Major Repair

Section 1 Exciter Armature

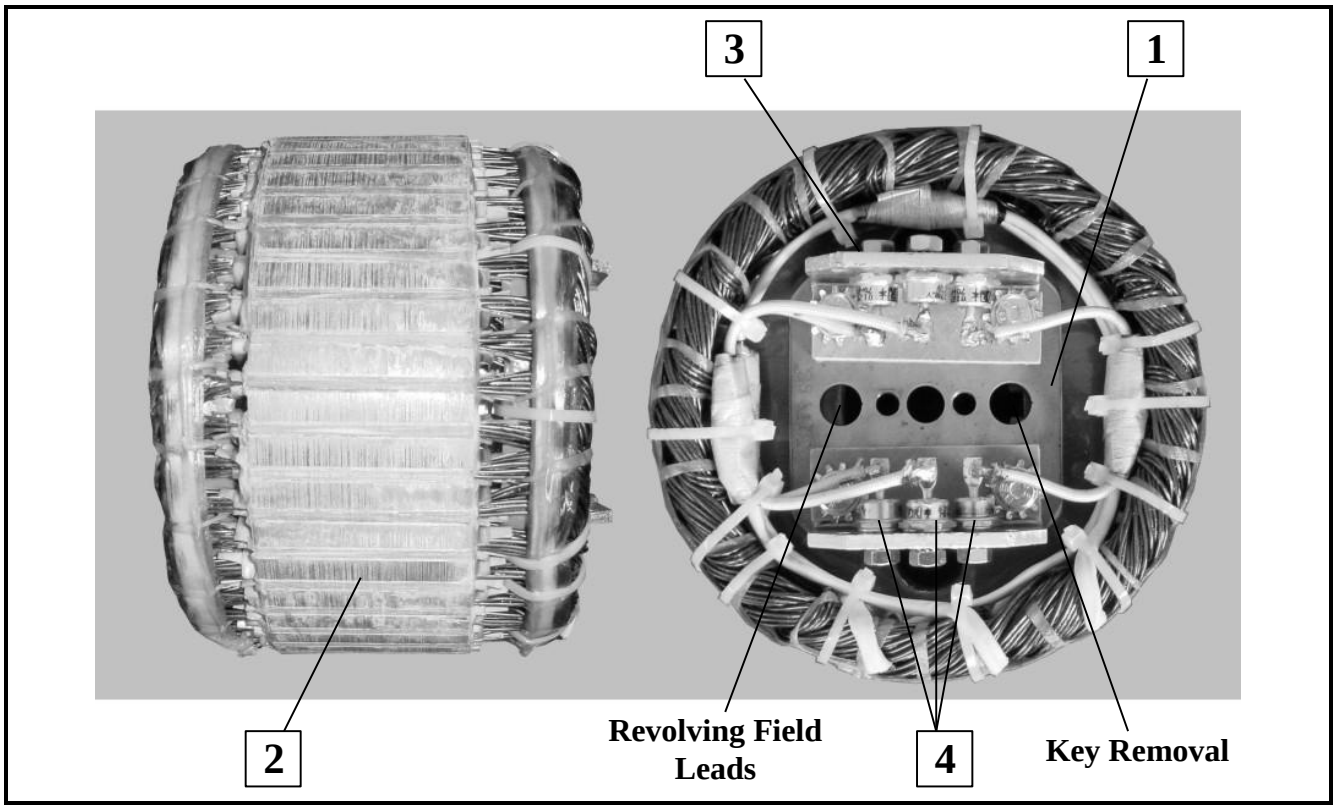
1) General

This section provides information and instructions for removal and installation of the exciter armature used on this generator set. Through design improvements, the exciter and rear main bearing can be removed without removing the generator from the generator set. The name “exciter armature” refers to the shaft-mounted, revolving, three-phase windings of the exciter.



1. Coupling Key (Not Shown)
2. Flex Coupling Assembly
3. Generator Housing & Stator Assembly
4. Armature Assembly
5. Exciter Housing & Coils Assembly
6. Exciter Cover
7. Exciter Armature Assembly
8. Exciter Key (Not Shown)
9. Front Bearing (Located Inside Housing Shown)
10. Rear Bearing (Located In Exciter Housing)

General Assembly
Figure 1



1. Exciter Core Flange
2. Exciter Core Lamination
3. Diode Mounting Plate
4. Silicon Diode

Exciter Armature
Figure 2

The exciter armature is mounted on the rear portion of the main generator armature shaft, which extends rearward beyond the rear generator bearing into the exciter housing (See Figure 1). Because of its location on the shaft, the exciter armature must be removed for rear main bearing replacement. The exciter armature has two M10-1.5 tapped holes in its diode mounting plate to accommodate pulling it off the shaft.

Since the removal and installation of exciter armatures can be rather complicated, this manual has been prepared to assist mechanics in the operation. It may be necessary to remove the exciter armature several times for bearing replacement during the life of a generator set.

2) Exciter Armature

The exciter armature used in this generator set consists of a revolving winding assembly on a laminated core, a rectifier assembly (diode mounting plate with diodes), and a mounting flange. The flange, core, and diode mounting plate are bolted together to make the complete exciter armature.

The exciter armature is mounted on the main generator armature shaft with a 3/8-inch square machine key that is held in place by a key retainer, and an M12-1.75 hex head cap screw in the center of the diode mounting plate.

3) Exciter Armature Replacement

a) General

As stated earlier, exciter armature removal is often required for rear bearing replacement rather than for replacement of the exciter armature itself. Other reasons for exciter armature removal are generator armature replacement, general overhaul, etc.

b) Tools needed for Exciter Armature Removal and Installation

In addition to the standard mechanic's hand tools such as wrenches, etc., you will need only the following items for removing the exciter armature:

- A small, lightweight, sling-hammer puller
- Two M10-1.5 x 127 mm long fully-threaded hex-head bolts

A small, lightweight, sling-hammer puller is shown in Figure 3. This tool is necessary for removing the threaded machine key, which keeps the exciter armature from spinning on the generator armature shaft. You may have such a puller in your equipment inventory. If not, Figure 3 also illustrates components and dimensions for fabricating such a tool. Sling-hammer pullers are also commercially available. Instructions for using tool are provided in this manual.

Once the threaded machine key is removed, No other special tools are required for removing the exciter from the generator shaft. This can be done using the two M10-1.5 fully-threaded hex-head bolts. Instructions for doing this are provided in this manual.

c) Conditions for Exciter Removal

The mechanics performing the work must decide upon the best and most convenient method of removing the exciter armature. If the exciter armature is being replaced, then the work may be performed without removing the generator from the machine. In a great majority of cases, exciter removal will be for the replacement of the rear bearing. This operation can also be accomplished without removing the generator. Replacement of the front bearing requires removal of the generator from the unit.

d) Preparation for Exciter Armature Removal

(1) Remove exciter cover from end canopy and the exciter armature cover from the end of the generator.

(2) Place a block bar (pry bar) into the generator fan assembly to keep the generator armature from rotating.

WARNING

To prevent personal injury, keep fingers and hands clear of generator assembly until the armature is block into place to prevent rotation.

(3) Remove exciter housing cover as required. Remove the M12-1.75 cap screw, which holds the exciter armature and key retainer on the generator shaft.

(4) Disconnect the two rectifier-to-generator field leads, which are attached to the rectifier mounting plate with ring terminals.

(5) Take **EXERCISE CARE** to prevent damage to leads. Remove kinks in the two generator leads as much as possible before starting removal operation (The exciter armature will be sliding over these leads.).

e) Exciter Armature Removal

(1) Removing the Threaded Key with Sling-Hammer Puller

Refer to Figure 2 for location of threaded machine key. Attachment of the assembled puller to the key in one operation is not recommended because the weight and bulk of the assembly make threading the 1/4 inch stud into the key rather clumsy. This could result in cross-threading and damage to key and stud. It is safer and easier to attach as follows:

a Thread stud (1, Figure 3) into adapter (2) until it bottoms, then thread this assembly (1) and (2) into key until stud bottoms in key threads. Tighten securely.

b If hammer (5) and rod (4) are not already assembled, thread one nut (3) onto adapter end of rod (4). Thread rod into adapter until it bottoms, then tighten nut securely against adapter. Slide hammer (5) onto rod and install washer (6) and two nuts (3). Thread nuts onto rod until both nuts are full threaded and locked together.

WARNING

Be very careful during removal process (slide-hammering) to avoid injury to hands.

CAUTION

Exercise care to prevent breaking or damaging stud.

c Position the hammer at the adapter end of the rod.

d Quickly move hammer to outer end of rod with a rapid, slinging motion. **HOLD** the hammer through the entire motion. If the hammer is allowed to slide free on the rod, the stud could be **DAMAGED** or **BROKEN.**

e Repeat step (c) and (d) as required to loosen key, then remove key and slide-hammer puller.

f After key is removed, apply penetrating oil in the armature and shaft keyways.

(2) Removing the Exciter Armature

CAUTION

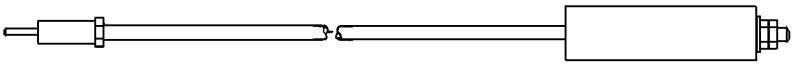
Leads may be damaged if armature is turned too far in either direction.

a Place a block bar (pry bar) into the generator fan assembly to keep the generator armature from rotating.

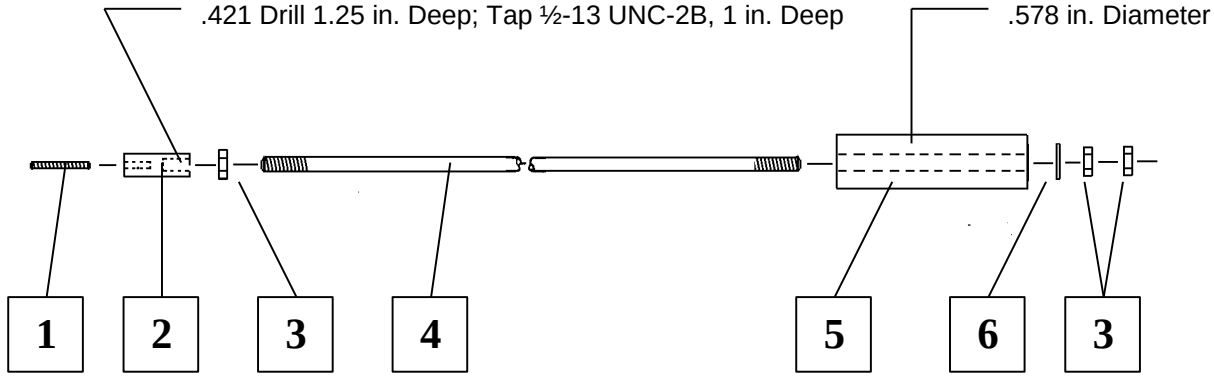
WARNING

To prevent personal injury, keep fingers and hands clear of generator assembly until the armature is block into place to prevent rotation.

b Attempt to loosen exciter armature on shaft by rotating it slightly back and forth. If armature cannot be loosened by hand, use two M10-1.5 hex-head bolts as shown in Figure 4 to force the exciter armature off the shaft. Turn each of the two screws a few turns at a time into the threaded holes of the diode mounting plate until the exciter armature is sufficiently loosened from the shaft to be removed from it by hand. Remove it slowly from the shaft and at the same time observe the following **CAUTION.**



Sling Hammer Assembly



Sling Hammer Components

1. Stud, 1/4-28 UNF 2A, Grade 5 or 8 ONLY
2. Adapter, 3/4" Round CR Steel
3. Nut, 1/2-13 Hex, Steel (3 required)
4. Rod, 1/2" Round, CR Steel
5. Hammer, 2" Round, CR Steel
6. Washer, Flat, 1/2" Steel

Sling Hammer Puller
Figure 3

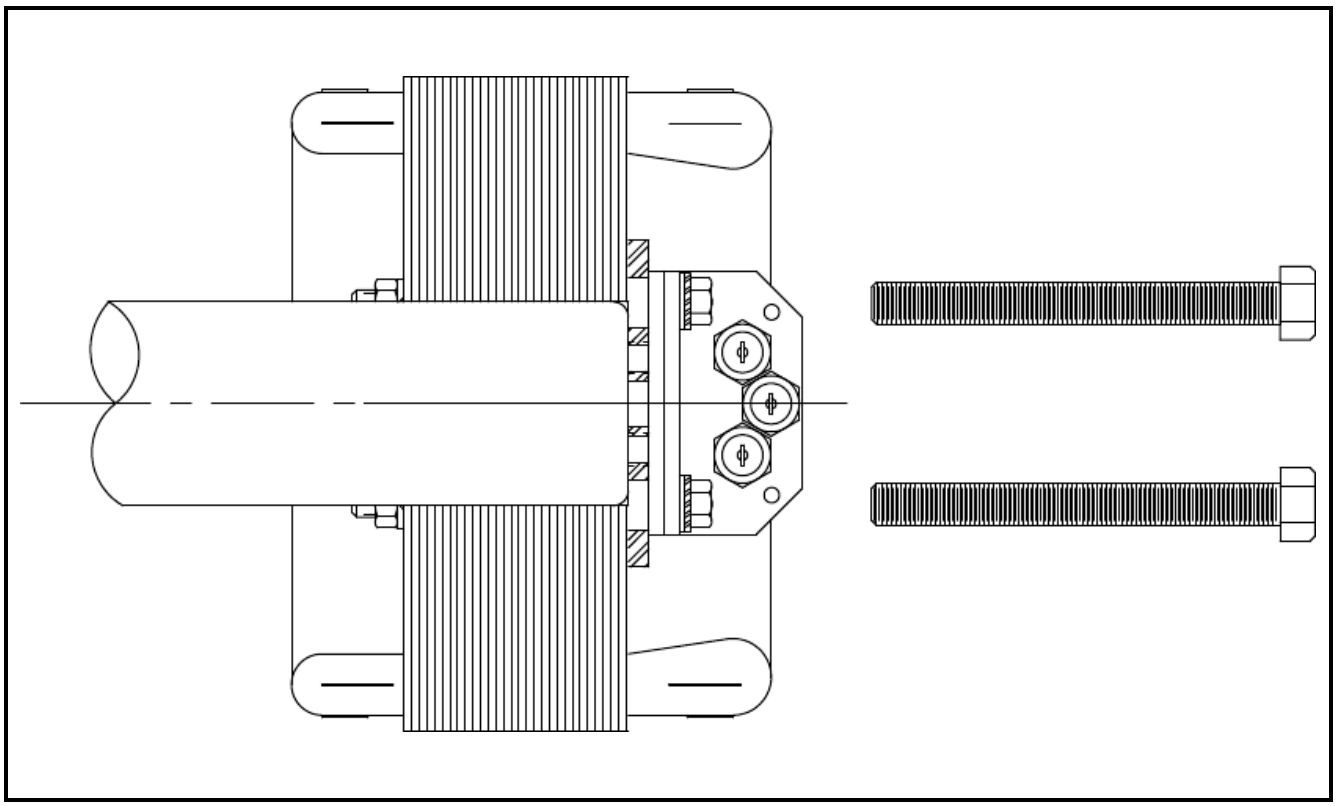
CAUTION	Pay close attention to field leads while pulling exciter armature from shaft. Make **CERTAIN** that the leads stay in the 1/2" keyway. One mechanic should watch them constantly while another operates the puller. Make certain that leads do not catch and be sure that they slide smoothly through the hole (Figure 2). Straighten leads and remove kinks as required to avoid damage to insulation.

4) Exciter Armature Installation

a) Preparation for Exciter Armature Installation

(1) Clean generator shaft and exciter armature bore. Remove all rust, corrosion, etc.

(2) Make **CERTAIN** that the leads are tucked into the 1/2" keyway, which is opposite from the 3/8" keyway in the generator armature shaft.



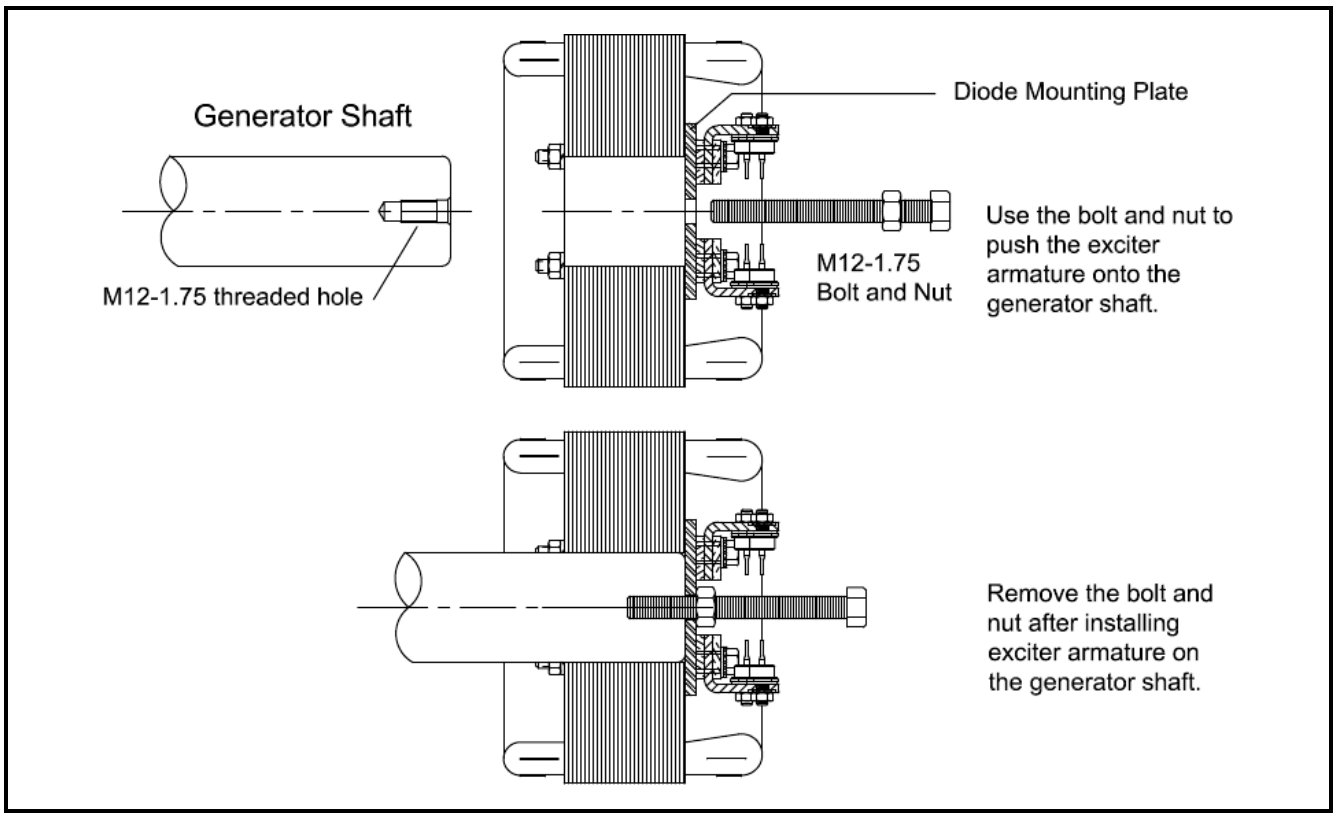
Exciter Armature Removal
Figure 4

(3) Route the revolving field leads (step 2 above) through exciter armature hole (Figure 2), which is opposite the keyway.

(4) Align armature keyway with key in shaft and start armature on shaft.

b) Exciter Armature Installation

(1) If the exciter armature-to-generator shaft fit is such that the exciter armature may be pushed on by hand, push it on very slowly while another mechanic carefully watches and pulls field leads through hole in the exciter armature diode mounting plate. Continue installation until the diode mounting plate contacts the end of the generator shaft. If the exciter armature cannot be pushed on by hand, use a M12-1.75 hex-head bolt and M12-1.75 nut as shown in Figure 5 to pull the exciter armature onto the generator shaft. Put the exciter armature on slowly and at the same time pull field leads through the hole (Figure 2) in the diode mounting plate. Screw the nut onto the bolt until it is near the head of the bolt. Insert the bolt through the hole in the center of the diode mounting plate as far as it will go, and screw it into the end of the armature shaft. Screw the nut up against the diode mounting plate. Continue turning the nut until the diode mounting plate contacts the end of the generator shaft, just as is shown in the lower portion of Figure 5. After installation, remove the bolt and nut.



Exciter Armature Installation
Figure 5

(2) Connect the two generator field leads to the exciter armature as follows:

a Connect lead with ring type terminal to the screw provided to the mounting plate (Figure 2).

b Connect the other field lead to the three leads coming off of the exciter armature windings. Use parallel splice connector, crimp and solder for a good connection.

c Insulate with sleeving material or wrap with electrical tape.

(3) Install the Machine Key

a Clean the machine key thoroughly. All mounting surfaces must be free of rust, corrosion, oil, grease, etc.

b Apply **LOCQUIC** primer, No. 47-56 grade T to **SIDES** of machine key. Do not over prime. A thin film is best. Allow to dry three to four minutes.

c Apply a thin coating of **LOCTITE**, No. 242 adhesive to **SIDES** of keyways in shaft and armature. Be certain to remove any excess from mounting surfaces on shaft and bore of armature.

NOTE: Application of "Loctite" is to compensate for any looseness in machine key and keyway (up to 0.005 inch). Manufacturers of **LOCTITE** and other recommended products are listed below.

When exciter armature removal is for the replacement of bearings and no kit is involved, be sure that **LOCTITE** is used (No. 242 is recommended), which is a milder adhesive than that recommended in the manual.

When kits are involved, the correct grade of **LOCTITE** is included in the Kit.

The application of **NEVER-SEEZ** to the shaft and armature bore is **NOT** recommended because there is a danger that it may mix with and contaminate the **LOCTITE.** Application of **NEVER-SEEZ** will be at the customer's risk. **LOCTITE** can lose its adhesive and tightening properties if contaminated by rust preventatives, oil, or other lubricants and antirust products.

Recommended Products Manufacturers:

- "LOCQUIC" No. 47-56, Primer Grade T
- "LOCTITE" No. 40-31, Retaining Compound, Manufactured by Loctite Corporation, Newington, Connecticut 06111
- "NEVER-SEEZ" No. NSBT-8 (8 oz. can), Manufactured by Never-Seez Compound Corporation, Broadview, Illinois 60153
- "NOCO10" Varnish No. T-211 (clear, air dry), Manufactured by Sterling Division of Reichhold Chemical Incorporated, Marysville, Pennsylvania 17053

d Apply **LOCTITE**, No. 242 to **SIDES** of new type threaded machine key. A thin film 0.005 to 0.010 inch thick is adequate and desirable.

e Ensure keyways in the generator armature shaft and exciter armature are aligned.

f Insert **UNTHREADED** end of key in keyways, and then tap lightly until threaded end is flush with end of shaft.

(4) Secure the exciter armature and key retainer on generator shaft with the M12-1.75 hex head cap screw.

CAUTION	Allow at least 6 hours for complete cure and set up of Loctite before operating machine.

Section 2 Dual Bearing Flexible Coupling

1) General

This manual provides basic instructions for removal, service and installation of a flexible coupling assembly, with generator fan, manufactured by **Hobart Ground Systems** as **Part Number 288481.** This assembly is illustrated in Figure 1. The primary function of this assembly is to couple a Hobart 2000 RPM Generator to a Diesel engine. The flexible coupling assembly compensates for slight misalignment between the engine and the generator, due to manufacturing tolerances. A tapered bushing and hub secures the coupling to the generator shaft.

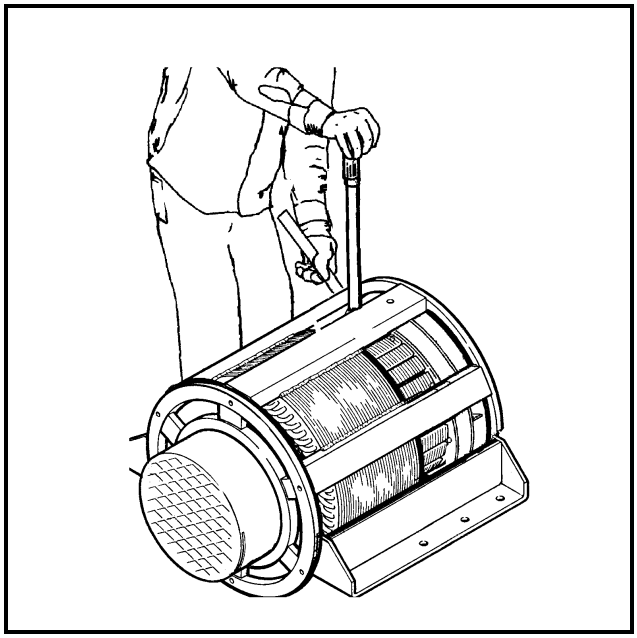
Coupling Assembly
Figure 1

2) Disassembly

Removal of the flexible coupling is required for servicing the generator armature, generator bearings, or the coupling itself. To remove the coupling, for any reason, it is necessary to separate the engine and generator. However, separating the engine and generator while they are installed in the Ground Power Unit is **VERY DIFFICULT** because of the limited working space. During removal **DO NOT** cut any cables or wires. Disconnect and tag them for re-assembly.

a) Separate Engine and Generator

(1) Refer to Chapter 3, Section 3 for generator assembly removal.



Access to Coupling Bolts
(for removal or installation)
Figure 2

b) Remove Coupling Assembly

WARNING

To prevent personal injury, keep fingers and hands clear of generator assembly until the armature is block into place to prevent rotation.

(1) Refer to Figure 3. Using a socket wrench, remove all three of the 3/8-16 bolts that secure the bushing to the hub.

(2) Using a 3/16-inch Allen wrench, loosen the set-screw in the bushing to release pressure on the key.

(3) To separate the bushing from the hub, lubricate two of the 3/8-16 bolts and insert them into the two threaded holes in the bushing flange. With socket wrench, screw these bolts into the bushing such that the bushing pops loose from the hub, alternating from bolt to bolt.

(4) When the bushing is loose in the hub, use a mallet to **GENTLY** tap the bushing out of the hub.

(5) Slide the coupling assembly off the shaft and remove the key.

(6) Inspect the coupling assembly components carefully as follows:

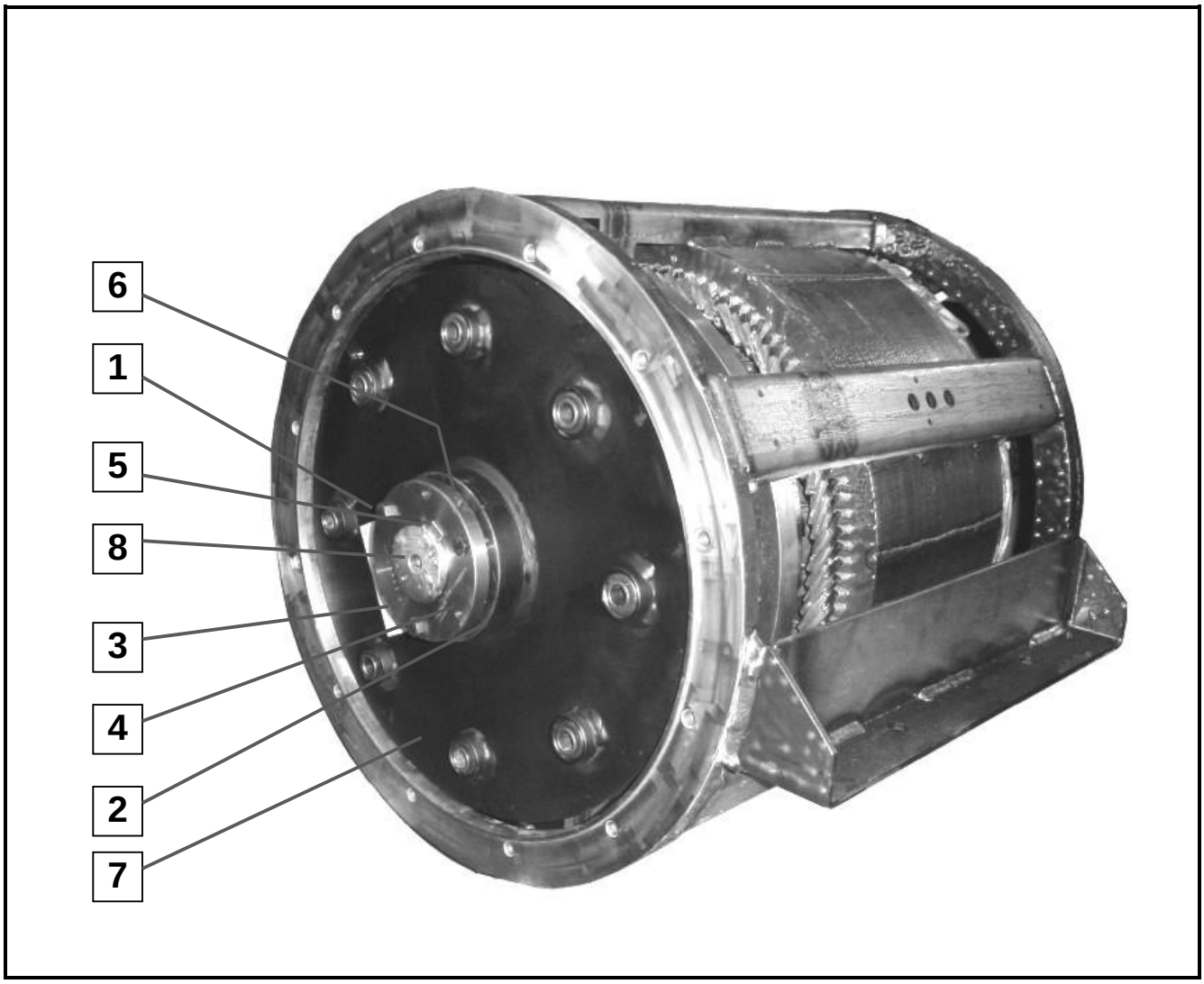
a Check for deformed fan blades and damage to the disk.

b Check the rubber exposed at both ends of the bushings for signs of deterioration.

c Check hub and bushing for cracks, evidence of galling, fretting and rust pits. Light rust is permissible on the bushing and the tapered bore of the hub.

d Check the shaft for any damage or deformation where the coupling was mounted on it.

e Check rubber bushing alignment to make sure that the dimension illustrated in Figure 4 is maintained.



1. Bolt, 3/8-16 UNC (3)
2. Taper Lock Bushing
3. Taper Lock Hub
4. Tapped holes (2)
5. Key
6. Set Screw
7. Fan/Coupling Disk
8. Armature Shaft

Hub and Bushing
Figure 3

3) Coupling Service

When ordering coupling kits from Hobart Ground Systems or an authorized distributor, be sure to include all pertinent information from the unit's identification plate (i.e. Specification No., Model No., and unit rating).

If you have any questions concerning your ITW GSE Group equipment, immediately contact our Service Department **by mail, telephone, e-mail, or FAX.**

Write:	Hobart Ground Systems Service Department 11001 US Highway 41, North Palmetto, FL 34221 U.S.A.
Call Inside U.S.A.:	(800) 899-1841 (Parts) (877) 874-5322 (Service)
Call From Foreign Countries:	(941) 721-1025 (Parts) (941) 721-1092 (Service)
FAX Inside U.S.A.	(800) 367-4945
FAX From Foreign Countries:	(937) 332-5121
E-Mail :	service@hobartsystems.com
Web Page :	www.hobartsystems.com

a) Replacement Coupling Kit

A replacement coupling kit is available from your Hobart Ground Systems. The kit provides a replacement coupling assembly with attaching hardware and installation instructions.

b) Bushing Kit

A bushing kit is available from the Hobart Ground Systems for replacing the rubber bushing only in the coupling assembly. However, it should be noted that the finished coupling assembly must be balanced to 1/2 inch-ounce (360 mg-m) minimum. If bushing replacement only is required, the kit part number is 480290. Each kit contains the required number of bushings, a container of lubrication, and installation instructions.

c) Bushing Replacement

To replace bushings only, proceed as follows:

(1) Press out all old bushings.

(2) Refer to Figure 4. Clean each bushing socket thoroughly, removing all traces of old rubber. DO NOT scratch or deform the bore of the bushing socket.

(3) Shake the container of lubricant (supplied with kit) vigorously and poor it into a small shallow dish.

(4) Roll a bushing in the lubricant to coat it thoroughly. Press it into a socket (from the chamfered end) to the dimension shown in Figure 4.

(5) Repeat step 4 until all new bushings are installed.

(6) Balance the complete coupling assembly to 1/2 inch-ounce (360 mg-m) minimum.

4) Coupling Installation

WARNING	To prevent personal injury, keep fingers and hands clear of generator assembly until the armature is block into place to prevent rotation.

CAUTION	Improper installation of the coupling assembly can result in serious damage to the equipment. Follow these installation instructions exactly.

a) Cleaning

Refer to Figure 5. It is **VERY IMPORTANT** that the shaft, the bore and the outside of the split bushing, and the tapered inside of the hub be thoroughly **CLEANED FREE OF DIRT AND GRIT.**

CAUTION	Do not lubricate any of the surfaces listed above. Lubrication of these surfaces can cause the coupling to fail and damage the generator set. Slight traces of rust are permissible on the surfaces.

b) Assembly

(1) If an adapter ring must be replaced, remove the bolts that secure it to the flywheel. Discard the old adapter ring and bolts. Install the new adapter ring using new socket head bolts.

Torque all bolts to 100 ft-lbs (135 N-m).

The new adapter ring and bolts are included in the kit, when required.

(2) Refer to Figure 6. Place a straight edge across the engine flywheel housing face and take a measurement from the face to the adapter plate. Record this dimension for locating the coupling assembly on the generator shaft in the next steps.

(3) Refer to Figure 3. Assemble the bushing into the hub.

CAUTION	Make certain that only the bolts are lubricated, and that no lubricant is permitted to get inside the bushing where the armature shaft will enter the bushing.

(4) Lubricate the three 3/8-16 bolts **SPARINGLY** and start them into the three (unthreaded) holes finger-tight.

(5) Slide the generator armature as far as it will go toward the fan housing. Block the armature to maintain this forward position throughout the installation procedure. Block the armature with a wooden block or wedge, being careful not to damage any components of the armature or exciter.

CAUTION

Do not rotate the armature while this block is installed.

(6) Install the key in the shaft keyway.

(7) Place the bushing in the hub over the installed key, and install the coupling assembly on the shaft, with the bushing approximately flush with the end of the shaft.

(8) Using a 3/16-inch Allen wrench, tighten the set screw in the bushing to apply pressure on the key.

(9) Refer to Figure 7. Place a straightedge across the two adjacent bushings and measure the distance from the bushings to the mounting face of the generator fan housing. Slide the coupling assembly on the shaft until this dimension is met and then move the coupling 1/16-inch (1.6 mm) less than the dimension recorded from the adapter ring measurement. The tapered hub will be pulled onto the split bushing 1/16-inch (1.6 mm) when the 3/8-16 bolts are completely tightened.

(10) Tighten the 3/8-16 bolts alternately and evenly as follows:

a Set a torque wrench to 30 foot-pounds (41 N-m) and tighten all three 3/8-16 bolts to that value. Block the coupling against clockwise rotation with a bar, as illustrated in Figure 2. Observe the **CAUTION** above when it is necessary to rotate the shaft.

b Repeat step (a) above until 3/8-16 bolts can no longer be tightened.

c Recheck the dimension in Figure 7 to be sure it is the same as the dimension in Figure 6.

5) Reassemble Engine and Generator

CAUTION

Use of the proper coupling bolts is very important. Failure to use the proper bolts, as outlined below, can result in coupling failure and damage to the generator set.

a) Insert the new coupling bolts with lock washers through the bushings from the fan side of the coupling.

b) Using a hoist, align the generator fan housing flange with the flange on the engine flywheel housing and insert two of the attaching bolts, one on each side of the flange. Start the bolts into the tapped holes in the flywheel housing just enough to ensure thread engagement. DO NOT TIGHTEN.

c) Block rotation of generator and turn all of the coupling bolts into the tapped holes in the flywheel until finger tight. DO NOT tighten with a wrench.

d) Insert all remaining attaching bolts through the generator flange, engaging the tapped holes in the flywheel housing, and tighten them all securely.

e) Torque all coupling bolts to 85 ft-lbs (115 N-m).

CAUTION

Remove all armature blocks, otherwise, damage to the armature could result.

6) Run-in and Periodic Check

a) Mount the engine-generator assembly in a suitable test area and operate it for a 2-hour run-in.

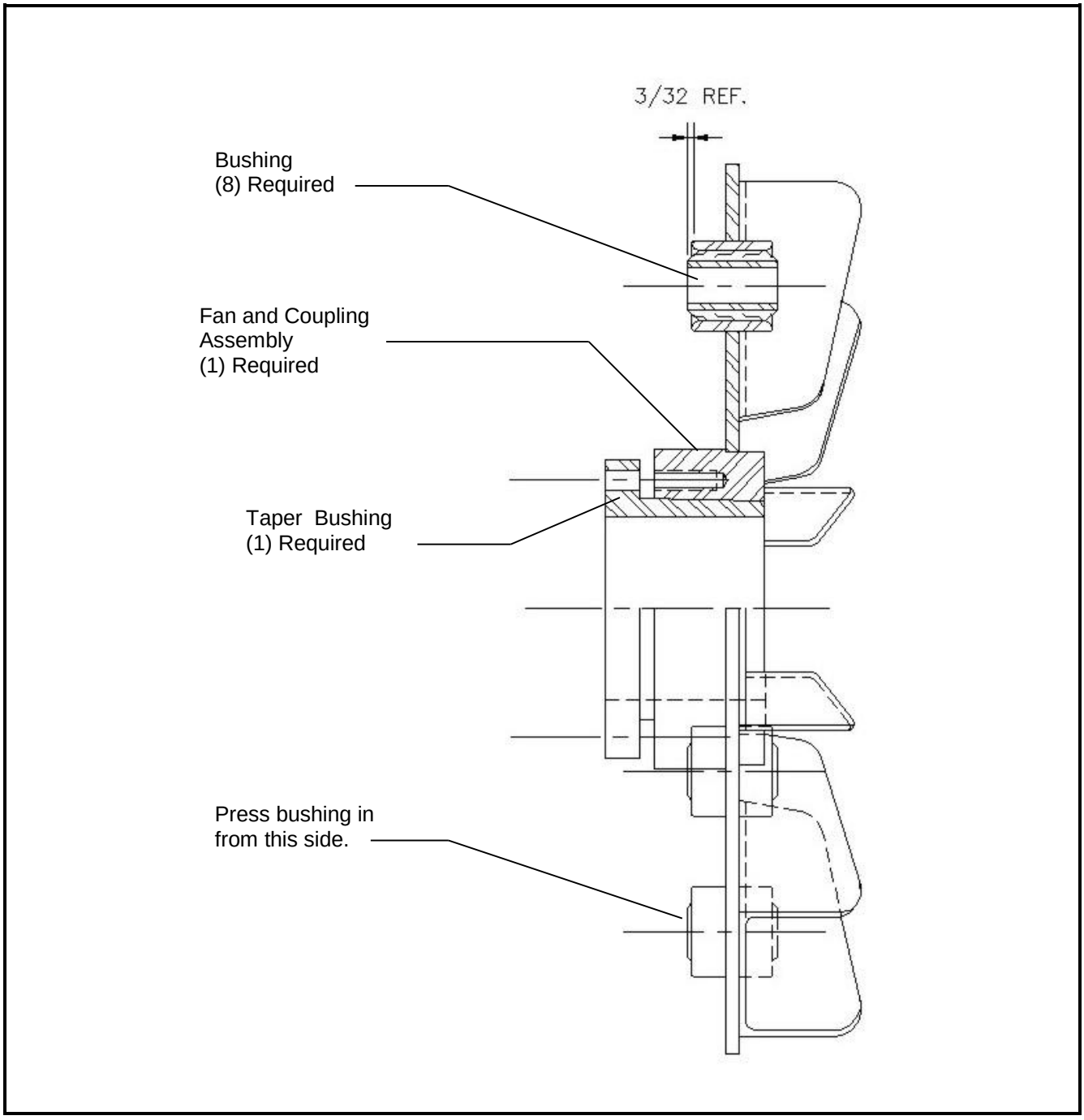
b) Shut down the engine after 2 hours and re-torque all coupling bolts to 85 foot-pounds (115 N-m) to compensate for normal torque relaxation.

c) Return the unit to normal service.

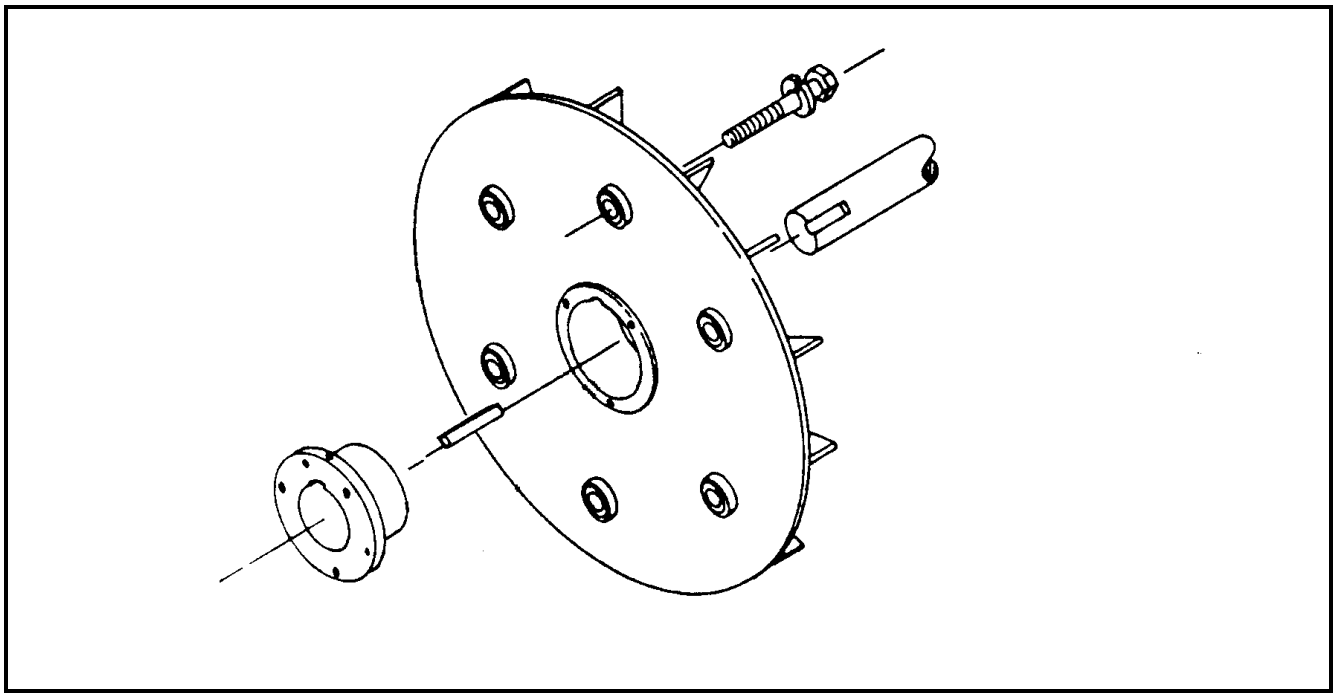
d) After 200 hours of operation, check all coupling bolts with a torque wrench set at 85 foot-pounds (115 N-m).

e) Return the unit to normal service.

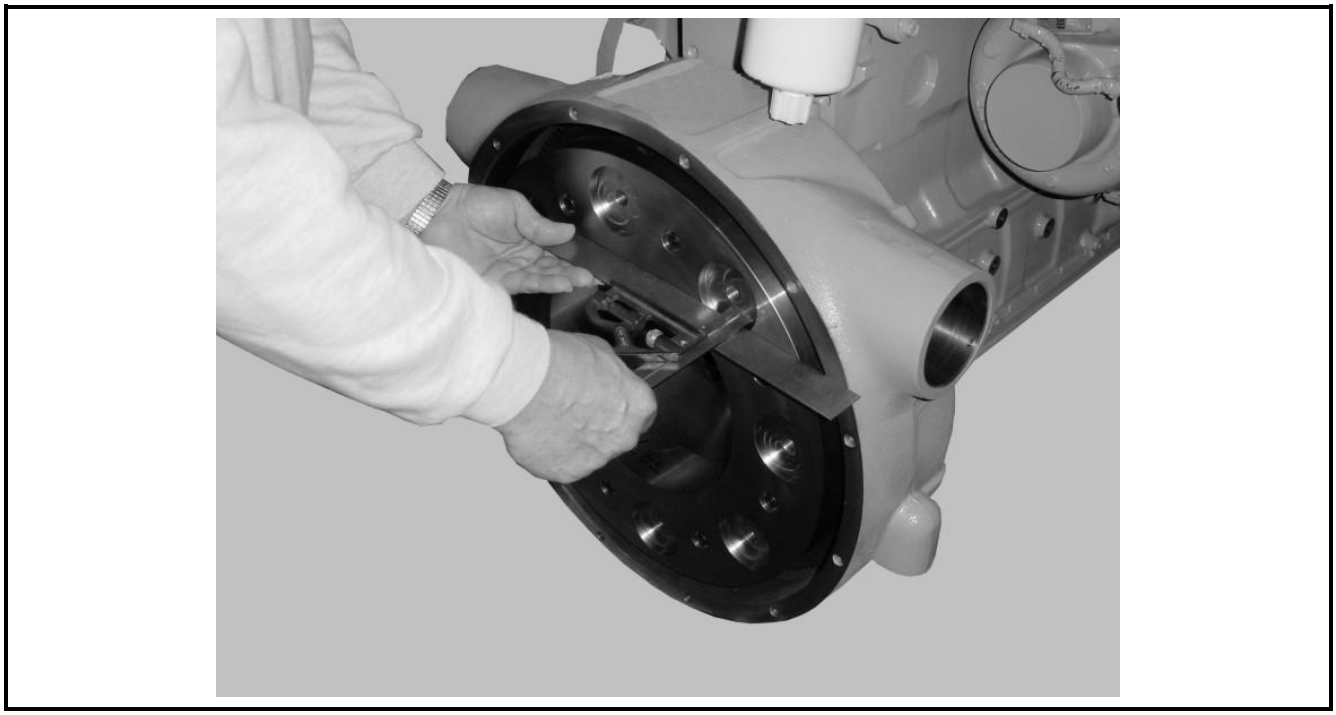
f) After each additional 2,000 hours of operation (or every year) recheck all coupling bolts to maintain the same torque value.



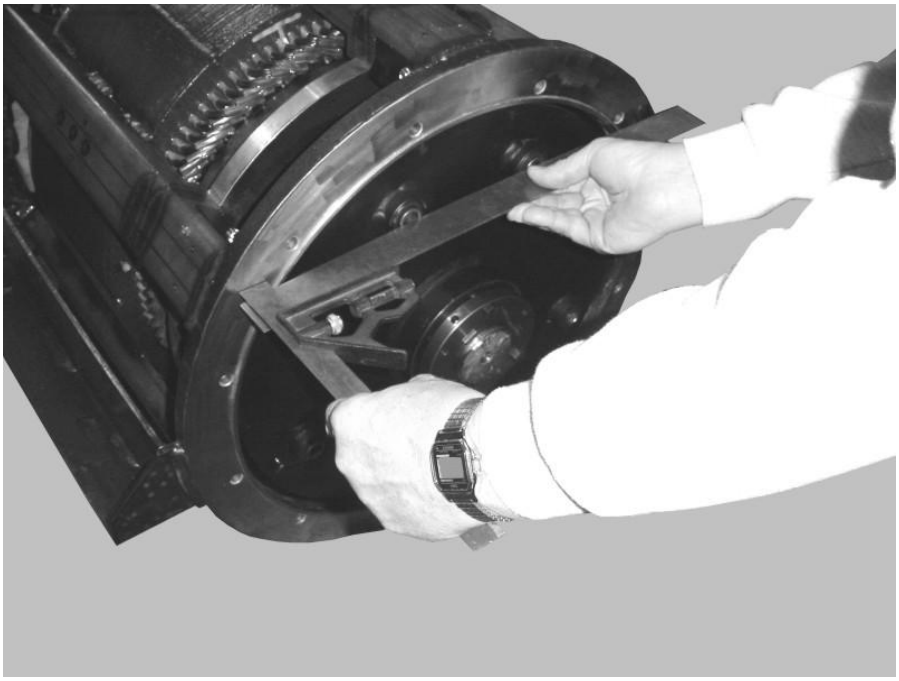
Bushing Installation
Figure 4



Assembly Procedure
Figure 5



Measure from mounting face to adapter ring.
Figure 6



Measuring From Mounting Face To Bushing
Figure 7

Section 3 Generator Assembly

1) General

This section provides information and instructions for removal and installation of the generator set.

2) Generator Assembly Removal

a) Procedure for Gaining Access to the Generator

WARNING

Before starting removal of the generator assembly, position the front section of the generator set under a hoist, which is capable of lifting at least 1500 pounds (560 kg).

When removing generator assembly, refer to Connection Diagram in Chapter 5 and proceed as follows:

(1) Disconnect battery leads from the generator set.

(2) Remove required canopy assembly components.

(3) Disconnect output cables from the power module load contactors.

(4) Disconnect plug connectors from the back of the control box and remove the control box

(5) Remove the air cleaner and the pipe/hoses connecting it to the engine.

Note: cover the turbo inlet while the air cleaner is removed.

(6) Remove the generator stator leads from the power module and remove the power module.

(7) Remove required support table components above the generator.

(8) Remove generator housing cover.

b) Removing the generator Assembly

(1) Remove the bolt that mounts the generator assembly to the frame of the generator set.

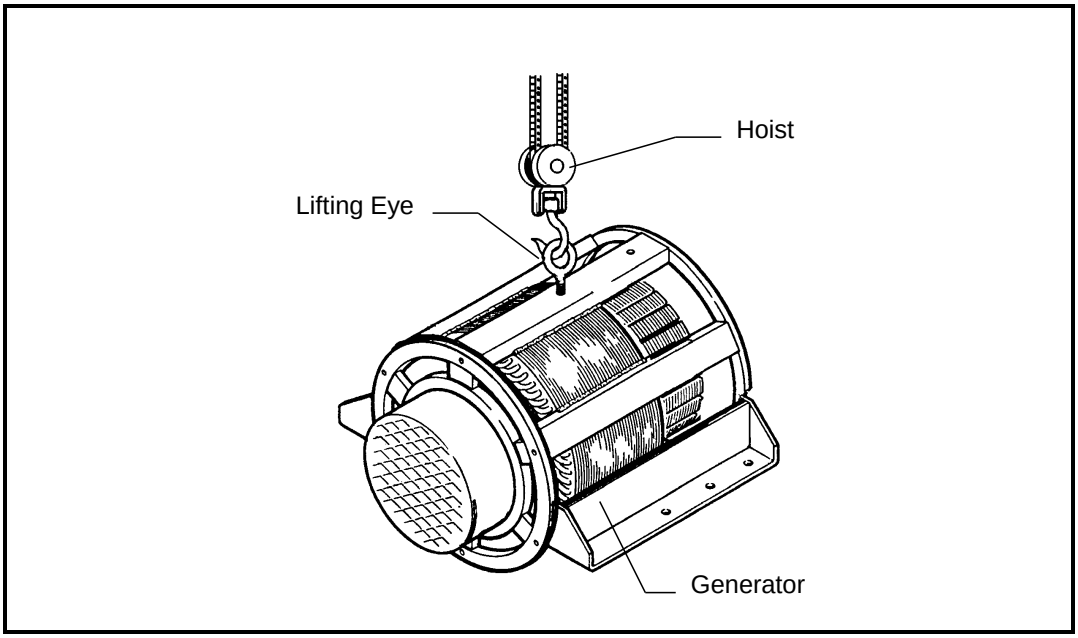
(2) Support the engine at the flywheel housing with wooden blocks, or second hoist if available.

(3) Using the hoist, support the generator assembly. For lifting convenience, a M12-1.75 threaded hole is drilled in the top of the generator housing. Insert a M12-1.75 eyebolt in the hole and attach the hoist chain to the eyebolt as shown in Figure 1.

(4) Remove the generator-to-flywheel coupling bolts.

(5) Remove the bolts and detach the generator housing from the engine.

(6) Carefully lift and separate the generator from the engine.



Generator Lifting Arrangement
Figure 1

3) Generator Assembly Installation

Installation of a generator assembly is essentially a reversal of the procedure for removal of the generator assembly: the re-mounting of the generator assembly to the frame of the generator set, and the remounting of the assemblies that were removed to gain access to the generator assembly. To install the generator assembly, refer to Connection Diagram, and proceed as follows:

a) Remounting the Generator Assembly

(1) Support engine at flywheel housing with wooden blocks, or second hoist if available.

(2) Using the hoist, support the generator assembly and lower it carefully and slowly into position for attachment to the engine.

(3) While still supporting the generator assembly with the hoist, attach the generator housing to the engine using the bolts removed earlier. Torque bolts to 30 ft-lb (41 N-m).

(4) Attach the flywheel coupling to the engine using the bolts removed earlier. Torque bolts to 85 ft-lb (115 N-m).

(5) Mount the generator housing to the frame of the generator set, using the bolts removed earlier. Torque bolts to 90 ft-lb (122 N-m).

(6) Install the generator wrapper on the generator assembly, using 1/4 - 20 x 1/2 tap-tite screws.

b) Remounting the previously removed assemblies

(1) Remount the remaining pieces of the unit in reverse order of disassembly procedure.

Chapter 4 Illustrated Parts List

Section 1 Introduction

1) General

The Illustrated Parts List identifies, describes, and illustrates main assemblies, subassemblies, and detail parts of an Engine-Generator Set manufactured by ITW GSE Group, Hobart Ground Systems.

2) Purpose

The purpose of this list is to provide parts identification and descriptive information to maintenance and provisioning personnel for use in provisioning, requisitioning, purchasing, storing, and issuing of spare parts.

3) Arrangement

Chapter 4 is arranged as follows:

Section 1 - Introduction

Section 2 - Manufacturer's Codes

Section 3 - Parts List

Section 4 - Numerical index

4) Explanation of Parts List

a) Contents

The parts list contains a breakdown of the equipment into assemblies, subassemblies, and detail parts. All parts of the equipment are listed except:

- Standard hardware items (attaching parts) such as nuts, screws, washers, etc., which are available commercially
- Bulk items such as wire, cable, sleeving, tubing, etc., which are also commercially available
- Permanently attached parts, which lose their identity by being welded, soldered, riveted, etc., to other parts, weldments, or assemblies

b) Parts List Form

This form is divided into six columns. Beginning at the left side of the form and proceeding to the right, columns are identified as follows:

(1) FIGURE-ITEM NO. Column

This column lists the figure number of the illustration applicable to a particular parts list and also identifies each part in the list by an item number. These item numbers also appear on the illustration. Each item number on an illustration is connected to the part to which it pertains by a leader line. Thus, the figure and item numbering system ties the parts lists to the illustrations and vice-versa. The figure and index numbers are also used in the numerical index to assist the user in finding the illustration of a part when the part number is known.

(2) FACTORY PART NUMBER Column

All part numbers appearing in this column are Hobart numbers. In all instances where the part is a purchased item, the vendor's identifying five-digit code and his part number will appear in the "NOMENCLATURE" column. Vendor parts, which are modified by Hobart, will be identified as such in the "NOMENCLATURE" column. In case Hobart does not have an identifying part number for a purchased part, the "FACTORY PART NUMBER" column will reflect "No Number" and the vendor's number will be shown in the "NOMENCLATURE" column. Parts manufactured by Hobart will reflect no vendor or part number in the "NOMENCLATURE" column.

(3) NOMENCLATURE Column

The item-identifying name appears in this column. The indenture method is used to indicate item relationship. Thus, components of an assembly are listed directly below the assembly and indented one space. Vendor codes and part numbers for purchased parts are also listed in this column when applicable. Hobart modification to vendor items is also noted in this column.

(4) EFF (Effective) Column

This column is used to indicate the applicability of parts to different models of equipment. When more than one model of equipment is covered by a parts list, there are some parts that are used on only one model. This column is used for insertion of a code letter A, B, etc., to indicate these parts and to identify the particular model they are used on. Since this manual covers more than one generator set specification, this column is used as follows:

EFF Code	Part & Dash Number	Fuel Tank	Exhaust	Mounting	AC Outputs	28.5 DC Output
A	500061A-001	Stainless	Vertical	Trailer	Single	Yes
B	500061A-101	Composite	Vertical	Trailer	Single	---
C	500061A-102	Composite	Vertical	Trailer	Dual	---
D	500061A-103	Composite	Vertical	Fixed	Single	---
E	500061A-104	Composite	Vertical	Fixed	Dual	---
F	500061A-105	Composite	Vertical	Trailer	Single	Yes
G	500061A-106	Composite	Vertical	Fixed	Single	Yes
H	500061A-107	Composite	Vertical	Truck	Single	Yes
J	500061A-201	Composite	Horizontal	Trailer	Single	---
K	500061A-202	Composite	Horizontal	Trailer	Dual	---
L	500061A-203	Composite	Horizontal	Fixed	Single	---
M	500061A-204	Composite	Horizontal	Fixed	Dual	---
N	500061A-205	Composite	Horizontal	Trailer	Single	Yes
P	500061A-206	Composite	Horizontal	Fixed	Single	Yes

(5) UNITS PER ASSEMBLY Column

This column indicates the quantity of parts required for an assembly or subassembly in which the part appears. This column does not necessarily reflect the total used in the complete end item.

Section 2 Manufacturer's Codes

1) Explanation of Manufacturer's (Vendor) Code List

The following list is a compilation of vendor codes with names and addresses for suppliers of purchased parts listed in this publication. The codes are in accordance with the Federal Supply Codes for Manufacturer's Cataloging Handbook H4-1, (CAGE CODES) and are arranged in numerical order. Vendor codes are inserted in the nomenclature column of the parts list directly following the item name and description. If a manufacturer does not have a code, the manufacturer's full name is listed in the nomenclature column.

Code	Vendor's Name and Address
D0024	SEMIKRON ELEKTRONIK GMBH Sigmundstrasse 200 P.O. Box 82 02 51 Nuernberg, Germany 90431
E0615	Kraus and Naimer 42 Miramar Avenue P.O. Box 15-009 Wellington, New Zealand
S7023	Bossard LTD Fasteners Steinhauserstrasse 70 Zug, Switzerland, CH-6300
0CYC7	Western Rubber & Supply 7888 Marathon Dr Ste Livermore, CA 94550 - 9314
0E8J0	Emka Inc. 1961 Fulling Mill Rd. Middletown, PA 17057-3125
0HZP9	Diesel Radiator Co. 1985 Janice Ave. Melrose Park, IL 60160-1008
0MR72	Henkel Corp 26941 Cablot Rd, Suite 124 Laguna Hills, CA 92653-7007
0TSE6	Infineon Technologies Industrial Power Inc. 1050 US HWY 22 Lebanon, NJ 08833-4208
00779	Tyco Electronics (Amp) 2800 Fulling Mill Rd Bldg-38 Middletown, PA 17057 - 3142
01XD4	Contact Industries Inc 25 Lex-Industrial Dr Mansfield OH 44903 - 8699
01428	Tuthill Corporation DBA Tuthill Controls Group 2110 Summit St. New Haven, IN 46774-9524
02660	Amphenol Corp. Spectra-Strip/ltd 40-60 Delaware Ave SIDNEY, NY 13838 - 1395
02768	Illinois Tool Works Inc. Fastex Division 195 S. Algonguin Rd. Des Plaines, IL 60016-6197
02929	Newark Electronics Div 4801 N Ravenswood Ave Chicago, IL 60640 - 4457
05HB5	Magnecomp Inc. 161 Eagles Nest Dr Pickens, SC 29671-7808
05YB3	Acon Inc. 22 Bristol Dr. South Easton, MA 02375-1108
1AA44	Collmer Semiconductor Inc. 2542 Highlander Way Carrollton, TX 75006
1DG36	Phillips And Temro Industries Inc E. M. Products Inc. 5380 Cottonwood Ln Prior Lake, MN 55372
1DL99	Fleetguard Inc. Div. of Cummins Engine Company 311 N. Park Street Lake Mills, IA 50450 - 1299

Code	Vendor's Name and Address
1E045	Austin Hardware and Supply Co. 950 Northwest Technology Dr Lees Summit, MO 64086 - 5692
1SPJ9	Hobart Ground Systems 11001 U.S. Hwy 41 N Palmetto, FL 34221
1W134	Eaton Corp. 4201 N. 27TH St Milwaukee, WI 53216-1897
12662	Peterson Mfg Co. 4200 E 135th St Grandview MO 64030-2896
13445	Cole-Herse 20 Old Colony Ave. Boston, MA 02127-2405
14552	Microsemi Corporation 2381 Morse Ave Irvine, CA 92614-6233
14799	Square D Company, Inc Dba Schneider Electric USA, Inc. 9522 Winona Ave Schiller Park, IL 60176-1084
16476	Maxima Technologies & Systems Llc 1811 Rohrerstown Rd Lancaster, PA 17601-2321
18265	Donaldson Company Inc. DBA Torit Products 1400 W. 94th St. Minneapolis, MN 55431-2370
2B428	MJO Industries Inc. DBA Hughes-Peters 8000 Technology Blvd. Huber Heights, OH 45424 - 1573
2B664	All-Phase Electric Supply Co 1620 W Main St P.O. Box 149 Springfield OH 45501-0149
2N562	Power Transmission Sales Inc. 531 Washington P.O. Box 229 Chagrin Falls, OH 44022-0229

Code	Vendor's Name and Address
23803	N T N Bearing Corp of America 191 Sheree Blvd Ste 101 Exton PA 19341-1265
24161	Gates Corporation 900 S Broadway Denver CO 80217-5887
24446	General Electric Co. 3135 Easton Tpke. Fairfield, CT 06431
25710	Deka Plastics Inc. 914 Westfield Ave. Elizabeth, NJ 07208-1222
27410	Harris Corp. 1025 W NASA Blvd. Melbourne, FL 32901
28520	Heyco Inc. 1800 Industrial Way N. Toms River, NJ 08755-4809
3A054	McMaster Carr Supply Co. 9630 Norwalk Blvd. Santa Fe Springs, CA 90670-2932
3Y208	Taylor And Summerville Battery Co 3485 Successful Way Dayton Oh 45414-4319
30104	Automotive Controls Corp. 1300 W. Oak St. P.O. Box 788 Independence, KS 67301-0788
30430	Marathon Electric Mfg. Corp. 398 Beach Rd. Burlingame, CA 94010-2004
311K7	Kissling Electrotec Incorporated 320 Business Pkwy, Ste A Greer, SC 29651
38151	Marathon Electric Mfg. Co. 100 E. Randolph St. Wausau, WI 54401-2568
39TH9	Motion Industries Inc. 8580 Industry Park Dr. Piqua, OH 45356-8535

Code	Vendor's Name and Address
40121	Peterson Mfg. Co. Inc. 700 W. 143rd St. Plainfield, IL 60544-9733
44655	Heico Ohmite LLC 1600 GOLF RD 850 ROLLING MEADOWS, IL 60008-4204
46922	Crawford Electric Co 445 E 32 Mile Rd Romeo MI 48065-5270
49234	Protectoseal Company 225 W Foster Ave Bensenville, IL 60106-1631
5N8K3	Alpha Devices 11963 Abbey Rd. Cleveland, OH 44133
5P059	Tech Products Corp. 2215 Lyons Rd Miamisburg, OH 45342-4465
50508	Magnetic Components Inc. 9520 Ainslie St. Schiller Park, IL 60176-1191
52793	Saginaw Products Corp. DBA CIGNYS 68 Williamson St. Saginaw, MI 48601-3246
54646	Clampco Products Inc. 1743 Wall Road Wadsworth, OH 44281-9558
55752	Parker Hannifin Corp. DBA Racor Div. 3400 Finch Rd. Modesto, CA 95354-4125
56289	Sprague Electric Company 678 Main St Sanford, MA, 04073-7003
57330	Remke Industries Inc. 310 Chadick Drive Wheeling, IL 60090-6039
57347	Wall Industries Inc. 5 Watson Brook Rd. Exeter, NH 03833-4589

Code	Vendor's Name and Address
57733	Stewart-Warner Corporation 333 Ludlow St Stamford, CT 06902-6987
59656	Dean Technology Inc. DBA CKE 1000 Lucerne Road Lucernemines, PA 15754-0211
6S553	Wes-Garde Components Group Inc 300 Enterprise Dr Westerville, OH 43081-8840
6Y440	Micron Technologies Inc. 8000 S. Federal Way Boise, ID 83716-7128
60038	Timken Corporation 1835 Dueber Ave Sw Canton, OH 44706-2728
61706	EAO Switch Corporation 98 Washington St. Milford, CT 06460-3133
62292	EBM Industries Inc. 110 Hyde Rd. P.O. Box 4009 Farmington, CT 06034-4009
62445	Deutz Corporation 3883 Steve Reynolds Blvd Norcross Ga 30093
66180	Automatic Timing and Controls 3312 Bloomingdale Melrose Park, IL 60160-1030
66844	Powerex Inc. 173 PAVILION LN Youngwood, PA 15697-1800
7M613	Wright F.B. Co. of Cincinnati 4689 Ashley Dr. Hamilton, OH 45011-9706
71382	Seal Master Bearings Sub Of Emerson Electric Co. 1901 Bilter Rd. Aurora, IL 60502-9704
71400	Cooper Bussmann Inc. 114 Old State Road Ellisville, MO 63021-5942

Code	Vendor's Name and Address
72619	Dialight Corporation 1501 State Rte 34 S Farmingdale, NJ 07727-3932
74400	Hobbs Corporation 1034 East Ash Street PO Box 19424 Springfield, IL 62794-9424
74542	Hoyt Electrical Instruments 23 Meter ST. Concord, NH 03303-1894
74545	Hubbell Inc Wiring Device Div 185 Plains Road Milford, CT 06460
74829	Ilsco Corp. 4730 Madison Rd. Cincinnati, OH 45227-1426
75418	Kysor Industrial Corporation 1 Madison Ave Cadillac, Michigan 49601-9784
75915	Littelfuse, Inc. 8755 W Higgins Road Ste 500 Chicago, IL 60631 - 2701
77342	TYCO Electronics Corporation 8010 Piedmont Triad Pkwy Greensboro, NC 27409
78388	Woodward Controls Inc. 6250 W Howard St Niles, Il 60714-3433
8A334	Cummins Bridgeway LLC 2297 SW Blvd Ste K Grove City, OH 43123-1822
8T246	Whitesell RO & Associates, Inc. 7009 CORPORATE WAY Dayton, OH 45459-4238
81483	International Rectifier Corp 233 Kansas St. El Segundo, CA 90245
81703	Mulberry Metal Products Inc. 2199 Stanley Terrace Union , NJ 07083-4399

Code	Vendor's Name and Address
82866	Research Products Corp. P.O. Box 1467 1015 E. Washington Ave. Madison, WI 53701
86797	Rogan Corp 3455 Woodhead Dr. Northbrook, IL 60062-1812
9Y826	Marsh Electronics Inc. 1563 S. 101st St. Milwaukee, WI 53214-4032
91637	Vishay Dale Electronics Inc. 1122 23RD St. Columbus, NE 68601-3647
91929	Honeywell International Inc. DBA Honeywell 11 W. Spring St. Freeport, IL 61032-4316
94222	Southco Inc. 210 N. Brinton Lake Rd. Concordville, PA 19331
97520	Basler Electric Company Route 143 Highland, IL 62249-1074

Section 3 Illustrated Parts List

1) Explanation of Parts List Arrangement

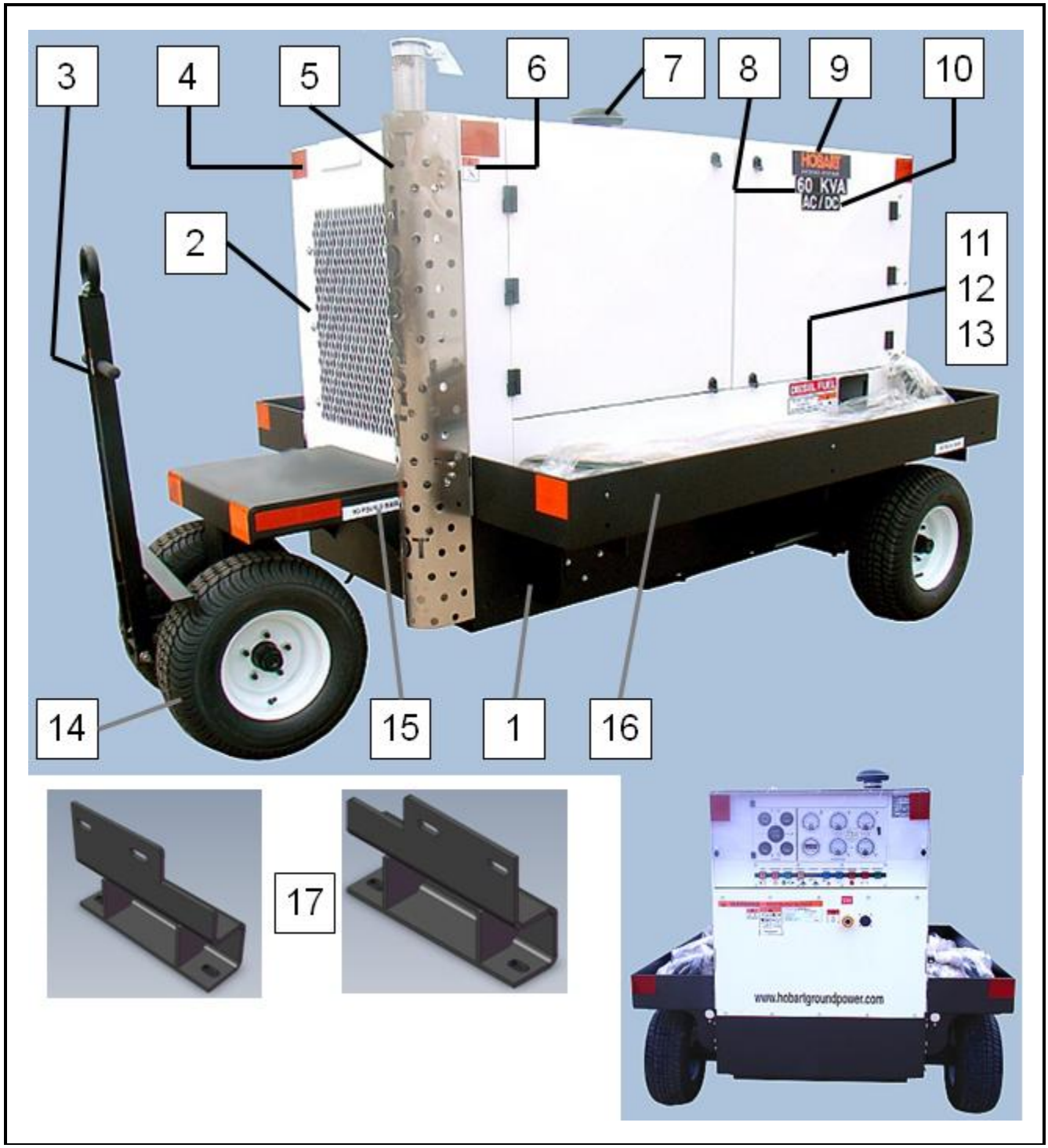
The parts list is arranged so that the illustration will appear on a left-hand page and the applicable parts list will appear on the opposite right-hand page. Unless the list is unusually long, the user will be able to look at the illustration and read the parts list without turning a page.

2) Symbols and Abbreviations

The following is a list of symbols and abbreviations used in the parts list:

*	-	Item not illustrated
A, or AMP	-	Ampere
AC	-	Alternating current
AR	-	As required
DC	-	Direct current
Fig.	-	Figure
hd.	-	Head
hex	-	Hexagon
Hz	-	Hertz (cycles-per-second)
I.D.	-	Inside diameter
IN or “	-	Inch
KVA	-	Kilovolt-ampere
uF	-	Microfarad
No.	-	Number
NHA	-	Next higher assembly
PRV	-	Peak reverse voltage
PSI	-	Pounds per square inch
Ref	-	Reference (the item has been listed previously)
RH	-	Right Hand
LH	-	Left Hand
TM	-	Technical Manual
T-R	-	Transformer-rectifier
V	-	Volt or used as a prefix indicating vendor code

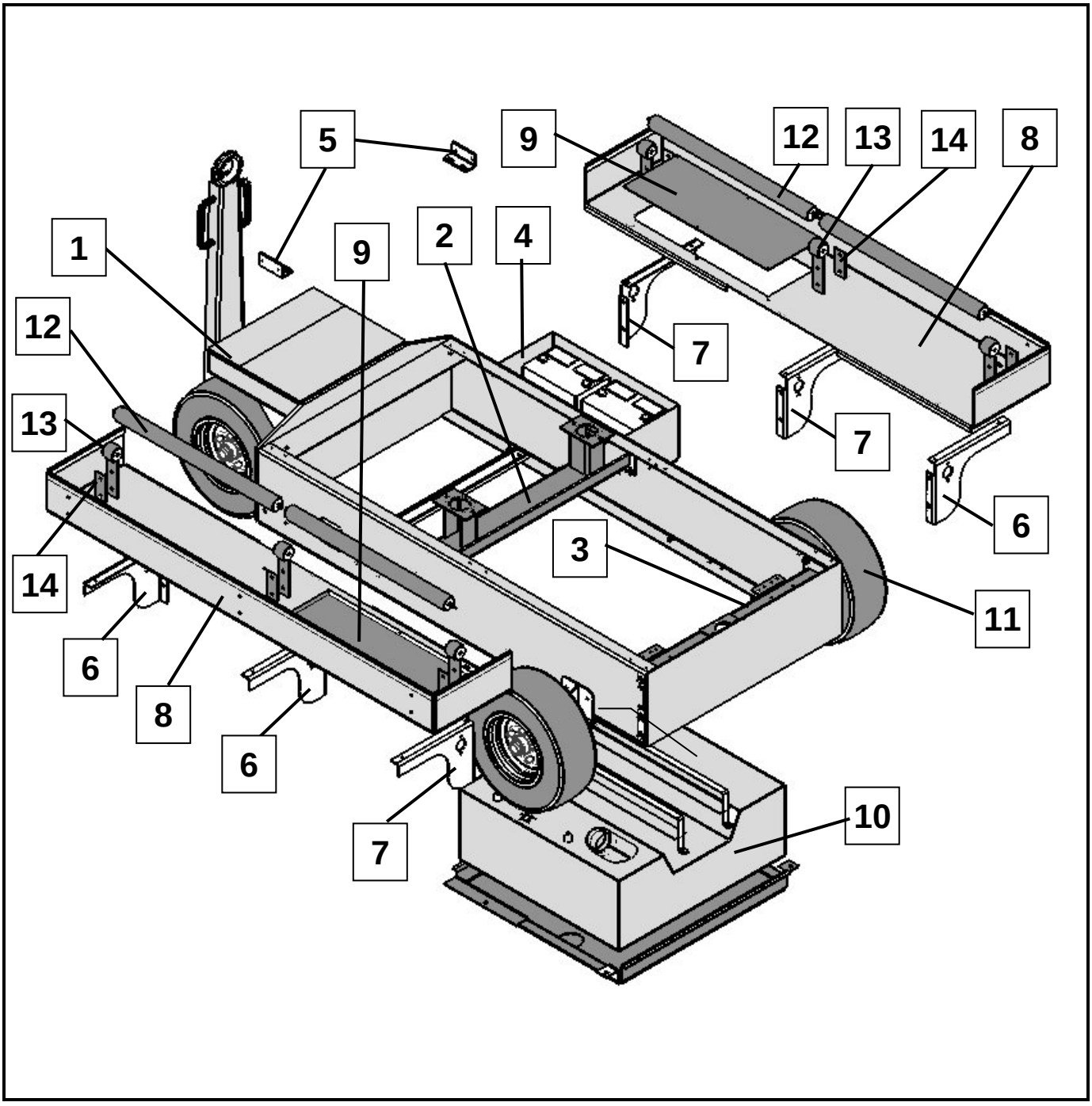
NOTE: An item which does not reflect an index number is an assembly which is not illustrated in it’s assembled state, or it is similar (right-hand, left-hand, top, etc.) to an item which is illustrated.



General Assembly
Figure 1

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
1-	1		Frame Assembly (See Figure 2)		Ref.
	2		Canopy Assembly (See Figure 3 and 4)		Ref.
	3	287465	Label, Warning Drawbar	A,B,C,F,H,J,K,N	2
	4	408665-001	Reflector. Red *(V12662 #B491)*	A,B,C,F,H,J,K,N	8
		408665-001	Reflector. Red *(V12662 #B491)*	D,E,G,L,M,P	4
		408665-002	Reflector, Amber *(V12662 #B491A)*	A,B,C,F,H,J,K,N	24
		408665-002	Reflector, Amber *(V12662 #B491A)*	D,E,G,L,M,P	12
	5		Engine Exhaust System (See Figure 13)		Ref.
	6	287463	Label, Hot Muffler		2
	7		Engine Air Intake System (See Figure 15)		Ref.
	8	283714-004	Label, kVA Rating (60)		2
	9	402987	Label, Hobart		2
	10	288164-001	Label, TR Unit	F,G,H,N,P	2
	11	76B1148	Label, Diesel Fuel		1
	12	287461	Label, Fuel (under Diesel Fuel label)		1
	13	290216	Low Emissions Label (near diesel fuel label)		1
	14		Wheel Assembly (See Figure 2)	A,B,C,F,H,J,K,N	Ref.
	15	287571	Label, Tire Pressure	A,B,C,F,H,J,K,N	4
	16		Cable Tray (See Figure 2)		Ref.
	17	291253-001	Bracket, Fixed Mount, LH (fixed mount units)	D,E,G,L,M,P	2
		291253-002	Bracket, Fixed Mount, RH (fixed mount units)	D,E,G,L,M,P	2
*	18	287462	Label, Radiator (on radiator access door)		1
*	19	287464	Label, Moving Parts (inside on the fan shrouds)		2
*	20	288862	Label, Caution, Engine Speed (near control panel)		1
*	21	407366	Label, Caution		1
*	22	288872	Label, Digital Controls		1
*	23	287467	Label, Glow Plug		2
*	24	289842-001	Label, www.hobartgroundpower.com		1
*	25	400435	Nameplate, 28 Volts	F,G,H,N,P	1

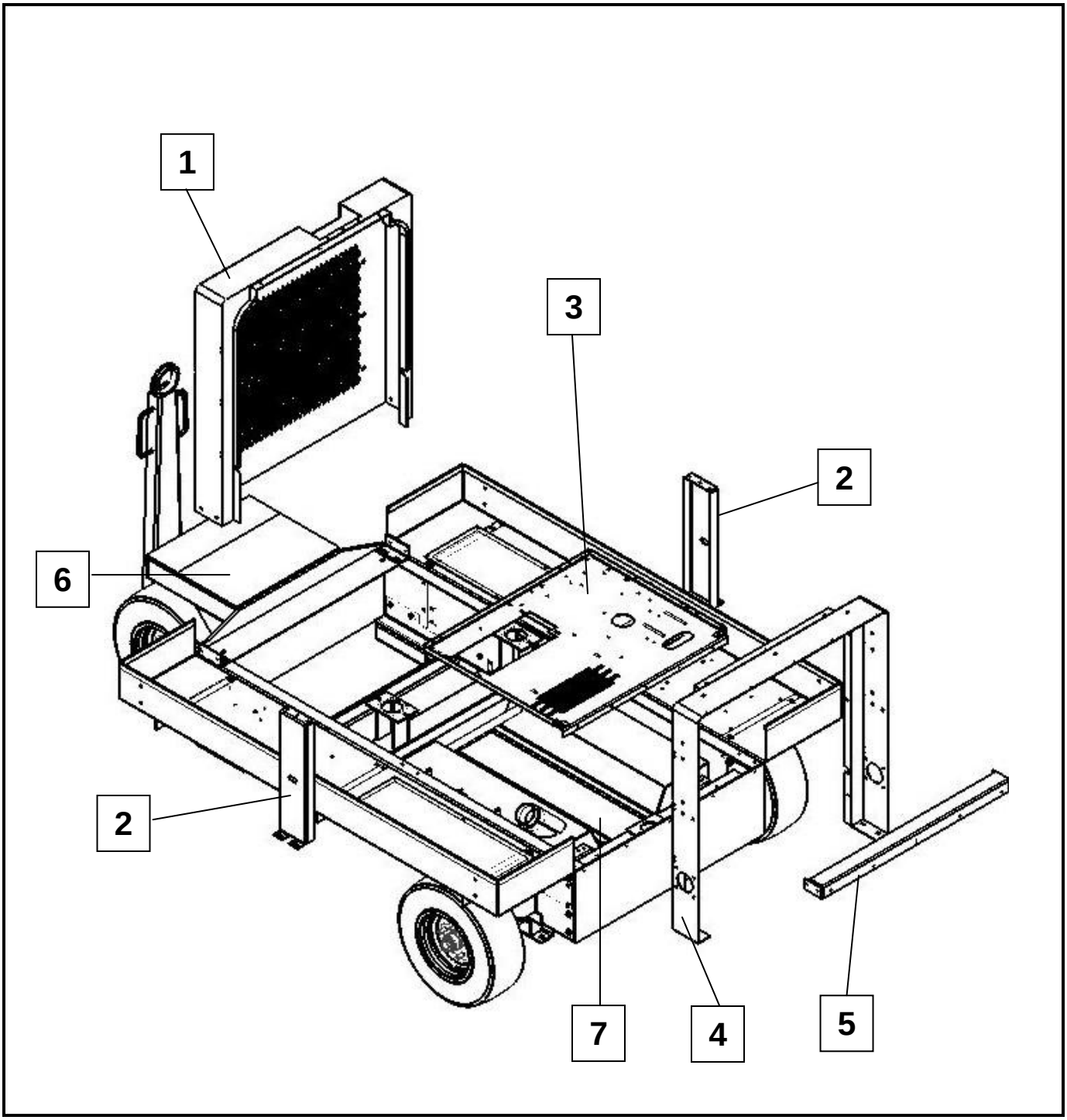
- Configurations A,B,C,F,H,J,K,N are trailer-mounted.
- Configurations D,E,G,L,M,P are fixed mount.
- Configurations F,G,H,N,P have the DC output option.



Trailer / Frame Assembly
Figure 2

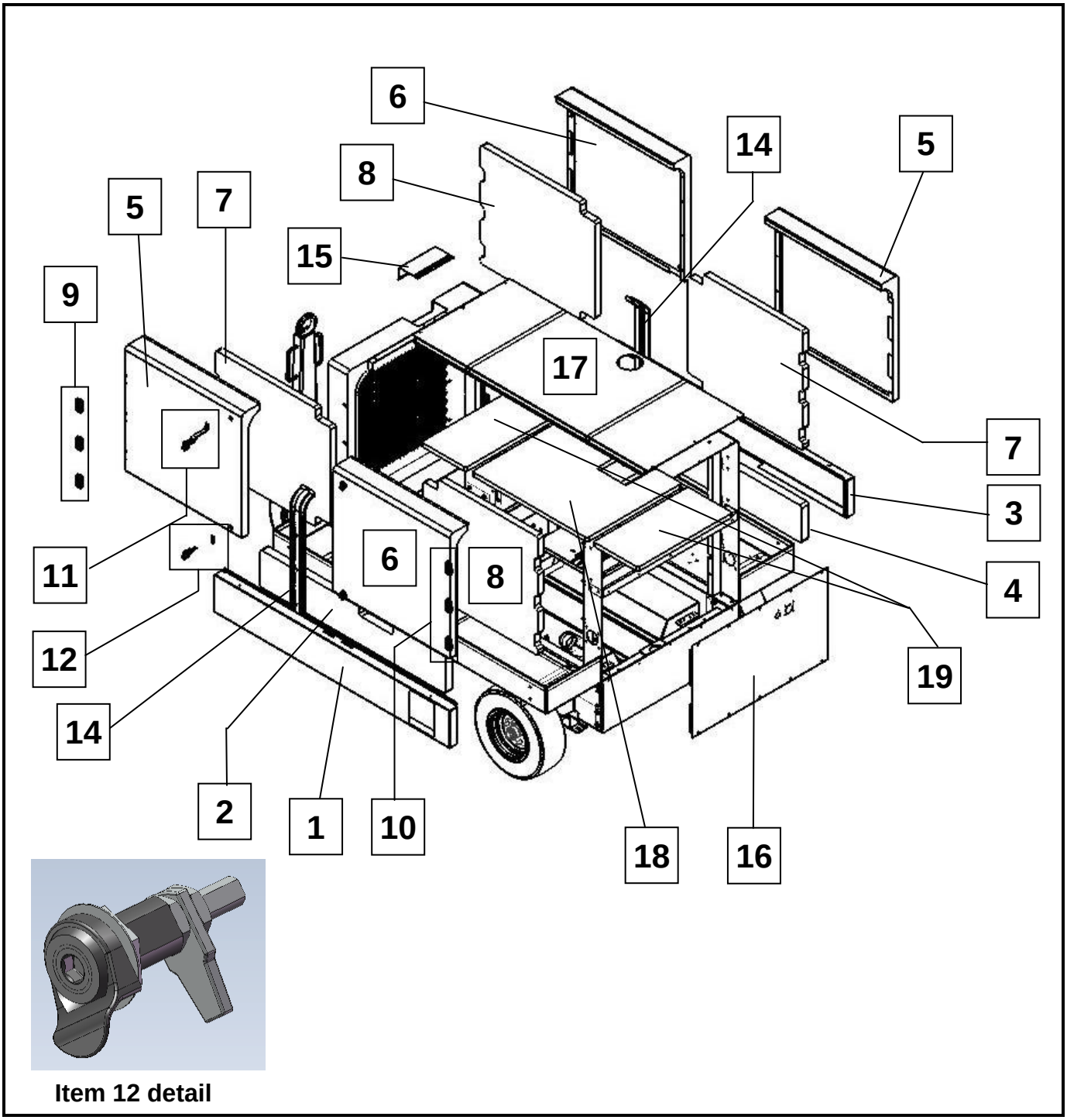
FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
2 -	1	292042	Trailer Assembly	A,B,C,F,H,J,K,N	1
	2	292012	…Engine Support (part of trailer)	A,B,C,F,H,J,K,N	1
	3	292016	…Generator Support (part of trailer)	A,B,C,F,H,J,K,N	1
	4		Battery Tray Assembly (See Fig.14)		Ref.
	5	287998	Front Panel Bracket		2
	6	291088	Bracket, Cable Tray Fender	A,B,C,F,H,J,K,N	3
	7	291089	Bracket, Cable Tray Fender	A,B,C,F,H,J,K,N	3
	8	291092	Cable Tray	A,B,C,F,H,J,K,N	2
	9	291093	Panel, Battery Tray Cover	A,B,C,F,H,J,K,N	2
	10		Fuel Tank (see Figure 12)		Ref.
	11	285418	Trailer Wheel Assembly	A,B,C,F,H,J,K,N	4
*		288987-006	Kit, Cable Tray Rollers, 1 output	Optional	Ref.
*	12	288961-002	…Roller, Cable Tray		2
*	13	288966	…Support, Roller		3
*	14	288989-002	…Spacer, Roller Support		3

Notes:
- Configurations A,B,C,F,H,J,K,N are trailer-mounted.
- The cable tray rollers are optional.



Canopy Frame Assembly
Figure 3

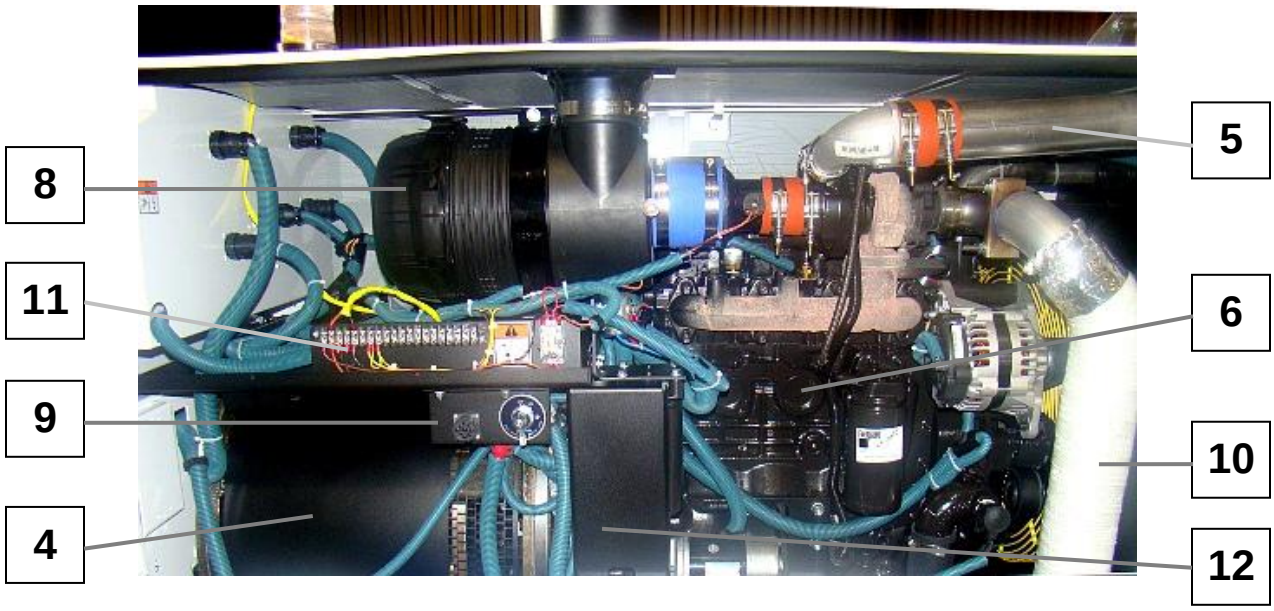
FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
3 -	1	291069	Front Panel		1
*		287998	…Front Panel Bracket (See Figure 2)		2
	2	291152	TR Panel Support Leg		2
	3	291066	TR Support Panel		1
	4	291056	Control Panel Support		1
	5	287986	Control Panel Support Bar		1
	6		Trailer/Frame Assembly (See Figure 2)		Ref.
	7		Fuel Tank Assembly (See Figure 12)		Ref.



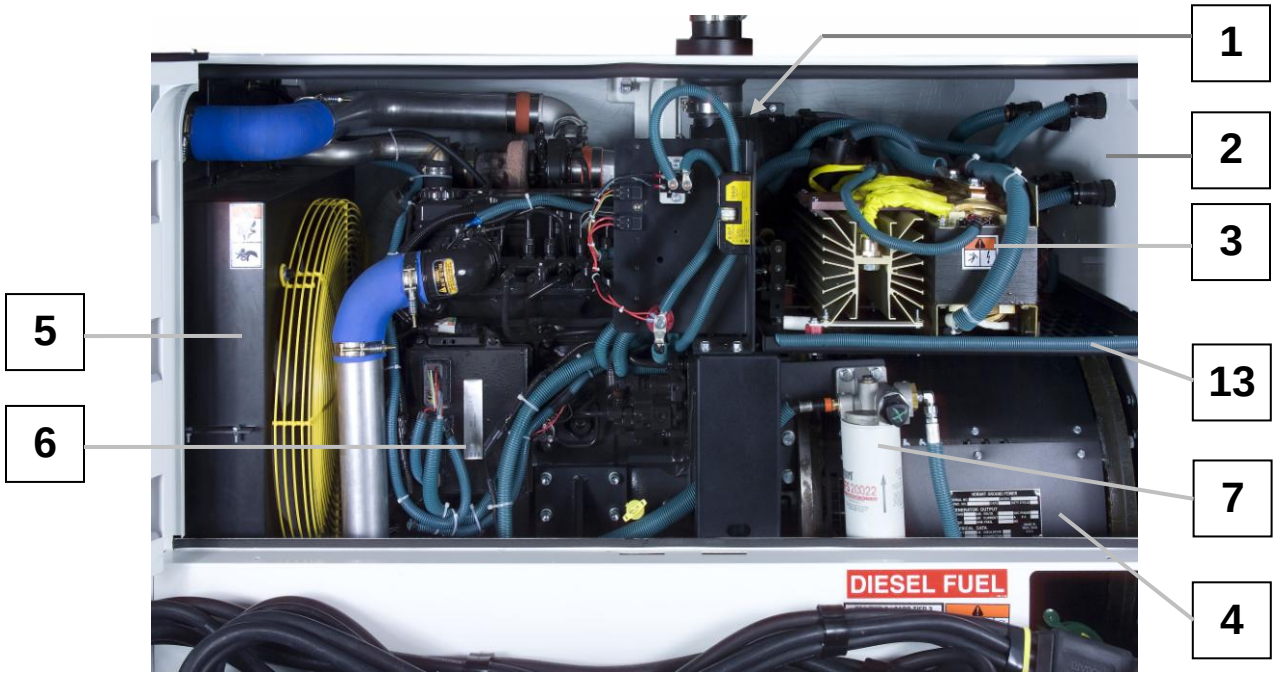
Item 12 detail

Canopy Assembly
Figure 4

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
4 -	1	291080	Fuel Side Lower Door Panel		1
	2	291237-002	Fuel Side Lower Door Panel Insulation		1
	3	291081	Lower Door Panel		1
*		287785	…Access Panel Fastener		2
	4	291237-001	Lower Door Panel Insulation		1
*		287785	…Access Panel Fastener		2
	5	291084	Access Door		2
	6	291297	Access Door		2
	7	291237-004	…Access Door Insulation		2
	8	291237-003	…Access Door Insulation		2
	9	283824	…Access Door Hinge Assembly *(To Door PN 291084)*		6
	10	283597	…Access Door Hinge Assembly *(To Door PN 291297)*		6
	11		…Access Door Top Latch Assembly		Ref.
*		291335	……Access Door Latch Pawl		4
*		287542-001	……Access Door Latch, Hex Recess		4
*		287526-002	……Access Door Latch Pull Tab		4
	12		…Access Door Bottom Latch Assembly		Ref.
*		291386	……Access Door Latch Pawl		4
*		287542-001	……Access Door Latch, Hex Recess		4
*		287526-002	……Access Door Latch Pull Tab		4
*	13	286485-001	…Access Door Gasket (cut into 31-inch strips)		124”
*		050984	…Access Door Gasket (cut into 62-inch strips)		124”
	14	291057	Access Door Stop		2
	15	291302	Radiator Cap Access Door		1
	16	291087	Lower Rear Panel		1
	17	291085	Top Canopy Assembly		1
	18	291237-006	…Top Canopy Insulation		1
	19	291237-005	…Top Canopy Insulation		2



Right Side

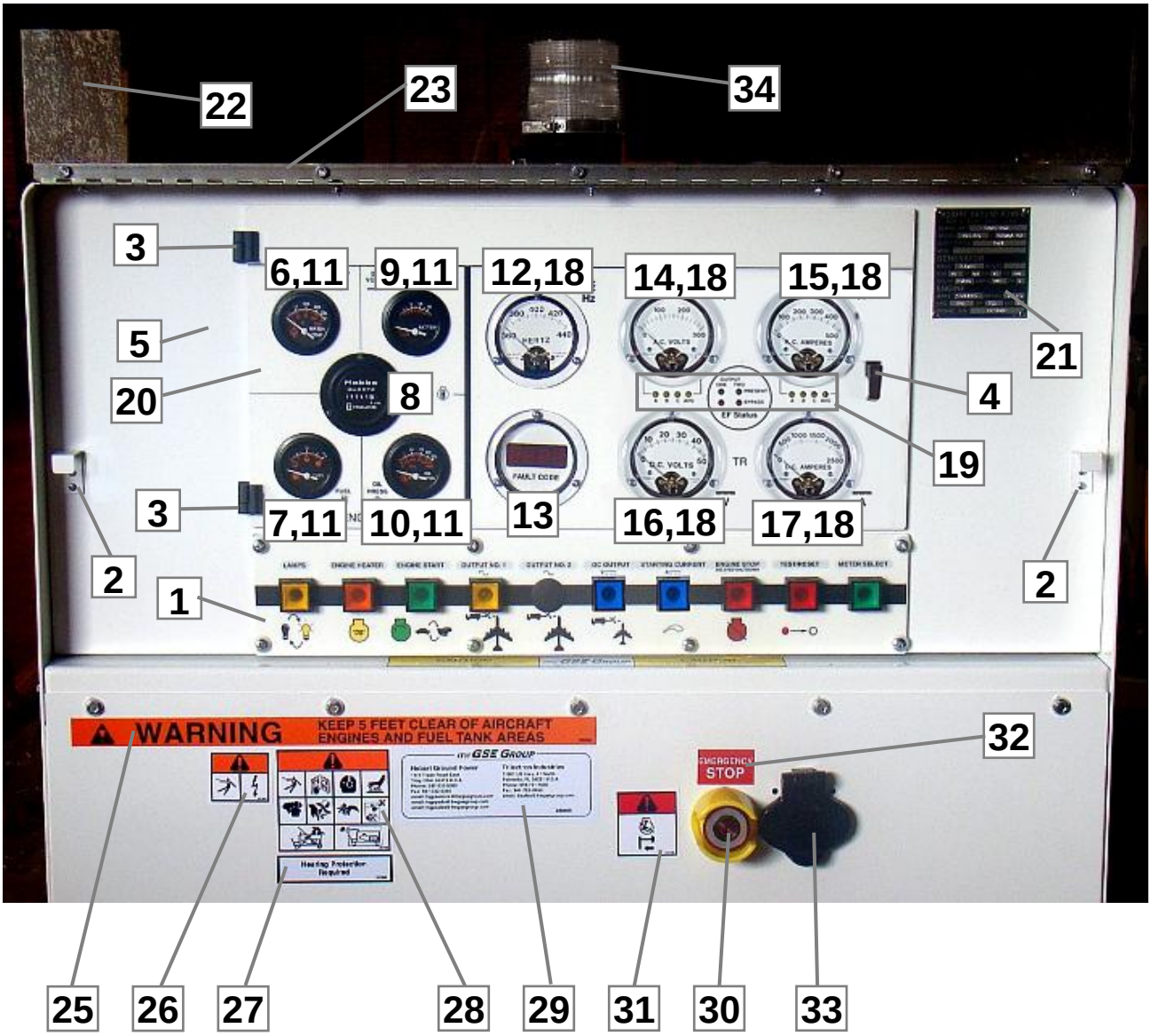


Left Side

Internal Components
Figure 5

FIGURE ITEM NO.	PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
5 -		**Left Side**		
1		**Engine Electronic Panel (See Figure 17)**		1
2		Control Box Assembly (See Figures 6, 7, and 8)		1
3	291255	28.5 VDC Transformer-Rectifier Assembly (optional)	F,G,H,N,P	1
4	288460-003	**Hobart Generator Assembly (See Figure 18)**		1
*	290870	…Flywheel Spacer Ring (mounted to engine flywheel)		1
*	290869	…Flywheel Housing Adapter		1
*	291055	…Bracket, Generator Support (mounted on generator)		1
*	24656	…Mount, Shock		1
5		Engine Cooling System Assembly (See Figure 10)		1
6	292051	**Engine, Cummins QSB4.5 (109 HP)**		1
*	292011	…Bracket, Engine Support (mounted on generator)		2
*	24656	…Mount, Shock		2
*	290678	…Wire Harness, Engine		1
*	482496-002	...Clamp, Universal		2
*	W10869-003	...Clamp, Hose, Stainless Steel		4
*	W10869-005	...Clamp, Hose, Stainless Steel		4
*	W10869-014	...Clamp, Hose, Stainless Steel		3
7		Engine Fuel System (See Figure 12)		Ref.
		Right Side		
8		Engine Air Intake System (See Figure 15)		Ref.
9		Engine Dongle/Battery Disconnect Panel (See Fig 11)		Ref.
10		Engine Exhaust System (See Figure 13)		Ref.
11	288895	Support, Option Terminal Block		1
*	289127	…Label, Terminal Block		1
		Miscellaneous		
12	291152	TR Panel Support Leg		2
13	291066	TR Support Panel		1

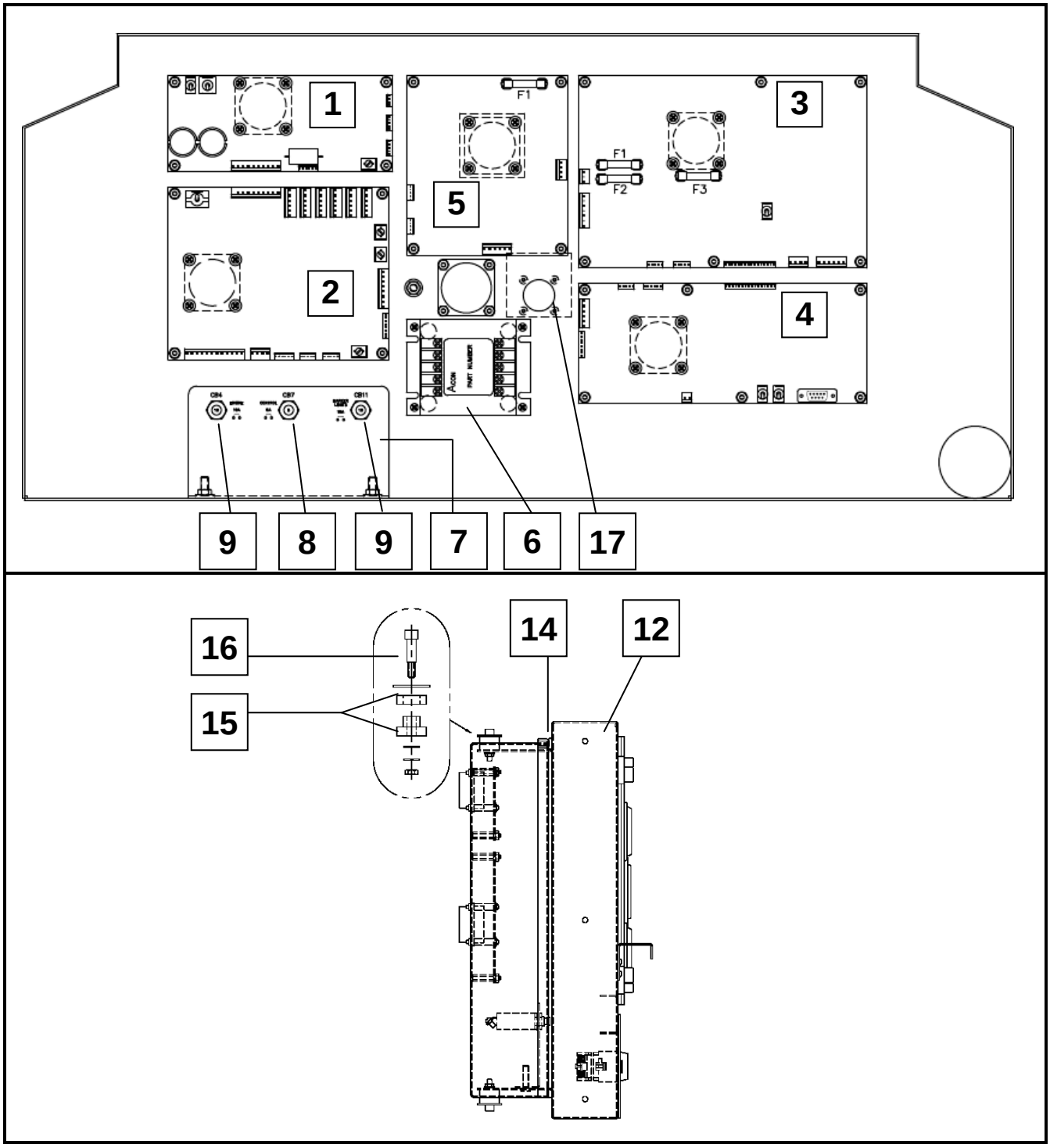
Note: Configurations F,G,H,N,P have the DC output option.



Note: Operator controls are shown with the analog generator meters and the DC output option.

Control Box and Door Assembly
Figure 6

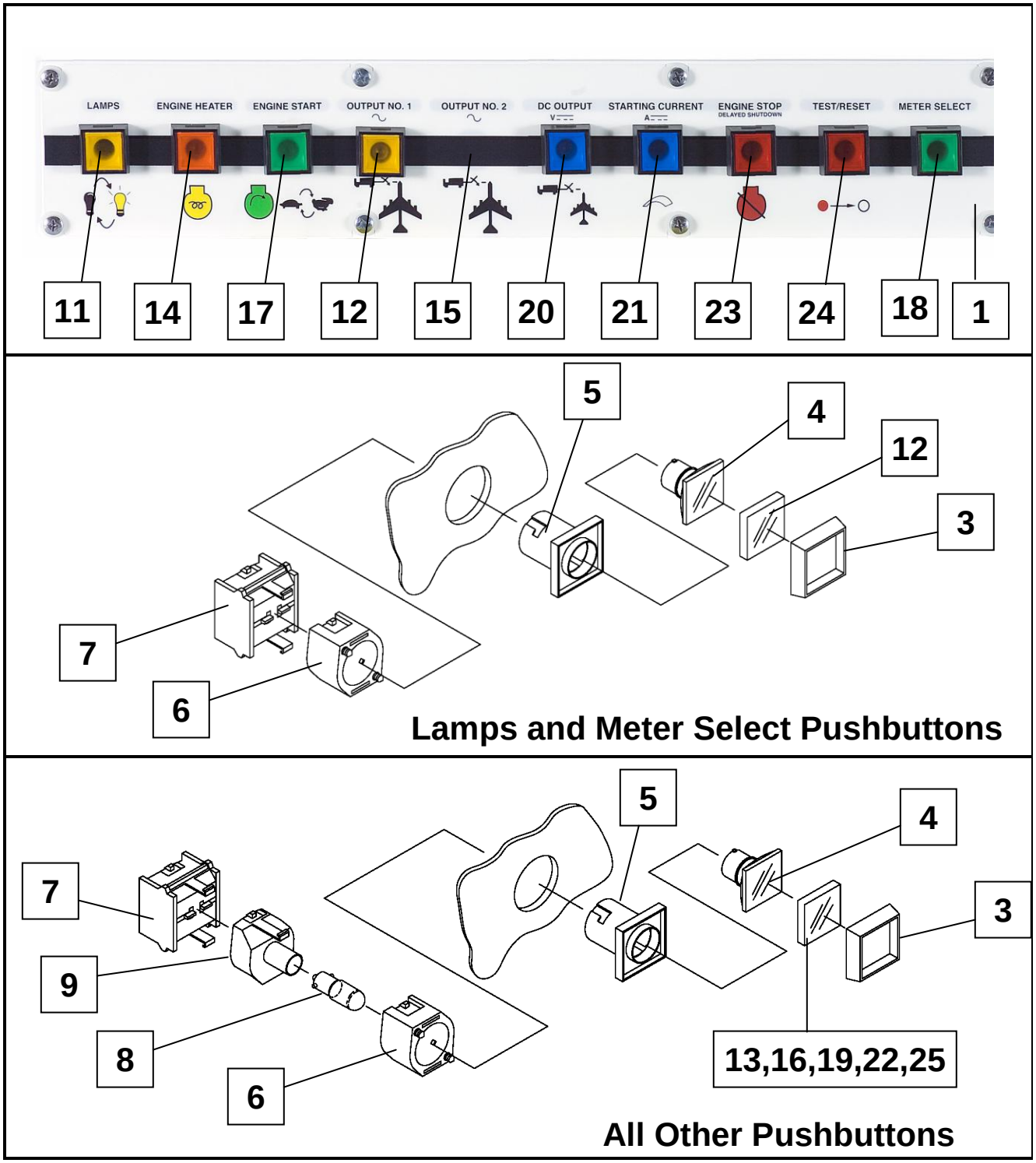
FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
6 -	1		Switch Panel (See Figure 8)		
*		291311	Control Box Interior Components (See Figure 7)		Ref.
	2	288020	Bracket, Cover Support		2
	3	288836-001	Top Door Hinge *(V94222 #96-141 Type A)*		1
		288836-002	Bottom Door Hinge *(V94222 #96-142 Type B)*		1
		289078	Spacer, Hinge		1
	4	288999-001	Control Box Door Latch		1
	5	291307	Control Box Enclosure		1
	6	287908	Water Temperature Gauge *(V16476 #06347-01)*		1
	7	494134-001	Fuel Level Gauge *(V16476 #06339-01)*		1
	8	181358	Hour Meter *(V74400 #85101)*		1
	9	286699-001	Battery Voltmeter *(V16476 #06351-01)*		1
	10	78A1117-002	Oil Pressure Gauge *(V16476 #06395-01)*		1
*	11	284486-001	Light, Gauge, Engine		4
	12	283167	Analog Frequency Meter		1
	12	288858-002	Digital Frequency Meter	optional	Ref.
	13	288858-004	Fault Code Meter		1
	14	W8105A-009	Analog AC Voltmeter		1
	14	288858-003	Digital AC Voltmeter	optional	Ref.
	15	288814-003	Analog AC Ammeter		1
	15	288858-001	Digital AC Ammeter	optional	Ref.
	16	400642-008	Analog DC Voltmeter	F,G,H,N,P	1
	17	400641-015	Analog DC Ammeter	F,G,H,N,P	1
*	18	285172	Light, Strip (with analog generator meters and no DC)	A-E,J-M	3
*		285172	Light, Strip (with analog generator meters and DC)	F,G,H,N,P	5
	19	288806	LED PC Board (shown opposite side)		1
		288820	...LED PC Board Gasket		1
	20	288995	Control Panel Door		1
		289017	...Control Panel Door Label		1
*		040213	...Gasket, Door, Neoprene		50 in.
	21	288917-002	Label, I.D.		1
	22	291329	Control Panel Cover (shown open)		1
	23	291330	Control Cover Hinge		1
*	24	288023	Wing Knob Latch		2
	25	282658	Label, Warning Clearance		1
	26	287460	Label, High Voltage		5
	27	287696	Label, Hearing Protection		1
	28	287459	Label, General		1
	29	288866	Label, Support Center		1
	30		Emergency Stop Button Assembly		Ref.
		285125	…Guard, Mushroom Button *(V14799 # K564M)*		1
	31	287466	…Label, Emergency Stop (symbols)		1
	32	288300	…Label, Emergency Stop (English)		1
		77A1157	…Switch, Maintained, Push-Pull *(V14799 #KR-9R-H6)*		1
*		291393	…Emergency Stop Harness Extension		1
	33		Block Heater Connection (Optional – See Figure 16)		Ref.
	34	289208	Low Fuel Beacon Light (Optional – See Figure 4)		Ref.



Control Box Interior Components
Figure 7

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
7 -		**291311-007**	**Control Box, Analog AC meters, 1 Output**	A,B,D,J,L	Ref.
		291311-008	**Control Box, Analog AC meters with DC**	F,G,H,N,P	Ref.
		291311-009	**Control Box, Analog AC meters, 2 Outputs**	C,E,K,M	Ref.
	1	288745	Engine Specific PC Board		1
*		284316-004	…PC Board Spacer		4
	2	288937	Engine Interface PC Board		1
*		284316-004	…PC Board Spacer		4
	3	288940B	Voltage Regulator PC Board		1
*		284316-004	…PC Board Spacer		6
	4	289026	Control PC Board		1
*		284316-004	…PC Board Spacer		6
	5	288914B	T-R PC Board	F,G,H,N,P	1
*		284316-004	…PC Board Spacer		4
	6	288818-001	Power Supply		1
*		288605	…Power Supply Support		1
	7	289122	Circuit Breaker Support		1
		289060	…Circuit Breaker Support Label		1
	8	283978-001	5 A Circuit Breaker *(V77342 #W23-X1A1G-5)*		1
	9	283978-002	10 A Circuit Breaker *(V77342 #W23-X1A1G-10)*		2
*	10	289073	Harness, Wire, Control Box Assembly		1
*	11	289072	DC Wire Harness	F,G,H,N,P	1
	12	291307	Control Box Enclosure		1
*	13	291298	Panel, Control Box Mounting		1
	14	286485-001	…Gasket		72 in.
	15	286388-001	Ring and Bushing Mount		4
	16	289104-001	Shoulder Bolt, #10-24		4
		286477-002	…Snubber Washer		4
	17	286611	Blank Label		2
*	18	288918-002	Label, Option List (inside control box door)		1

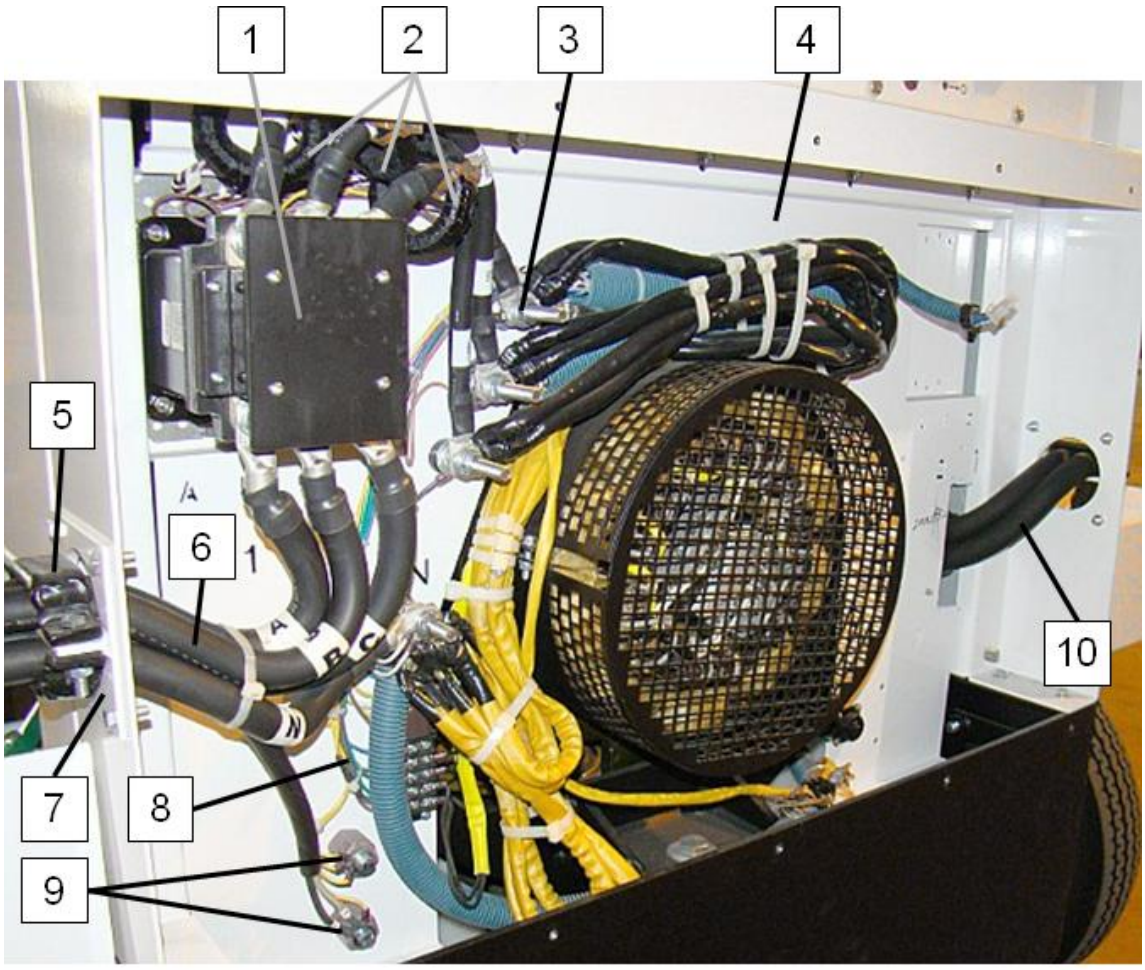
Note: Configurations F,G,H,N,P have the DC output option.

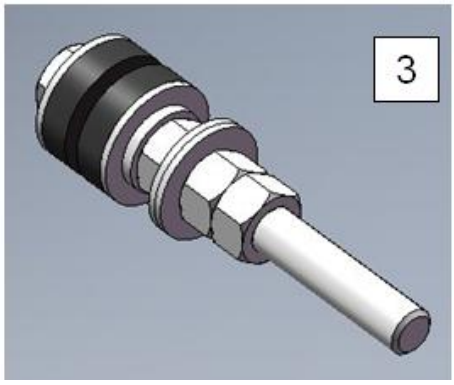


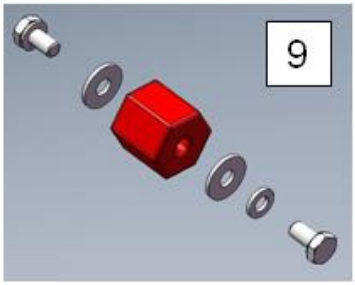
Control Switch Panel Components
Figure 8

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
8 -	1	289004	Switch Panel		1
		289014	…Switch Panel Label		1
*		040201	…Strip, Gasket, Neoprene		66 in.
*	2	289015	Switch Panel Wire Harness		1
			Common Pushbutton Parts		
	3	285029-001	Bezel Frame*(V61706 #704-701.0)*		1
	4	285031-001	Lens Holder*(V61706 #704-709.7)*		1
	5	285032-001	Sleeve Actuator *(V61706 #704-731.0)*		1
	6	285033	Mounting Flange*(V61706 #704-950.5)*		1
	7	284475-001	N.O. Contact Block *(V61706 #704-900.3)*		1
	8	400613-004	Lamp, 12 – 16 V, #1815 *(V02929)*		1
	9	285034-001	Lamp Holder *(V61706 #704-950.0)*		1
*	10	290080	Contact Block Cover		1
	11		***Lamps Pushbutton***		1
	12		***Output # 1 Pushbutton***		1
	13	285030-002	Yellow Lens *(V61706 #704-702.4)*		1
	14		***Pre-heater Pushbutton***		1
	15		***Output # 2 Pushbutton***	C,E,K,M	1
	16	285030-004	Orange Lens *(V61706 #704-702.3)*	C,E,K,M	1
	17		***Engine Start Pushbutton***		1
	18		***Meter Select Pushbutton***		1
	19	285030-003	Green Lens *(V61706 #704-702.5)*		1
	20		***DC Output Pushbutton***	F,G,H,N,P	1
	21		***Current Pushbutton***	F,G,H,N,P	1
	22	285030-005	Blue Lens *(V61706 #704-702.6)*	F,G,H,N,P	1
	23		***Engine Stop Pushbutton***		1
	24		***Test/Reset Pushbutton***		1
	25	285030-001	Red Lens *(V61706 #704-702.2)*		1

Notes:
- Configurations C,E,K,M have a second AC output.
- Configurations F,G,H,N,P have the DC output option.





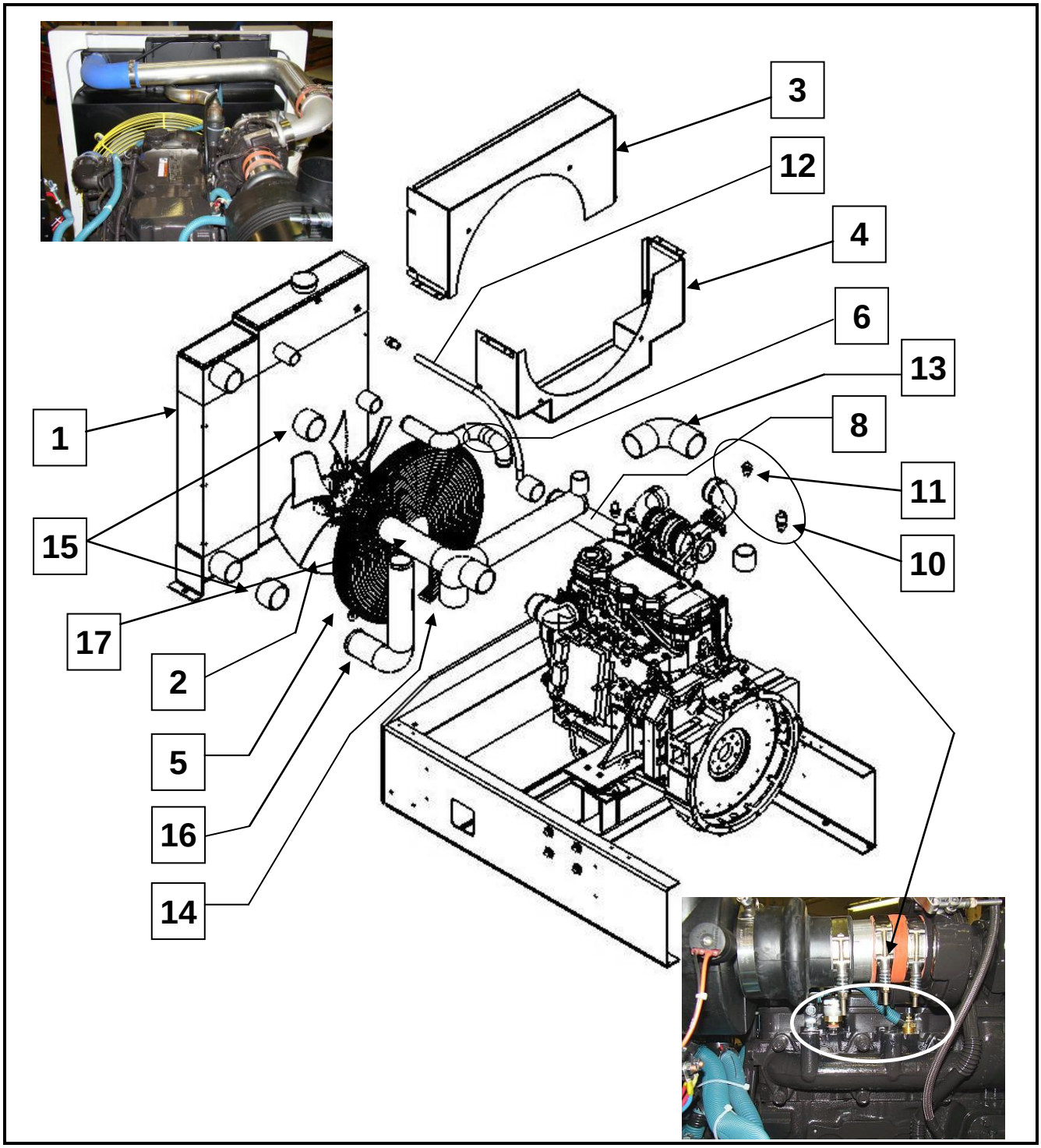


Note: Shown with one AC and one DC output

400 Hz. Power Module Assembly
Figure 9

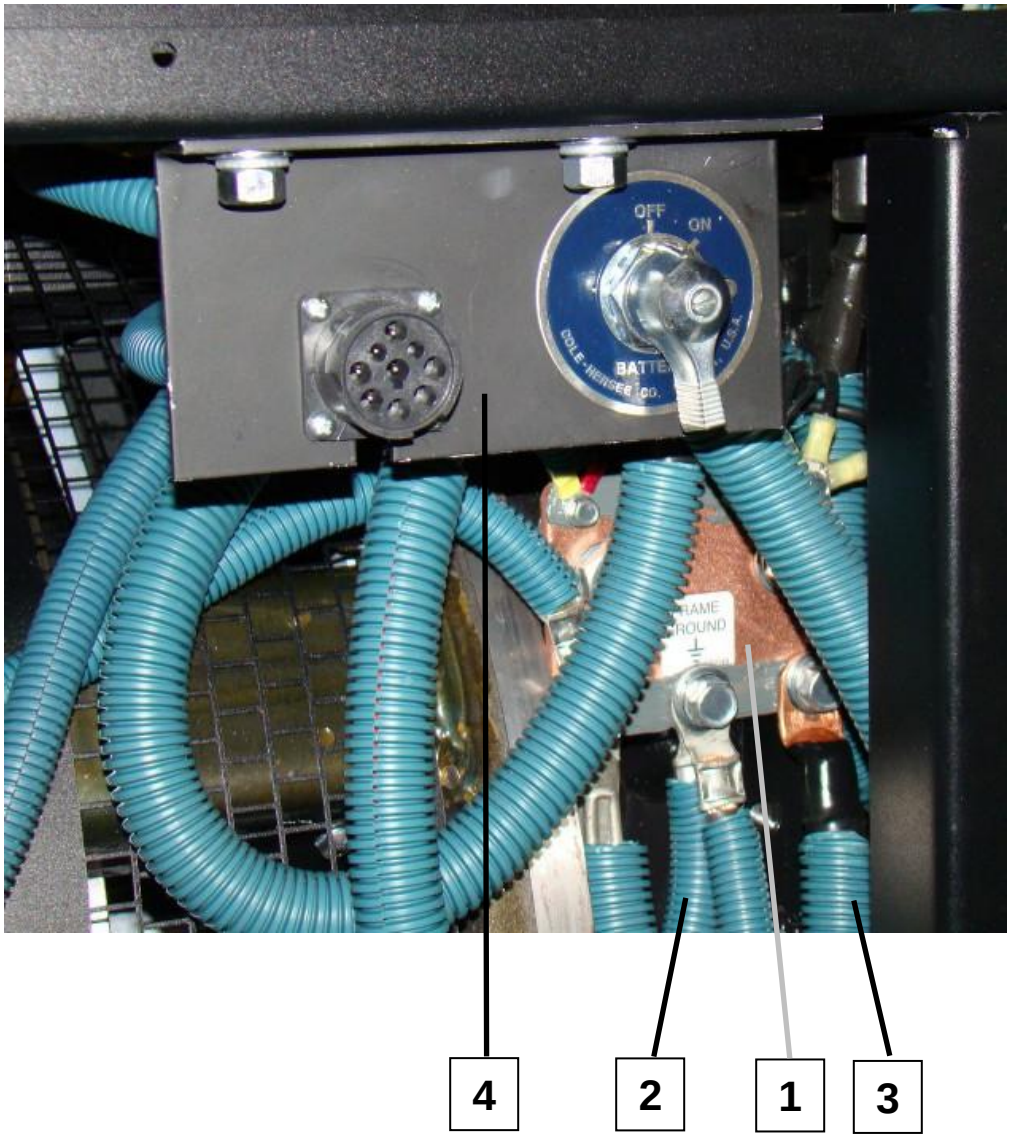
FIGURE ITEM NO.		PART NO.	NOMENCLATURE	UNITS PER ASSY.		
				1 AC out	2 AC out	1 AC, 1 DC
9 -		291115-003	**Power Module Assembly - single**	1	-	1
		291115-004	**Power Module Assembly - dual**	-	1	-
	1	282130-001	Contactor, Line, 3-Pole	1	2	1
	2	285102-001	Current, Transformer *(V05HB5 # 20130)*	3	6	3
	3		Generator Lead Connection Assembly	Ref.	Ref.	Ref.
*		AW626	…Bushing, Insulating [A-B-C-N]	4	5	4
		A25	…Washer, Insulating	8	10	8
		W11097-028	...Screw, 3/8-16 X 3.5 LG, HHC, ST.	4	5	4
		W11242-018	…Washer, Large Flat, 3/8”	8	10	8
		W11242-010	…Washer, Flat, 3/8”	8	10	8
		W11254-006	…Washer, Lock, 3/8”	8	10	8
		W11278-005	…Nut, 3/8-16, Hex	12	15	12
	4	291058	…Power Module Panel	1	1	1
	5	7J422-000	Output Cable Clamp (one AC output)	2	4	3
*	6	402034-xxx	Cable, AC Output 30 ft. (optional)	1	2	1
	7	288120	Output Cable Bracket (one AC or ACDC)	1	2	1
	8	290683	Harness, Wire	1	1	1
		401911-010	…Block, Terminal	1	1	1
	9	286266	Standoff, Short [E-F]	2	4	2
		402119-002	...Screw, 1/4-20 X .5 LG, HHC, ST.	4	8	4
	10	402025-xxx	Cable, DC Output 30 ft. (optional)	-	-	1
*	11	289318	Harness, Wire, 2nd Output (2 AC outputs)	-	1	-
*	12	282089-011	Diode, Flyback	1	1	1
*	13	288892-009	Resistor, ID, Power Module	1	1	1
*	14	288974	Noise Suppression Capacitors	1	1	1
*	15	488640	Bracket, Output Cable (for DC)	-	-	1
*	16	287698-001	Cover, Output Cables (for single output)	1	-	-
*	17	290640	Bracket, Shield, Heat	“H” only		
*	18	291180	Generator Lead Cover	“H” only		

Configurations A,B,D,J,L have one AC output.
Configurations C,E,K,M have two AC outputs.
Configurations F,G,H,N,P have AC and DC outputs



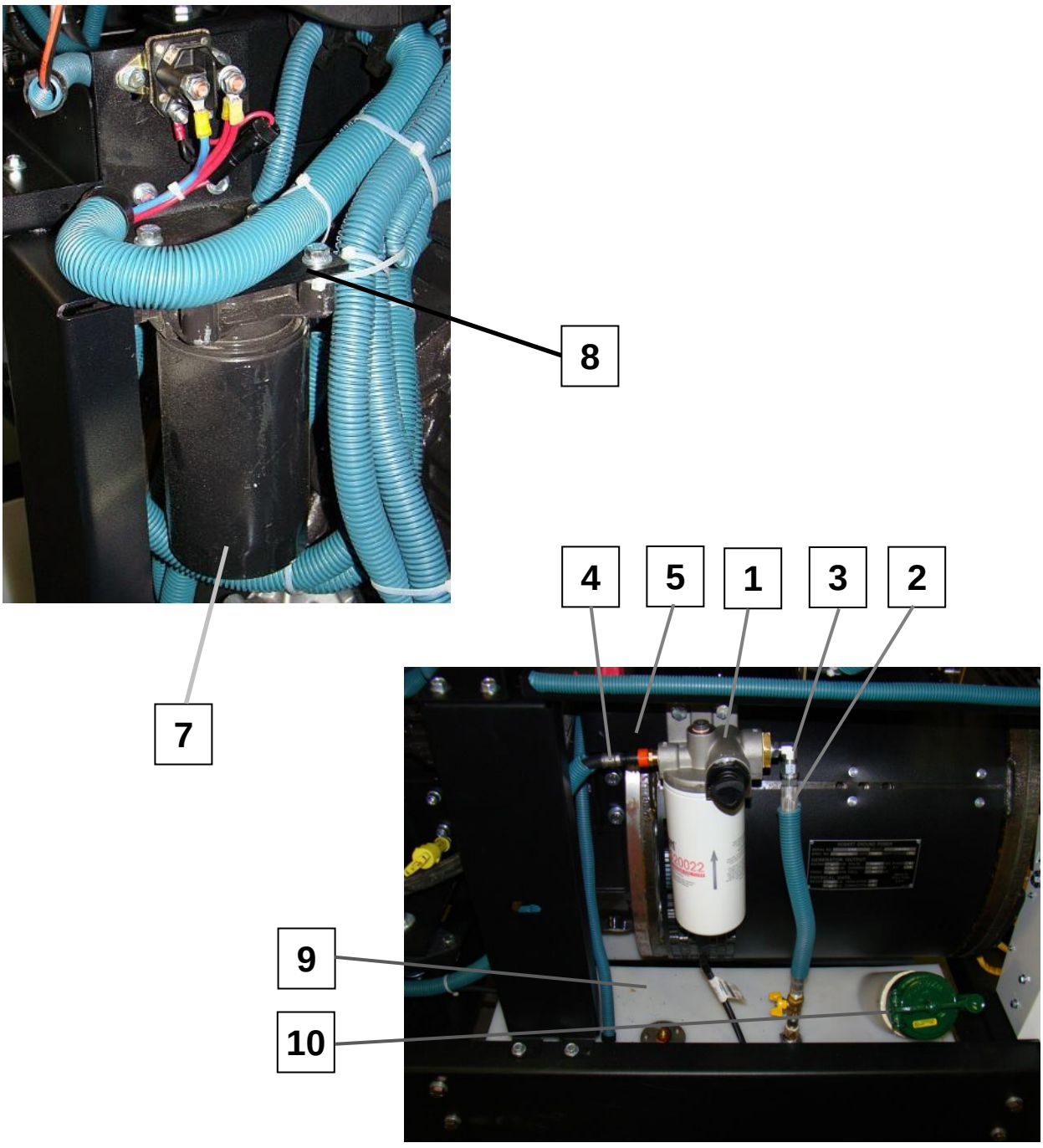
Engine Cooling System Assembly
Figure 10

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
10 -	1	291223	Radiator/CAC Assembly		1
*		290145	…Coolant Level Sensor		1
*		283873	…Radiator Drain Valve		1
*		056535	…Hose, Low Pressure, 3/8” ID		1’
	2	291224	Radiator Fan, 22” Diameter		1
	3	291070	Top Fan Shroud		1
*		291097	…Panel, Access, Shroud		1
	4	291071	Bottom Fan Shroud		1
	5	291225	Fan Guard		1
	6	291072	Top Radiator Hose (pipe)		1
	7	289200-001	…1.75” ID Hose (two 3” pieces)		6”
	8	291073	Bottom Radiator Hose (pipe)		1
	9	289200-002	…2.25” ID Hose (two 3” pieces)		6”
	10	403782-002	Water Temp Sw, 210° F *(V75418 #1002-04880-36)*		1
	11	287909	Water Temperature Sender *(V16476 #02019)*		1
*		W7814-004	…Bushing, Reducer		1
	12		Deaeration Line		Ref.
		288187	Fitting, Straight		1
		056535	Hose, Low Pressure, 3/8” ID		32”
		W10869-014	Clamp, Hose, SS		2
	13	289828	90° Elbow, 3.00” ID		1
	14	289827	90° Elbow, 3.00” ID		1
	15	290936	Hose, CAC, Straight, 3.0” ID		2
	16	291075	CAC Intake Manifold Hose		1
	17	291074	CAC Turbo Outlet Hose		1
*	18	290597-001	CAC Cooler Hose Clamps		8



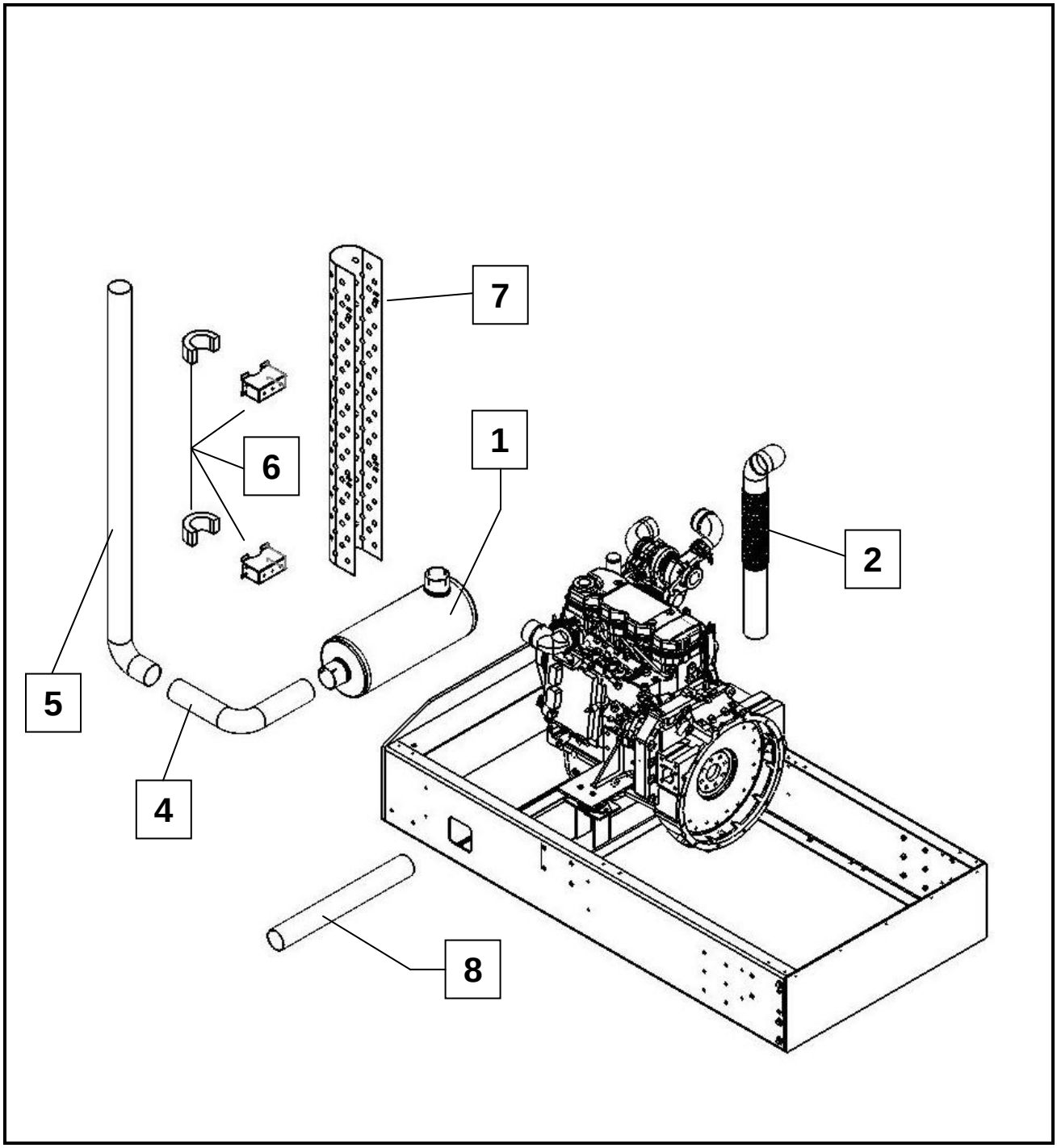
Engine Ground Plate and Battery Disconnect Switch
Figure 11

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
11 -	1	291079	Plate, Ground		1
*		405548	…Label, Ground		2
	2	W9407-446	Cable, Engine to Ground		2
	3	W9360-381	Cable, #111, Power Mod. To Ground		1
	4		**Engine Dongle and Battery Disconnect Panel**		Ref.
*		291334	…Panel, Engine Dongle/Battery Disconnect		1
*		290831	…Switch, Battery Disconnect		1
*		290847	…Plate, Disconnect Switch		1
*		291482	…Cable, Disconnect Switch to Starter		1
*		W9360-289	…Cable, Disconnect Switch to Electronics Panel		1
*	5	290678	Wire Harness, Engine		1
*		HF2962	…Clamp, Shield, Ignition, Large		1



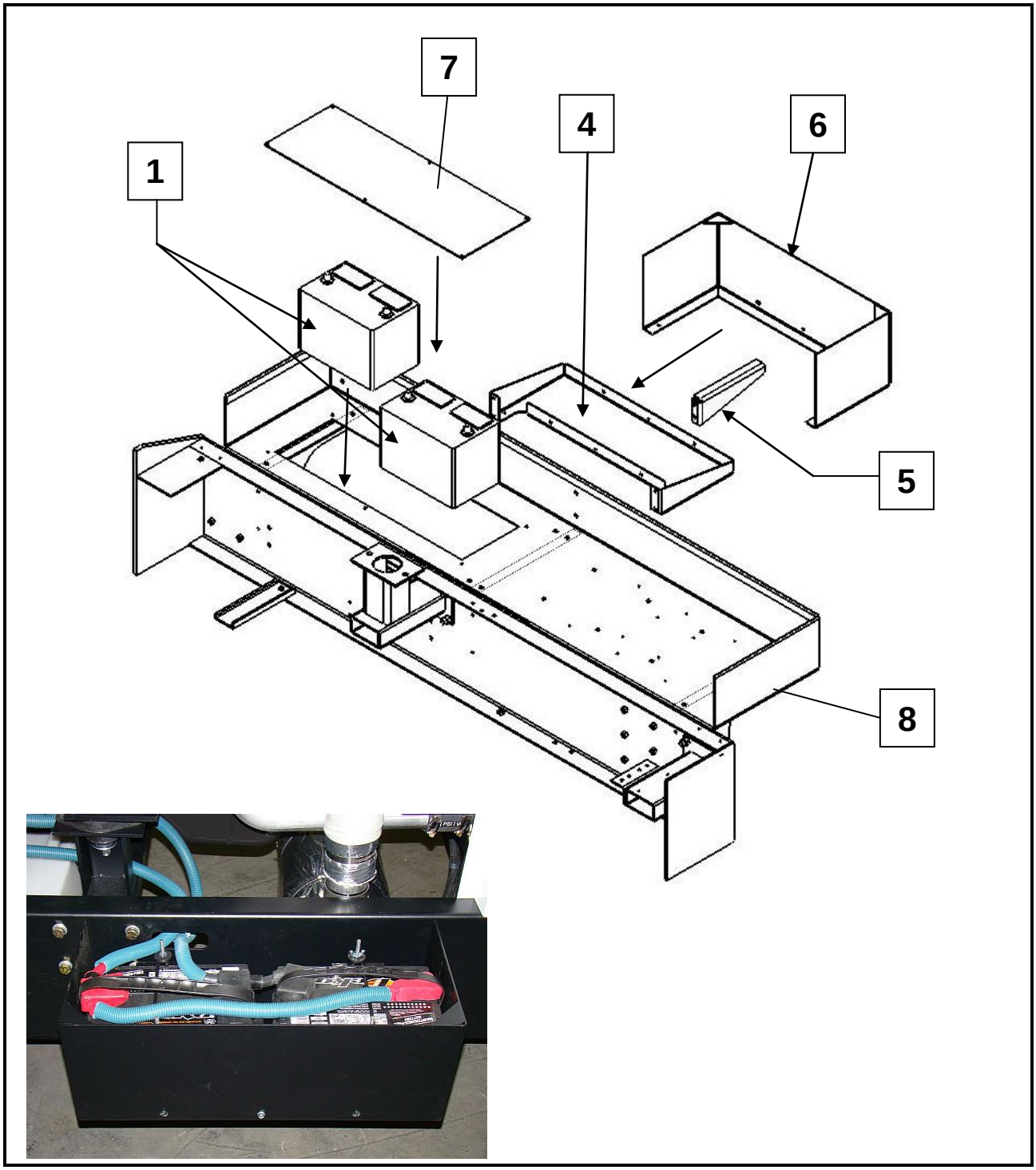
Engine Fuel Filters and Fuel Lines
Figure 12

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
12 -	1	286897-031	Filter, Lubricity Fuel		1
	2	291114	Line, Fuel, Tank to Filter		1
	3	290388	Adapter, 12 mm x 3/8 MJIC		1
	4	Call Factory	Line, Fuel, Filter to Pump		1
	5	289037	Bracket, Lubricity Fuel Filter		1
*	6	290686	Line, Fuel, Return		1
	7	286897-036	Filter, Primary Fuel		1
	8	291076	Bracket, Primary Fuel Filter		1
	9	291420	Fuel Tank, Composite, 50 Gallon	B – P	1
*		486719-005	…Sender, Gauge, Fuel, 12V		1
*		291407	…Bellypan, Fuel, Tank	B – P	1
*		291408	…Strap, Fuel Tank	B – P	2
*		291409	…Rubber, Strap, Fuel Tank	B – P	2
	9	291550	Fuel Tank, Stainless Steel	A	1
*		486719-005	…Sender, Gauge, Fuel, 12V		1
	10	282562	Cap, Fuel Neck *(V49234 #1275G/12T)*		1



Engine Exhaust Components
Figure 13

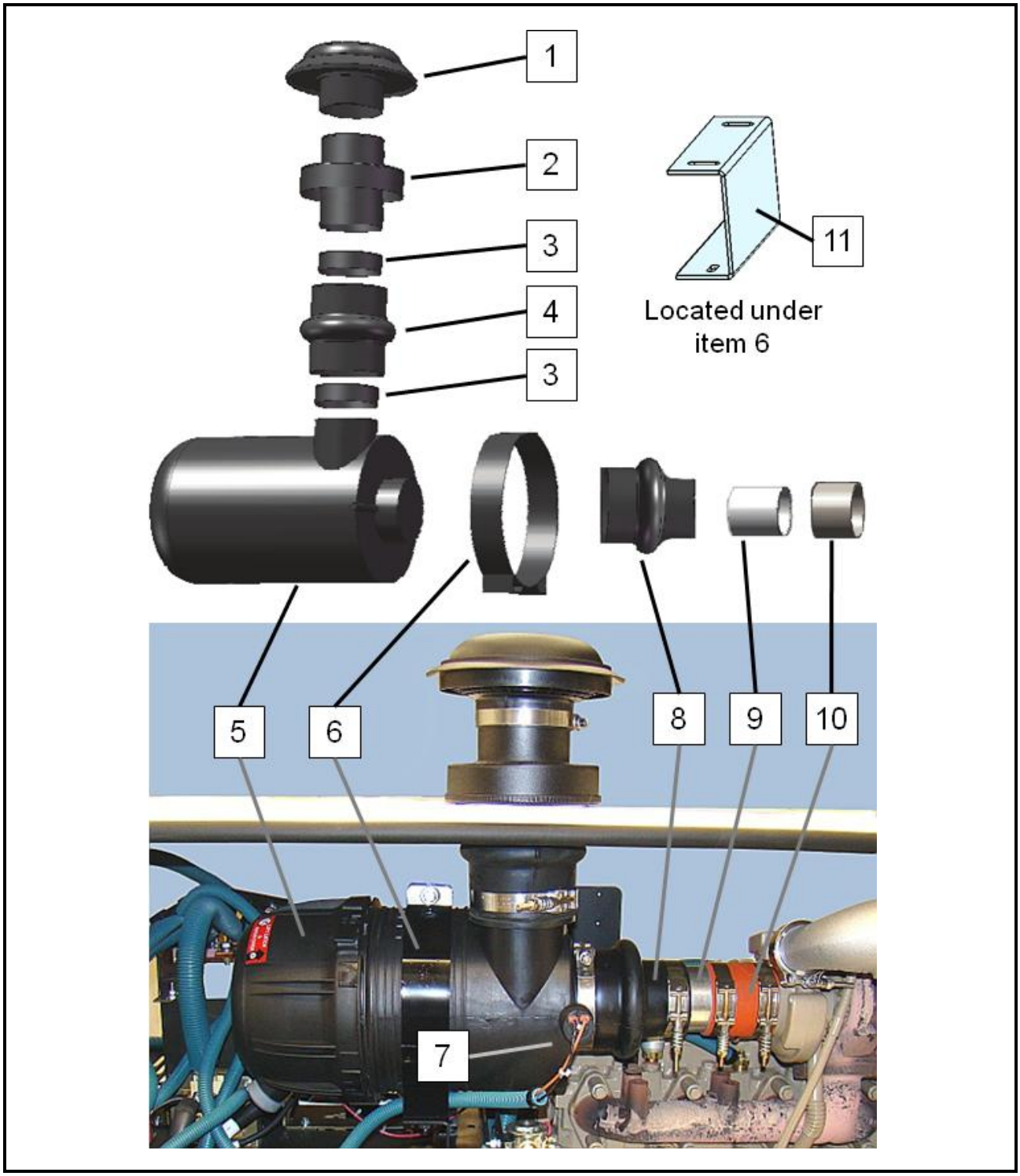
FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
13 -			**Common Exhaust Components**		
	1	291168	Muffler and Exhaust Ay.		1
*		IN5016	…Muffler Wrap Insulation		3.5 ft^2
*		288052-002	…Accuseal Clamp (3.0”)		2
	2	291077	Exhaust Flex Pipe Assembly		1
*		EB5224	…Muffler Wrap Insulation		1.7 ft^2
*		404154-013	…Full Circle Clamp, 3.0”		1
*		W10869-006	…Stainless Steel Hose Clamp		7
*	3	291394	Exhaust Hole Cover		1
*		291395	Vertical Exhaust Components	A-H	REF
	4	291379	Exhaust Outlet Elbow	A-H	1
*		288052-002	…Accuseal Clamp (3.0”)	A-H	1
*		EB5224	…Muffler Wrap Insulation	A-H	3.0 ft^2
*		W10869-006	…Stainless Steel Hose Clamp	A-H	2
	5	291380	Exhaust Outlet Pipe (vertical)	A-H	1
*		288052-002	…Accuseal Clamp (3.0”)	A-H	1
	6	291383	Stainless Steel Exhaust Clamp	A-H	2
	7	291382	Guard, ¾, Exhaust, Stainless Steel	A-H	1
			Horizontal Exhaust Components		
	8	291169	Exhaust Outlet Pipe (horizontal)	J-P	1
*		288052-002	…Clamp, Accuseal, 3”	J-P	1
*		EB5224	…Muffler Wrap Insulation (Elbow)	J-P	3 ft^2
*		W10869-006	…Clamp, Hose, Stainless Steel	J-P	2



12 VDC Battery System
Figure 14

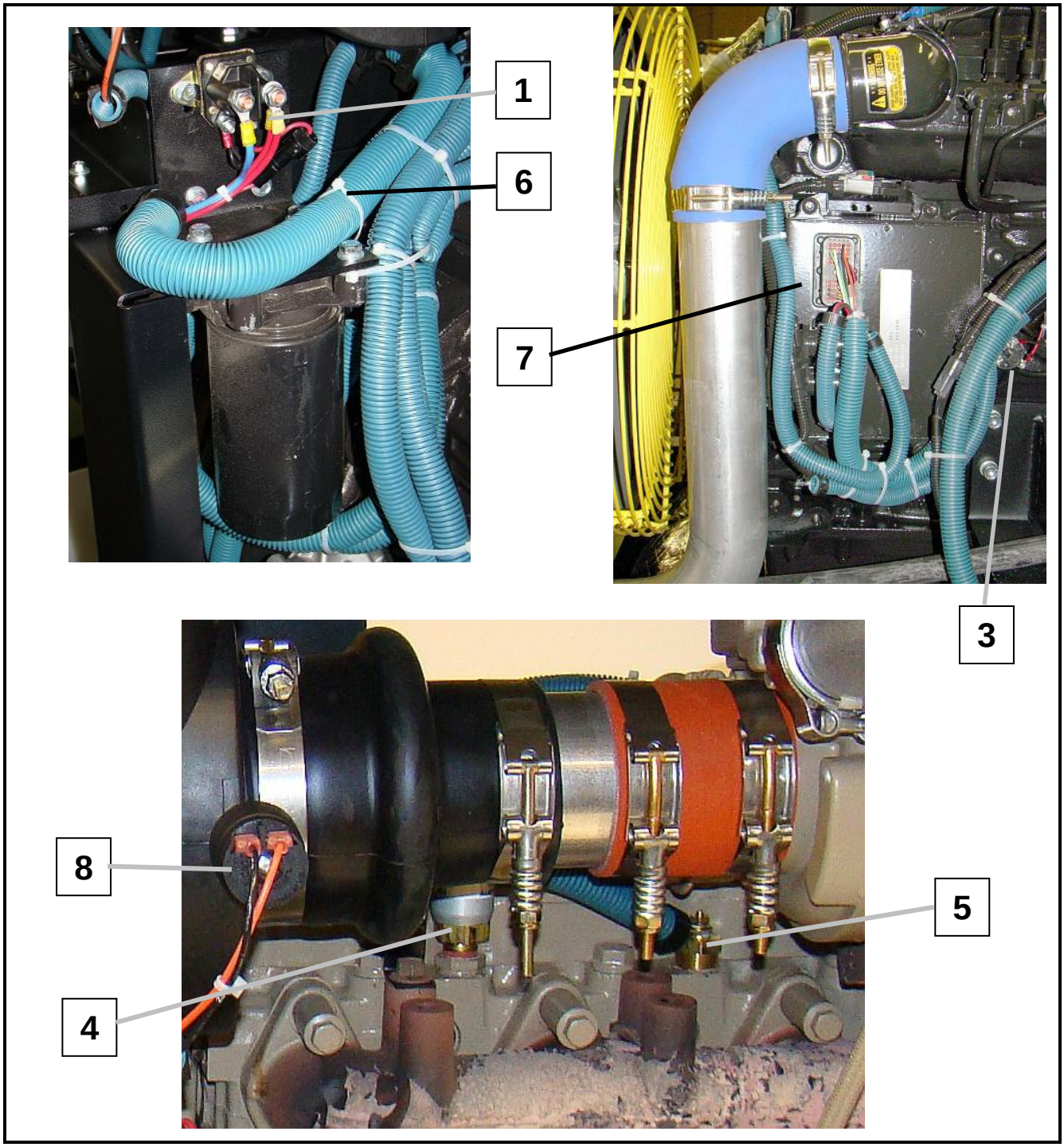
FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
14 -	1	281881-001	Battery, 12 V *(V25710 #1231-PMF)*		2
*		287796	…Hold Down, Battery *(V3Y208)*		2
*		494295	…Bolt, Hold Down, Battery *(V3Y208)*		4
*	2	290902	Cable, Battery, Negative *(V3Y208)*		1
*	3	291481	Cable, Battery, Positive *(V3Y208)*		1
	4	287795	Battery Tray		1
	5	291160	Battery Tray Support Bracket		1
	6	291067	Battery Tray Housing		1
	7	291093	Panel, Battery Tray Cover		2
	8	291092	Cable Tray	A,B,C,F,J,K,N	2

Note: Configurations A,B,C,F,J,K,N are trailer-mounted.



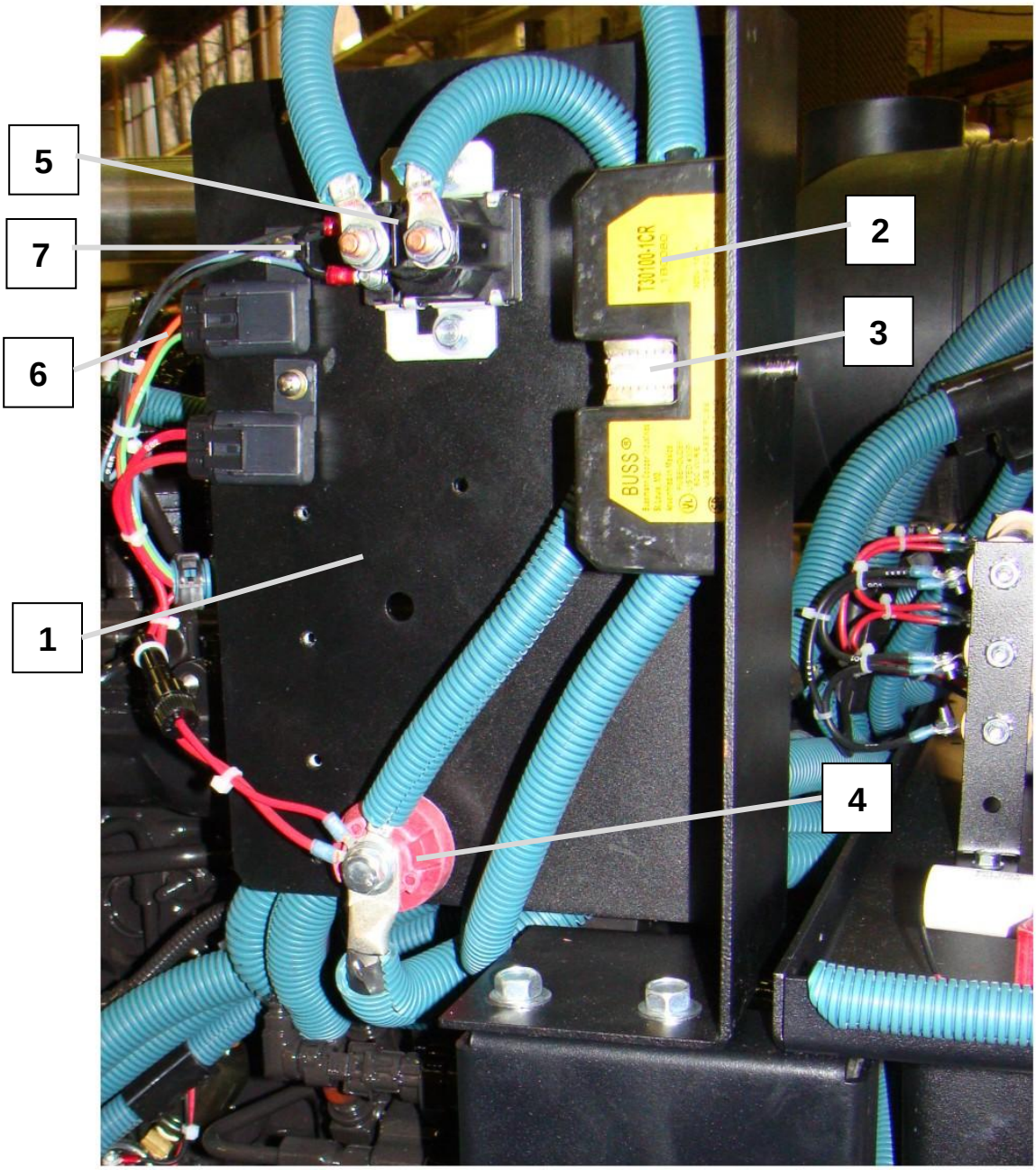
Engine Air Intake Assembly
Figure 15

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
15 -	1	290939	Weather Hood		1
*			…Clamp, Hose (included with hood)		Ref.
	2	290951	Intake, Air Extension		1
	3	290952	Hump Hose Sleeve (3-3/4” to 4”)		2
	4	290953	Hose, Hump, 4” ID		1
*		291516	…Clamp, SS, Gear		2
	5	290938	Air Cleaner		1
*		290941	…Replacement Air Filter Element		1
	6	290940	Bracket, Air Filter, Mounting		1
	7	282918	Air Restriction Indicator (see also Figure 16)		1
*		282919	…Adapter, Indicator		1
	8	288197-001	Fitting, Rubber, Reducer Hump (4” to 3”)		1
*		290597-006	…Clamp, Floating Bridge, 4.5”		1
*		290597-007	…Clamp, Floating Bridge, 3.5”		1
	9	291453	Tube, Intake Air		1
	10	290936	Hose, CAC, Straight, 3” ID		1
*		290597-001	…Clamp, Floating Bridge, 3.25”		2
	11	291078	Bracket, Air Filter Mounting		1



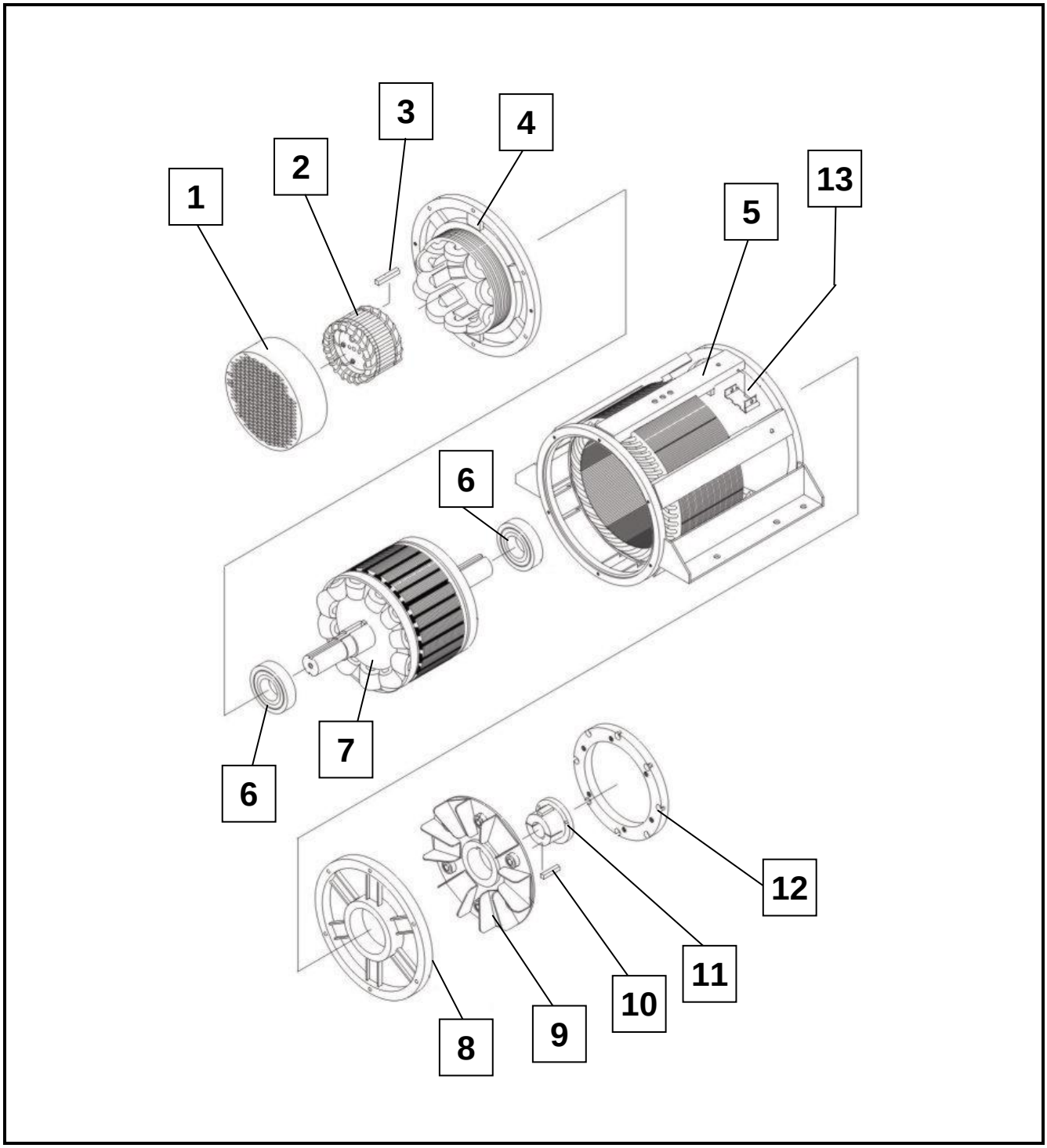
Engine Components
Figure 16

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
16 -	1	286850	Starter Solenoid *(V13445 # 24059)*		1
		288973-001	…Diode, Starter Solenoid, Assembly		1
*	2	403809-002	Switch, Oil Pressure *(V75419 #1042-08210-20)*		1
	3	78B1118-002	Sender, Oil Pressure *(V16476 #16476)*		1
*		W7814-000	…Bushing, Pipe, Steel, 1/4 X 1/8		1
*		286903	…Adapter, M14-1.5 x 1/4 NPT		1
*		W10910-000	…Fitting, Tee		1
*		W10750-001	…Nipple, Pipe, $^{1}/_{8}$”		1
	4	403782-002	Water Temp Sw, 210° F *(V75418 #1002-04880-36)*		1
	5	287909	Sender, Water Temperature *(V16476 #02019)*		1
	6	290678	Wire Harness, Engine		1
	7	290944	Electronic Engine Wire Harness		1
	8	282918	Air Restriction Indicator *(V18265 #REX77-0062)*		1
*		282919	…Adapter, Indicator		1
*	9	289261-001	Block Heater Kit, 120V(Optional)		Ref
*		289249-005	…Heater, Engine Block		1
*		289250-001	…Cable, Engine Block Heater		1
*		76A1131	…Z-Flex, ½” D		68”
	10	056525	Hose, Rubber, 3/4 ID x 1/8 Wall (crankcase)		66”



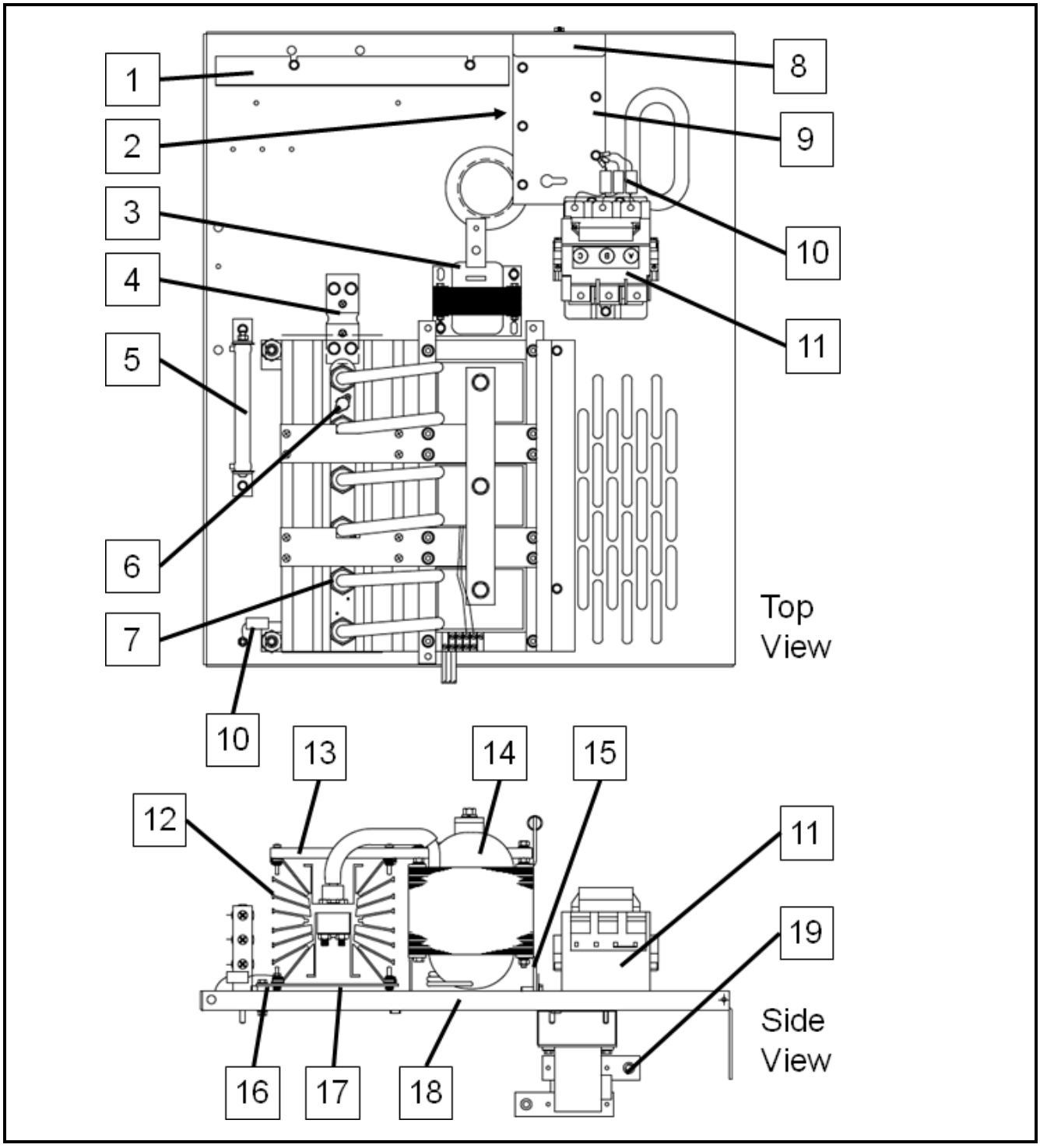
Engine Electronic Panel Components
Figure 17

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
17 -	1	291248	Panel, “E” Engine, Parts		1
	2	287145-001	Holder, Fuse		1
	3	287144-002	Fuse, Fast Acting		1
	4	283154-001	Insulator, Standoff		1
	5	288331	Relay, Grid Heater, Power *(V02929 50F3662)*		1
	6	290944	Harness, Wire, Engine, Electronic		1
*	7	489658-007	…Diode Assembly		1



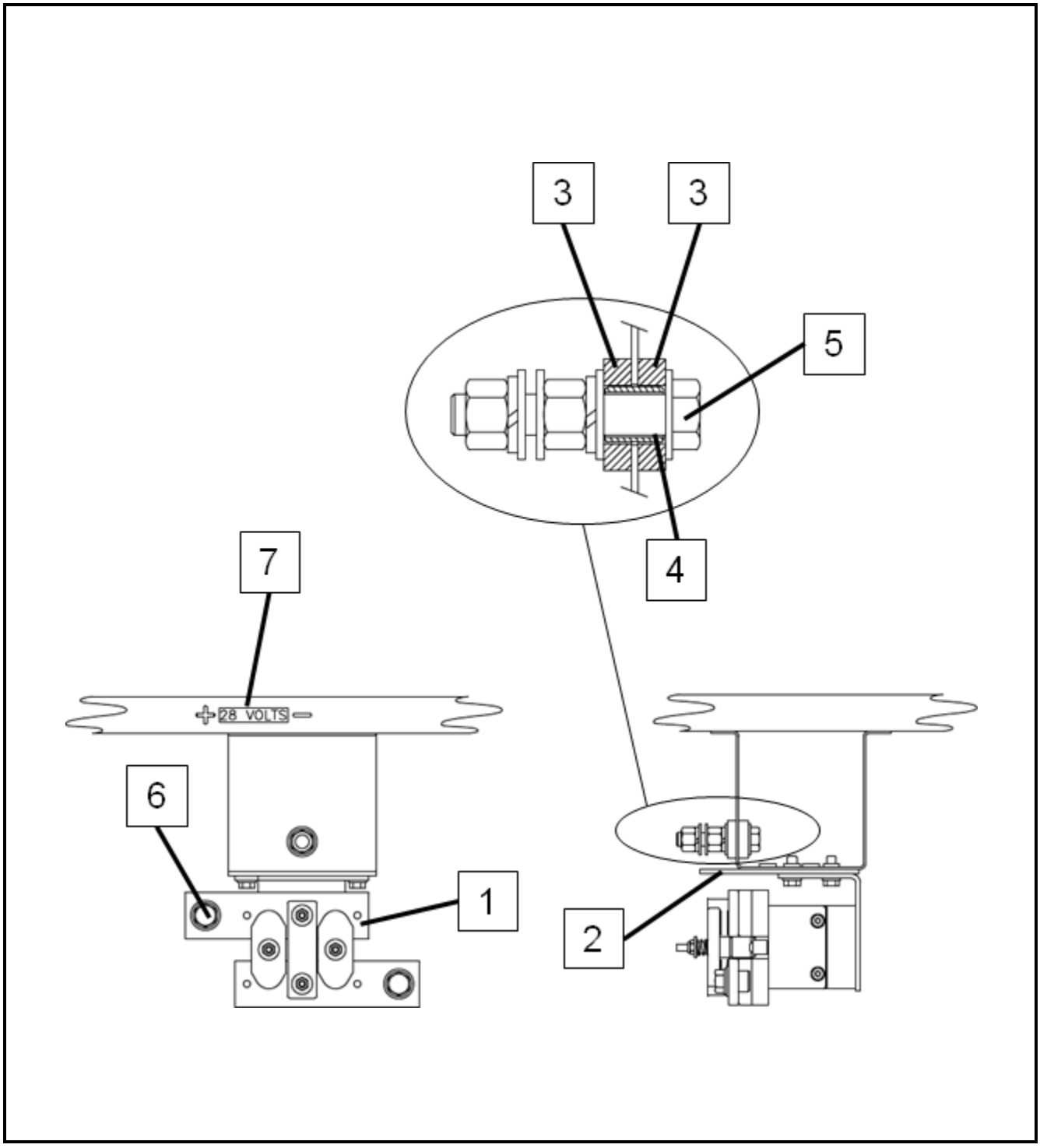
Generator Assembly
Figure 18

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
18 -	1	288486	Exciter Cover		1
	2	288494	Exciter Armature		1
	3	180696-003	Exciter Key		1
	4	288440	Exciter Housing and Coils Assembly		1
	5	291082	Generator Housing and Coils Assembly		1
	6	W10072-068	Bearing		2
	7	288447-003	Generator Rotor		1
	8	288461	Front Bearing Support		1
	9	288481	Flexible Coupling Kit		1
*		480290	…Rubber Coupling Bushing		8
	10	85B1039	Coupling Key		1
	11	85C1004-001	Split Taper Bushing		1
	12	290870	Flywheel Adapter Ring		1
	13	288458	Generator Air Deflector		6
*	14	291103	Generator Cover		1
*	15	288491	Tab, Fastener, Exciter Key		1



Transformer Rectifier Assembly – Part 1
Figure 19

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNITS PER ASSY.
19		291255	**Transformer Rectifier Assembly**	F,G,H,N,P	Ref.
	1	288895	Support, Options Terminal Block (see Figure 5)		1
	2	288117	Capacitor, TR, PC Board (under item 9)	F,G,H,N,P	1
	3	288092	Choke, DC	F,G,H,N,P	1
	4	280022	Shunt, 800 A, 50 mV	F,G,H,N,P	1
*		290827	…Bus Bar, Shunt Mounting	F,G,H,N,P	1
	5	288095-001	Resistor, Preload, Assembly	F,G,H,N,P	1
*		288380-001	…Resistor, Fixed, 10 Ohm, 100W	F,G,H,N,P	Ref.
	6	404044-004	Thermostat	F,G,H,N,P	1
	7	W10931-003	Diode, Silicon, 275 A, Positive Base	F,G,H,N,P	6
	8	291558	Bracket, Capacitor and PC Board	F,G,H,N,P	1
	9	289006	Support, PC Board	F,G,H,N,P	1
	10	290534-001	Kit, Noise Suppression Filter	F,G,H,N,P	1
		290533-001	Capacitor Assembly	F,G,H,N,P	3
		290533-002	Capacitor Assembly	F,G,H,N,P	1
	11	282130-001	Contactor, Input	F,G,H,N,P	1
*		77A1107	…Label “A”	F,G,H,N,P	1
*		77A1108	…Label “B”	F,G,H,N,P	1
*		77A1109	…Label “C”	F,G,H,N,P	1
	12	286603	Heat Sink, Extruded	F,G,H,N,P	1
	13	288404	Support, Heat Sink	F,G,H,N,P	2
	14	286604	Transformer, 28.5 VDC	F,G,H,N,P	1
*		281971-002	Resistor Assembly	F,G,H,N,P	1
	15	288085	…Bracket, Transformer	F,G,H,N,P	1
	16	286266	Standoff, Short	F,G,H,N,P	5
	17	288147	Bracket, Heat Sink	F,G,H,N,P	2
	18	291066	Panel, Support, TR		1
*	19		Contactor, Output (see Figure 20)	F,G,H,N,P	Ref.
*	20	289156	Harness, Wire, TR Assembly	F,G,H,N,P	1
*	21	289096	Chart, Cable	F,G,H,N,P	1



Transformer Rectifier Assembly – Part 2
Figure 20

FIGURE ITEM NO.		PART NO.	NOMENCLATURE	EFF	UNIT PER ASSY.
20	1	286810-001	Contactor, DC, 800 A, 24 VDC	F,G,H,N,P	1
	2	286849	Insulator, Contactor	F,G,H,N,P	1
	3	A25	Washer, Insulating	F,G,H,N,P	2
	4	288099	Bushing, Insulating	F,G,H,N,P	1
**	5		Output Stud	F,G,H,N,P	Ref.
			…Screw, 3/8-16 X 2, HHC	F,G,H,N,P	1
			…Washer, 3/8, Flat	F,G,H,N,P	6
			…Washer, 3/8, Lock	F,G,H,N,P	2
			…Nut, 3/8-16, Hex	F,G,H,N,P	2
**	6		Contactor Studs	F,G,H,N,P	Ref.
			…Screw, 3/8-16 X 1.0, HHC, ST.	F,G,H,N,P	2
			…Washer, 3/8, Flat	F,G,H,N,P	2
			…Washer, 3/8, Lock	F,G,H,N,P	2
	7	400435	Label, 28 Volts	F,G,H,N,P	1

** Standard SAE hardware.

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Section 4 Numerical Index

1) Explanation of Numerical Index

The purpose of this index is to assist the user in finding the illustration and description of a part when the part number is known. Part numbers are arranged in alphanumerical sequence.

FIGURE – ITEM NO.	HOBART PART NO.
8-	040201
6-	040213
13-	IN5016
4-	050984
16-10	056525
10-	056535
18-3	180696-003
6-8	181358
19-4	280022
14-1	281881-001
19-	281971-002
9-12	282089-011
9-1	282130-001
19-11	282130-001
12-10	282562
6-25	282658
15-7	282918
16-8	282918
15-	282919
16-	282919
17-4	283154-001
6-12	283167
4-10	283597
1-8	283714-004
4-9	283824
10-	283873
7-8	283978-001
7-9	283978-002
7-	284316-004
5-	24656
8-7	284475-001
6-11	284486-001
8-3	285029-001
8-25	285030-001
8-13	285030-002
8-19	285030-003
8-16	285030-004
8-22	285030-005
8-4	285031-001
8-5	285032-001
8-6	285033
8-9	285034-001
9-2	285102-001
6-	285125
6-	285172
6-18	285172
2-11	285418
9-9	286266
19-16	286266
7-15	286388-001
7-	286477-002
4-13	286485-001
7-14	286485-001
19-12	286603
19-14	286604
7-17	286611
6-9	286699-001
20-1	286810-001
20-2	286849
16-1	286850

FIGURE – ITEM NO.	HOBART PART NO.
12-1	286897-031
12-7	286897-036
16-	286903
17-3	287144-002
17-2	287145-001
6-28	287459
6-26	287460
1-12	287461
1-18	287462
1-6	287463
1-19	287464
1-3	287465
6-31	287466
1-23	287467
4-	287526-002
4-	287542-001
1-15	287571
6-27	287696
9-16	287698-001
4-	287785
14-4	287795
14-	287796
6-6	287908
10-11	287909
16-5	287909
2-3	292016
3-5	287986
2-5	287998
3-	287998
6-2	288020
6-24	288023
13-	288052-002
19-15	288085
19-3	288092
19-5	288095-001

FIGURE – ITEM NO.	HOBART PART NO.
20-4	288099
5-	24656
19-2	288117
9-7	288120
19-17	288147
1-10	288164-001
10-	288187
15-8	288197-001
6-32	288300
17-5	288331
19-	288380-001
19-13	288404
18-4	288440
18-7	288447-003
18-13	288458
5-4	288460-003
18-8	288461
18-9	288481
18-1	288486
18-15	288491
18-2	288494
7-	288605
7-1	288745
6-19	288806
6-15	288814-003
7-6	288818-001
6-	288820
6-3	288836-001
6-	288836-002
6-15	288858-001
6-12	288858-002
6-14	288858-003
6-13	288858-004
1-20	288862
6-29	288866

FIGURE – ITEM NO.	HOBART PART NO.
1-22	288872
9-13	288892-009
5-11	288895
19-1	288895
7-5	288914B
6-21	288917-002
7-18	288918-002
7-2	288937
7-3	288940B
2-12	288961-002
2-13	288966
16-	288973-001
9-14	288974
2-	288987-006
2-14	288989-002
6-20	288995
6-4	288999-001
8-1	289004
19-9	289006
8-	289014
8-2	289015
6-	289017
7-4	289026
12-5	289037
7-	289060
7-11	289072
7-10	289073
6-	289078
19-21	289096
7-16	289104-001
7-7	289122
5-	289127
19-20	289156
10-7	289200-001
10-9	289200-002

FIGURE – ITEM NO.	HOBART PART NO.
6-34	289208
16-	289249-005
16-	289250-001
16-9	289261-001
9-11	289318
10-14	289827
10-13	289828
1-24	289842-001
8-10	290080
10-	290145
1-13	290216
12-3	290388
19-	290533-001
19-	290533-002
19-10	290534-001
10-18	290597-001
15-	290597-001
15-	290597-006
15-	290597-007
9-17	290640
5-	290678
11-5	290678
16-6	290678
9-8	290683
12-6	290686
19-	290827
11-	290831
11-	290847
5-	290869
5-	290870
18-12	290870
14-2	290902
10-15	290936
15-10	290936
15-5	290938

FIGURE – ITEM NO.	HOBART PART NO.
15-1	290939
15-6	290940
15-	290941
16-7	290944
17-6	290944
15-2	290951
15-3	290952
15-4	290953
2-2	292012
2-1	292042
5-	292011
5-	291055
3-4	291056
4-14	291057
9-4	291058
3-3	291066
5-13	291066
19-18	291066
14-6	291067
3-1	291069
10-3	291070
10-4	291071
10-6	291072
10-8	291073
10-17	291074
10-16	291075
12-8	291076
13-2	291077
15-11	291078
11-1	291079
4-1	291080
4-3	291081
18-5	291082
4-5	291084
4-17	291085

FIGURE – ITEM NO.	HOBART PART NO.
4-16	291087
2-6	291088
2-7	291089
2-8	291092
14-8	291092
2-9	291093
14-7	291093
10-	291097
18-14	291103
12-2	291114
9-	291115-003
9-	291115-004
3-2	291152
5-12	291152
14-5	291160
13-1	291168
13-8	291169
9-18	291180
10-1	291223
10-2	291224
10-5	291225
4-4	291237-001
4-2	291237-002
4-8	291237-003
4-7	291237-004
4-19	291237-005
4-18	291237-006
17-1	291248
1-17	291253-001
1-	291253-002
5-3	291255
19-	291255
4-6	291297
7-13	291298
4-15	291302

FIGURE – ITEM NO.	HOBART PART NO.
6-5	291307
7-12	291307
6-	291311
7-	291311-007
7-	291311-008
7-	291311-009
6-22	291329
6-23	291330
11-	291334
4-	291335
5-6	292052
13-4	291379
13-5	291380
13-7	291382
13-6	291383
4-	291386
6-	291393
13-3	291394
13-	291395
12-	291407
12-	291408
12-	291409
12-9	291420
15-9	291453
14-3	291481
11-	291482
15-	291516
12-9	291550
19-8	291558
1-25	400435
20-7	400435
8-8	400613-004
6-17	400641-015
6-16	400642-008
9-	401911-010

FIGURE – ITEM NO.	HOBART PART NO.
9-10	402025-xxx
9-6	402034-xxx
9-	402119-002
1-9	402987
10-10	403782-002
16-4	403782-002
16-2	403809-002
19-6	404044-004
13-	404154-013
11-	405548
1-21	407366
1-	408665-001
1-4	408665-001
1-	408665-002
18-	480290
5-	482496-002
12-	486719-005
9-15	488640
17-7	489658-007
6-7	494134-001
14-	494295
16-	76A1131
1-11	76B1148
19-	77A1107
19-	77A1108
19-	77A1109
6-	77A1157
6-10	78A1117-002
16-3	78B1118-002
9-5	7J422-000
18-10	85B1039
18-11	85C1004-001
9-	A25
20-3	A25
9-	AW626

FIGURE – ITEM NO.	HOBART PART NO.
12-4	Call Factory
11-	HF2962
18-6	W10072-068
16-	W10750-001
5-	W10869-003
5-	W10869-005
13-	W10869-006
5-	W10869-014
10-	W10869-014
16-	W10910-000
19-7	W10931-003
9-	W11097-028
9-	W11242-010
9-	W11242-018
9-	W11254-006
9-	W11278-005
16-	W7814-000
10-	W7814-004
6-14	W8105A-009
11-	W9360-289
11-3	W9360-381
11-2	W9407-446

Chapter 5 Manufacturer's Literature

Vendor Literature

Type	Diagram Description
Engine	Operation and Maintenance Manual (Cummins Bulletin # 4021531) Parts Catalog (Cummins Bulletin # 4056563) - not Included -- purchased separately from Cummins.

Diagram Number	Diagram Description
291331, Rev. 1	Diagram, Schematic & Connection
289022, Rev. 2	Diagram, Connection, Control Box
289102, Rev. 3	Diagram, Connection, Power Module
289013, Rev. 3	Diagram, Connection, Switch Box
289155, Rev. 3	Diagram, Schematic & Connection, Transformer-Rectifier

Contact Hobart Ground Systems if copies of these drawings or manuals are not with this manual (unless otherwise noted above). Refer to Appendix A for specific information on 60CU20, 400 Hz. Generator Set, optional equipment.

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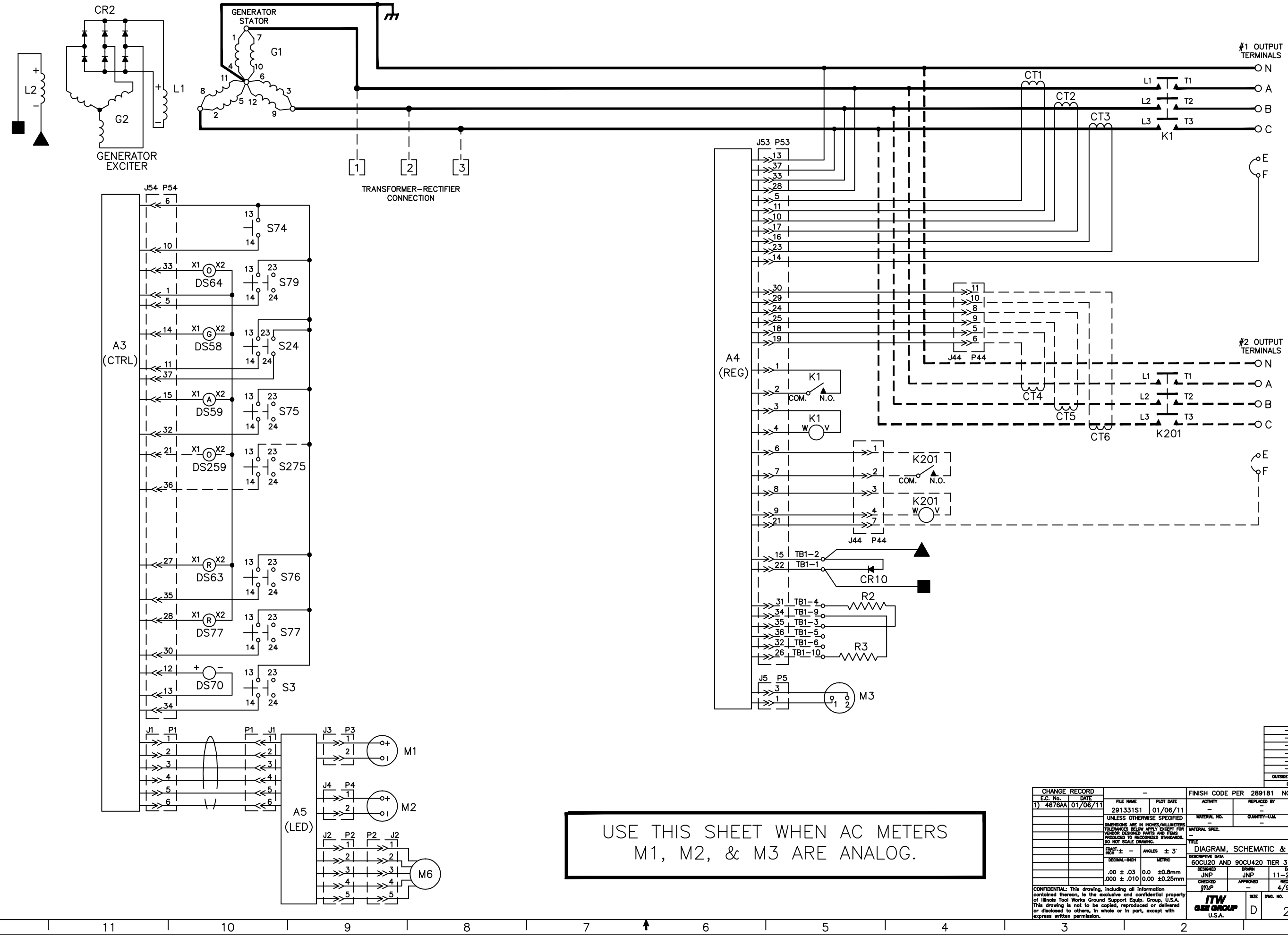

USE THIS SHEET WHEN AC METERS M1, M2, & M3 ARE ANALOG.

CHANGE RECORD		–	FINISH CODE PER 289181 NONE		
E.C. No.	DATE	FILE NAME / PLOT DATE	ACTIVITY	REPLACED BY	REPLACES
1) 4676AA	01/06/11	291331S1 01/06/11	–	–	–
		UNLESS OTHERWISE SPECIFIED	MATERIAL NO. –	QUANTITY–U.M. –	COMM. CLS. –
		DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.	MATERIAL SPEC. –		
		FRACT. INCH ± – ANGLES ± 3°	TITLE DIAGRAM, SCHEMATIC & CONNECTION		
		DECIMAL–INCH .00 ± .03 .000 ± .010 METRIC 0.0 ±0.8mm 0.00 ±0.25mm	DESCRIPTIVE DATA 60CU20 AND 90CU420 TIER 3 CUMMINS		
			DESIGNED JNP	DRAWN JNP	DATE 11–20–09
			CHECKED	APPROVED	RECORDS 4/9/10
					SCALE NONE
					ITEM TYPE –

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ITW GSE GROUP U.S.A.

SIZE D DWG. NO. SHEET 1 OF 7 291331

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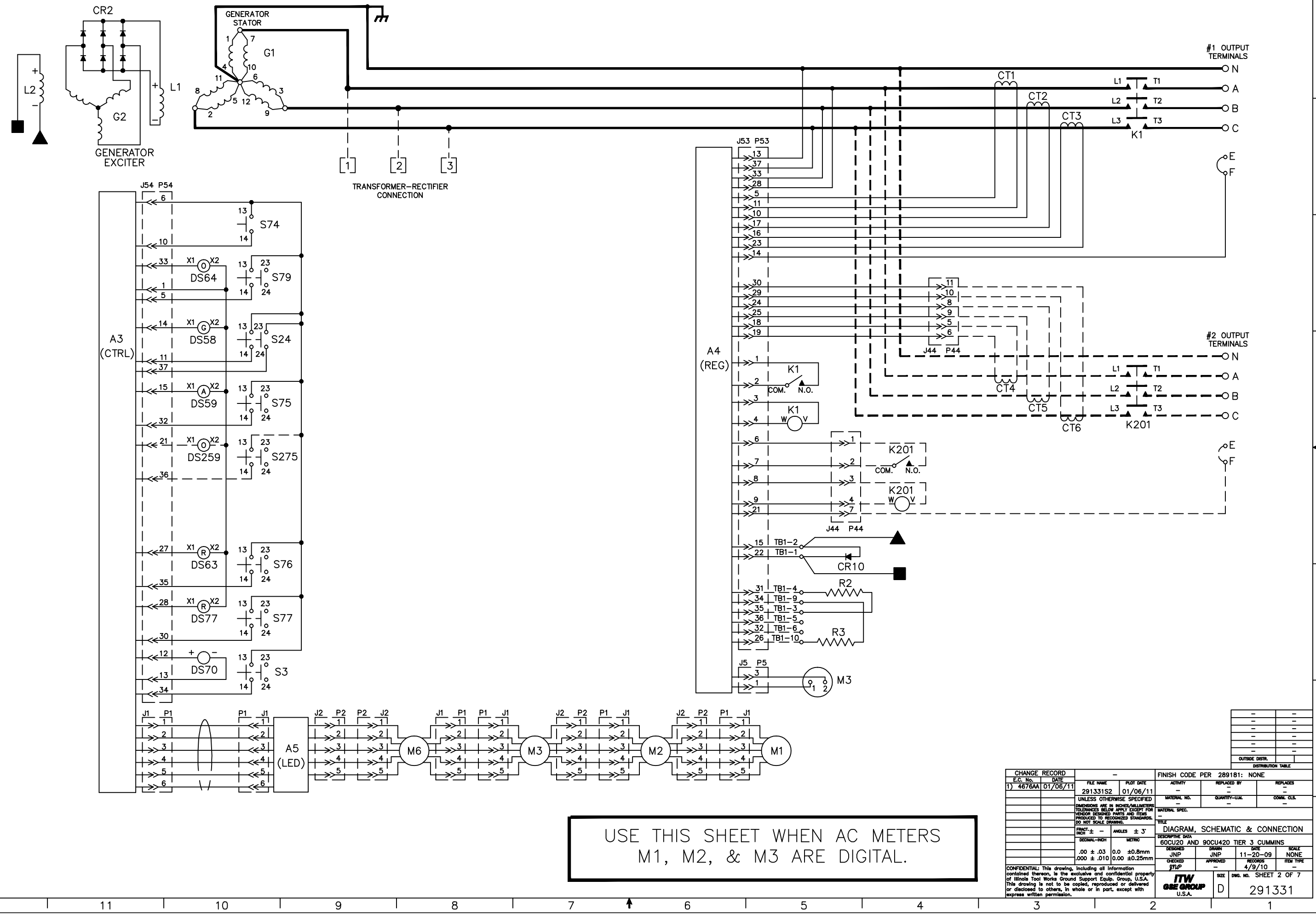
OUTSIDE DISTR.	

DISTRIBUTION TABLE



USE THIS SHEET WHEN AC METERS M1, M2, & M3 ARE DIGITAL.

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		DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.	MATERIAL SPEC. –		
		FRACT. INCH ± – ANGLES ± 3°	TITLE DIAGRAM, SCHEMATIC & CONNECTION		
		DECIMAL–INCH .00 ± .03 .000 ± .010 METRIC 0.0 ±0.8mm 0.00 ±0.25mm	DESCRIPTIVE DATA 60CU20 AND 90CU420 TIER 3 CUMMINS		
			DESIGNED JNP	DRAWN JNP	DATE 11–20–09
			CHECKED	APPROVED	RECORDS 4/9/10
					SCALE NONE
					ITEM TYPE –

OUTSIDE DISTR.	
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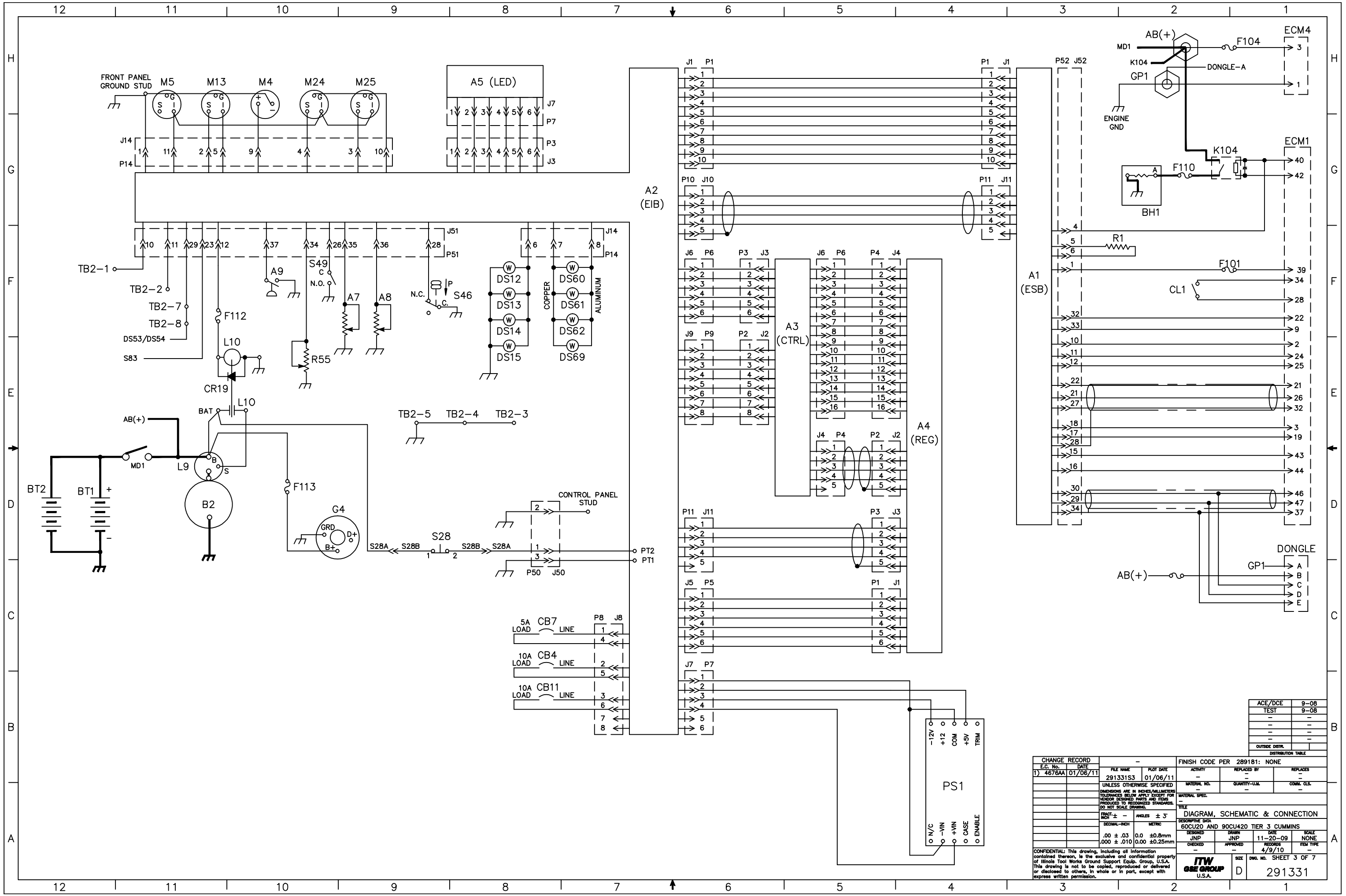
DISTRIBUTION TABLE

ITW GSE GROUP U.S.A.

SIZE D DWG. NO. 291331 SHEET 2 OF 7



ACE/DCE	9-08
TEST	9-08
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OUTSIDE DISTR.	

DISTRIBUTION TABLE

CHANGE RECORD		
E.C. No.	DATE	
1) 4676AA	01/06/11	

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FINISH CODE PER 289181: NONE

FILE NAME	PLOT DATE
291331S3	01/06/11

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.

FRACT. ± | ANGLES ± 3°

DECIMAL-INCH	METRIC
.00 ± .03	0.0 ±0.8mm
.000 ± .010	0.00 ±0.25mm

ACTIVITY	REPLACED BY	REPLACES
–	–	–
	–	–
MATERIAL NO.	QUANTITY-U.M.	COMM. CLS.
–	–	–

MATERIAL SPEC.
–

TITLE
DIAGRAM, SCHEMATIC & CONNECTION

DESCRIPTIVE DATA
60CU20 AND 90CU420 TIER 3 CUMMINS

DESIGNED	DRAWN	DATE	SCALE
JNP	JNP	11-20-09	NONE
CHECKED	APPROVED	RECORDS	ITEM TYPE
–	–	4/9/10	–

ITW GSE GROUP U.S.A.

SIZE D | DWG. NO. 291331 | SHEET 3 OF 7

LEGEND

A1	BOARD, P.C., ENGINE SPECIFIC BOARD (ESB)
A2	BOARD, P.C., ENGINE INTERFACE BOARD (EIB)
A3	BOARD, P.C., CONTROL BOARD (CTL)
A4	BOARD, P.C., REGULATOR BOARD (REG)
A5	BOARD, P.C., LED BOARD (LED)
A7	SENSOR, WATER TEMPERATURE
A8	SENSOR, OIL PRESSURE
A9	SENSOR, AIR CLEANER SERVICE
AB(−)	AUX. NEGATIVE BATTERY TERMINAL
AB(+)	AUX. POSITIVE BATTERY TERMINAL
B2	STARTER, ENGINE, 12 V.
BH1	GRID HEATER
BT1, BT2	BATTERY, 12 V.
CL1	SENSOR, COOLANT LEVEL
CB4	CIRCUIT BREAKER, ENGINE ELECTRICAL, 10 A.
CB7	CIRCUIT BREAKER, CONTROL CIRCUIT, 5 A.
CB11	CIRCUIT BREAKER, MARKER LIGHTS, 10 A.
CR2	RECTIFIER, GENERATOR REVOLVING FIELD
CR10	DIODE, FLYBACK, EXCITER
CR19	DIODE, FLYBACK, AUXILIARY STARTER SOLENOID
CT1−CT3	TRANSFORMER, CURRENT, #1 OUTPUT
CT4−CT6	TRANSFORMER, CURRENT, #2 OUTPUT (WHEN FURNISHED)
DS12	LIGHT, VOLTMETER, BATTERY (WHITE)
DS13	LIGHT, OIL PRESSURE GAUGE (WHITE)
DS14	LIGHT, TEMPERATURE GAUGE (WHITE)
DS15	LIGHT, FUEL GAUGE (WHITE)
DS58	INDICATOR, PUSHBUTTON, ENGINE START (GREEN)
DS59	INDICATOR, PUSHBUTTON, OUTPUT NO. 1 (ORANGE)
DS60	LIGHT, STRIP, FREQUENCY METER
DS61	LIGHT, STRIP, AMMETER
DS62	LIGHT, STRIP, VOLTMETER
DS63	INDICATOR, PUSHBUTTON, DELAYED ENGINE SHUTDOWN (RED)
DS64	INDICATOR, PUSHBUTTON, PRE−HEATER (ORANGE)
DS69	LIGHT, STRIP, FAULT METER
DS70	LIGHT, STRIP, SWITCH BOX
DS77	INDICATOR, PUSHBUTTON, TEST/RESET (RED)
DS259	IND., PUSHBUTTON, OUTPUT NO. 2 (YELLOW) (WHEN FURNISHED)
ECM1	CONNECTOR, ELECTRONIC CONTROL MODULE (MAIN)
ECM2	CONNECTOR, ELECTRONIC CONTROL MODULE (DONGAL)
ECM4	CONNECTOR, ELECTRONIC CONTROL MODULE (POWER)
F102	FUSE, "E" ENGINE, 5A.
F103−F105	FUSE, "E" ENGINE, 7.5A.
F106, F107	FUSE, "E" ENGINE, 10A.
F110	FUSE, PRE−HEATER
F112	FUSE, STARTER SOLENIOD, 3 A., 250 V.
F113	FUSE, LINK, ALTERNATOR
G1	GENERATOR, STATOR
G2	EXCITER, ARMATURE GENERATOR
G4	ALTERNATOR, ENGINE, 12 V.
GP1	GROUND PLATE
J44	RECEPTACLE, POWER MODULE, 2ND OUTPUT
J50	RECEPTACLE, POWER
J51	RECEPTACLE, ENGINE INTERFACE (EIB)
J52	RECEPTACLE, ENGINE SPECIFIC PCB (ESB)
J53	RECEPTACLE, REGULATOR PCB (REG)
J54	RECEPTACLE, CONTROL PCB (CTRL)
K1	CONTACTOR, #1 A.C. OUTPUT
K104	RELAY, AIR INTAKE, HEATER
K201	CONTACTOR, #2 A.C. OUTPUT (WHEN FURNISHED)
L1	FIELD, REVOLVING, GENERATOR
L2	FIELD, EXCITER, GENERATOR
L9	SOLENOID, STARTER
L10	SOLENOID, STARTER, AUXILIARY
M1	AMMETER, A.C. GENERATOR
M2	VOLTMETER, A.C. GENERATOR
M3	FREQUENCY METER
M4	RUNNING TIME METER, ENGINE−GENERATOR
M5	VOLTMETER, BATTERY
M6	GAUGE, FAULT CODE
M13	GAUGE, FUEL, ELECTRIC
M24	GAUGE, WATER TEMPERATURE
M25	GAUGE, OIL PRESSURE
MD1	SWITCH, MASTER DISCONNECT
P44	PLUG, 2ND OUTPUT (WHEN FURNISHED)
P50	PLUG, POWER
P51	PLUG, ENGINE INTERFACE BOARD
P52	PLUG, ENGINE SPECIFIC BOARD
P53	PLUG, REGULATOR PCB TO POWER MODULE
P54	PLUG, CONTROL BOARD
PS1	POWER SUPPLY
R1	RESISTOR, ENGINE I.D., 1K, 1/4W, 1%
R2	RESISTOR, GENERATOR/KVA, I.D.
R3	RESISTOR, POWER MODULE I.D.
R55	SENDER, ELECTRIC FUEL GAUGE
S3	SWITCH, METER SELECTOR
S24	SWITCH, ENGINE START
S28	SWITCH, PUSHBUTTON, EMERGENCY STOP
S28A	SWITCH. EMERGENCY STOP, MALE CONNECTOR
S28B	SWITCH, EMERGENCY STOP, FEMALE CONNECTOR
S46	SWITCH, LUBE OIL PRESSURE ENGINE
S49	SWITCH. HIGH TEMPERATURE, ENGINE
S74	SWITCH, PUSHBUTTON, LAMPS AND FUEL CHECK
S75	SWITCH. PUSHBUTTON, OUTPUT NO. 1
S76	SWITCH, PUSHBUTTON, ENGINE STOP & ENGINE FAULT RESET
S77	SWITCH, PUSHBUTTON, TEST/RESET
S79	SWITCH, PUSHBUTTON, PRE−HEATER
S83	SWITCH. LOW COOLANT, (WHEN FURNISHED)
S275	SWITCH. PUSHBUTTON, OUTPUT NO. 2 (WHEN FURNISHED)
TB1	TERMINAL BLOCK, POWER MODULE
TB2	TERMINAL BLOCK, OPTIONS

DISTRIBUTION TABLE	
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–	–
OUTSIDE DISTR.	

CHANGE RECORD		–
E.C. No.	DATE	
1) 46766A	01/06/11	

FILE NAME	PLOT DATE
231331S4	01/06/11

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS
TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS.
DO NOT SCALE DRAWING.

FRACT. INCH	± –	ANGLES	± 3'
DECIMAL-INCH		METRIC	
.00	± .03	0.0	±0.8mm
.000	± .010	0.00	±0.25mm

FINISH CODE PER 289181: NONE

ACTIVITY	REPLACED BY	REPLACES
–	–	–
MATERIAL NO.	QUANTITY-U.M.	COMM. CLS.
–	–	–

MATERIAL SPEC.
–

TITLE
DIAGRAM, SCHEMATIC & CONNECTION

DESCRIPTIVE DATA
60CU20 AND 90CU420 TIER 3 CUMMINS

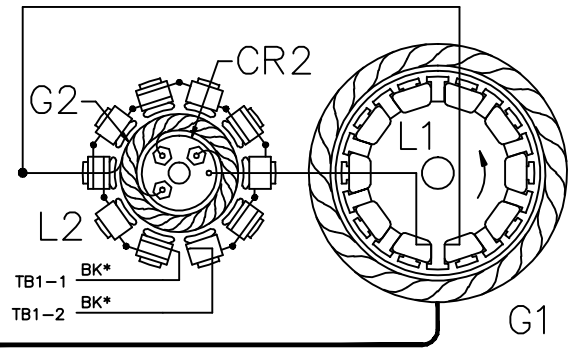
DESIGNED	DRAWN	DATE	SCALE
JNP	JNP	11-20-09	NONE
CHECKED	APPROVED	RECORDS	ITEM TYPE
–	–	4/9/10	–

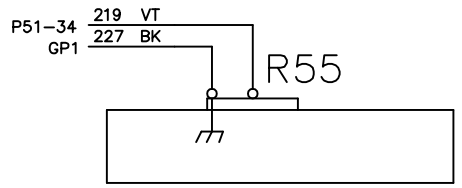
ITW GSE GROUP U.S.A.

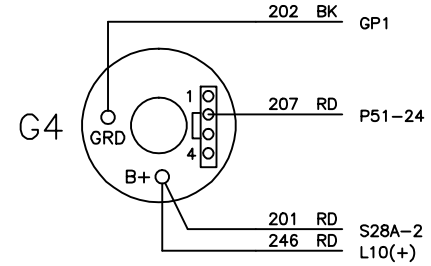
SIZE D | DWG. NO. 291331 | SHEET 4 OF 7

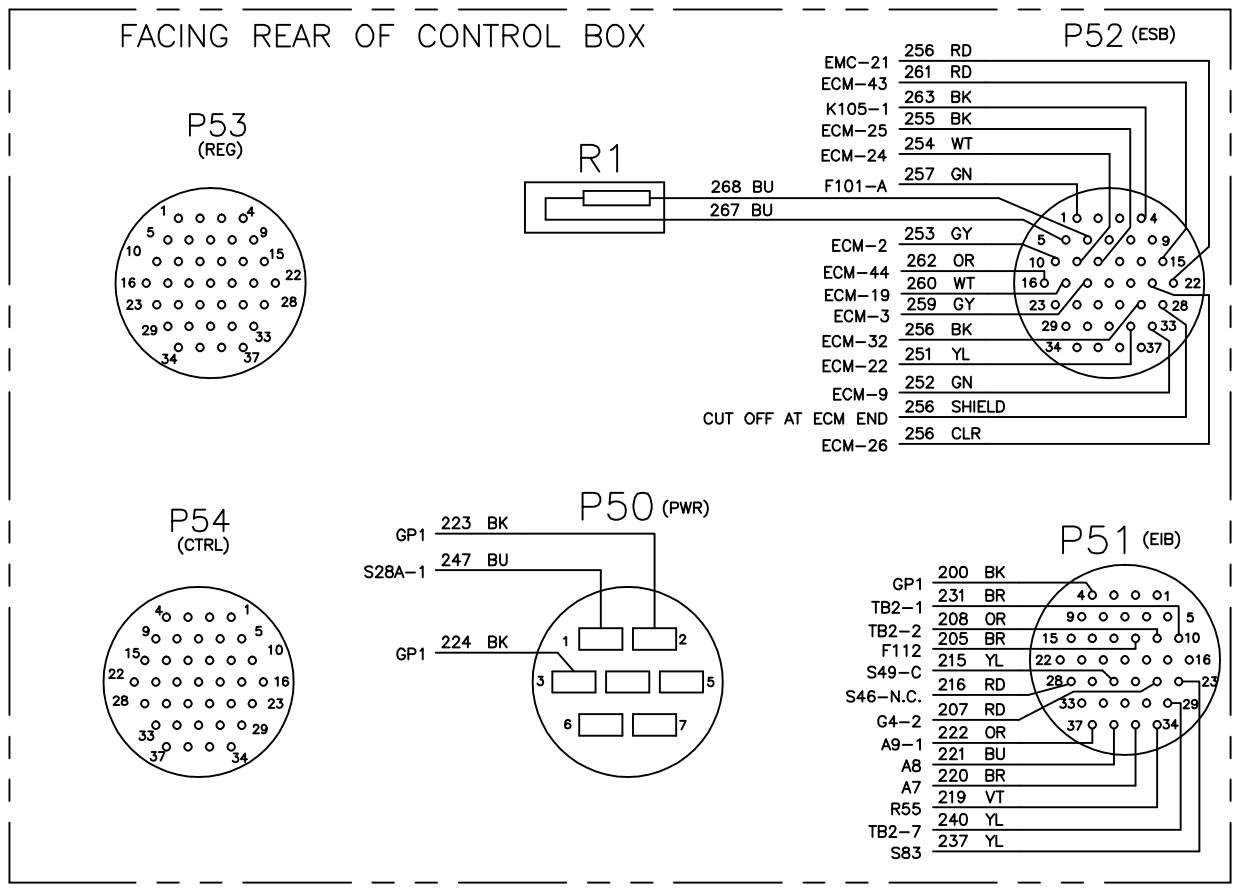
NOTES:

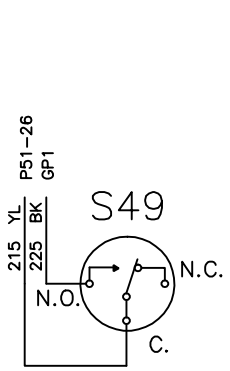
1. * WIRES FURNISHED.
2. WRAP TERMINAL ON WIRE 218 AND TUCK INTO HARNESS.

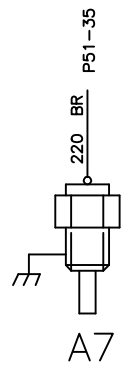


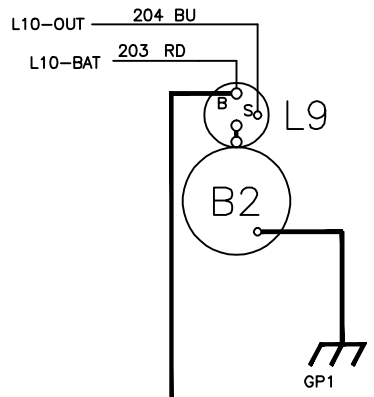


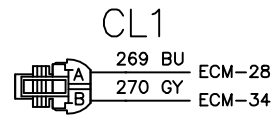


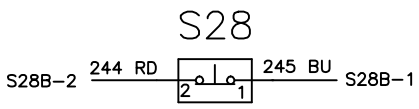


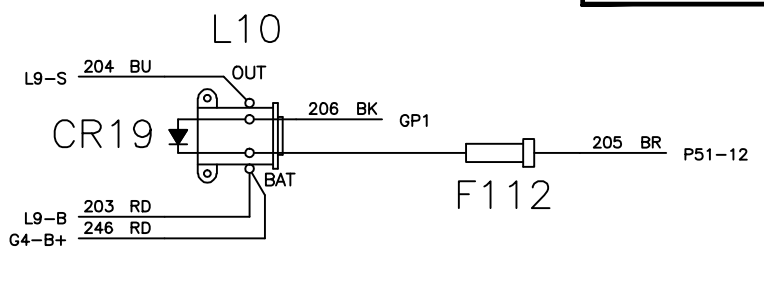


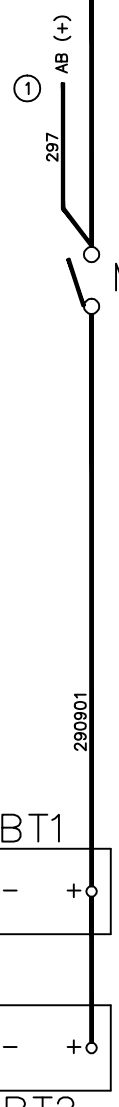


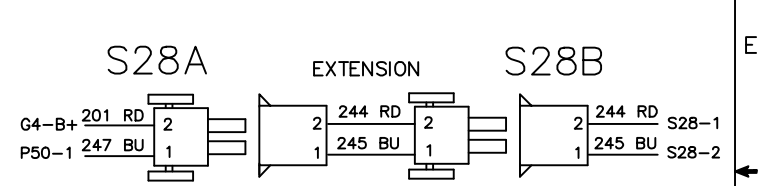


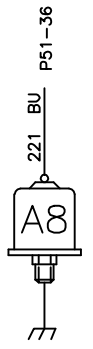


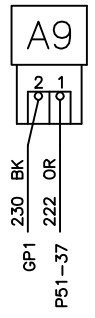


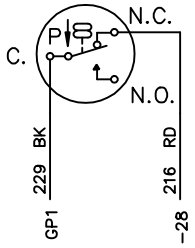


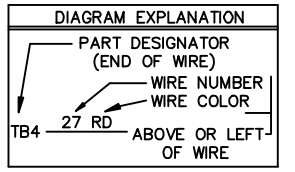




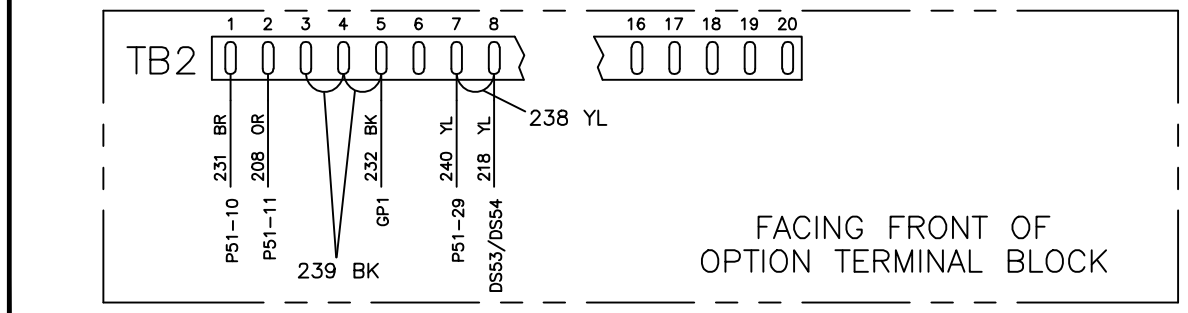


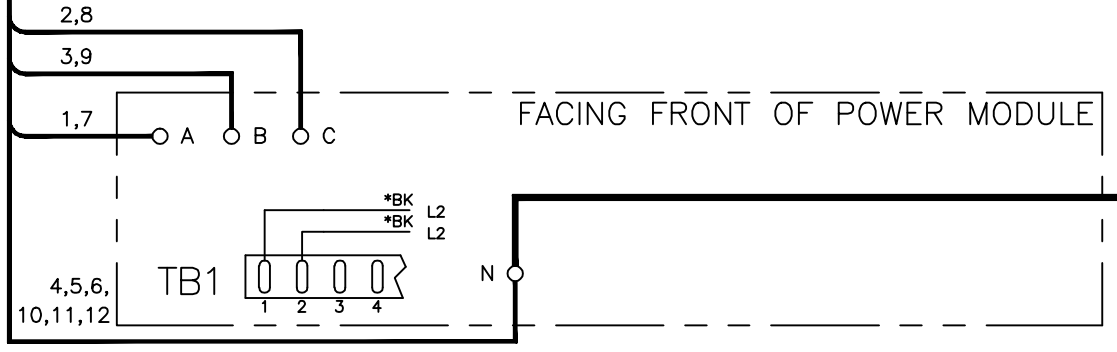


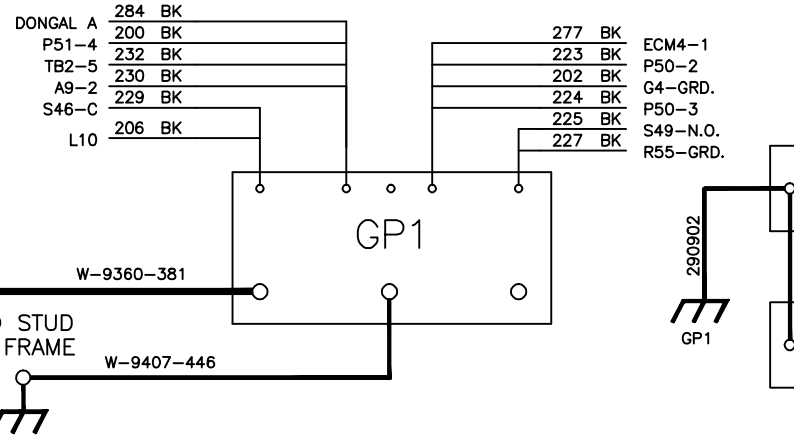


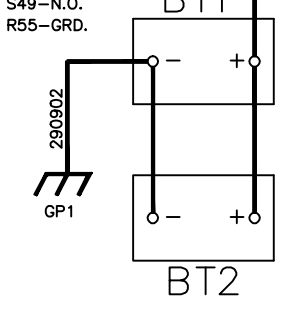


COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET(PURPLE)
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)









CHANGE RECORD									
E.C. No.	DATE	–			FINISH CODE PER 289181 NONE				
1) 4676AA	01/06/11	FILE NAME	PLOT DATE		ACTIVITY	REPLACED BY	REPLACES		
		291331S5	01/06/11		–	–	–		
		UNLESS OTHERWISE SPECIFIED			MATERIAL NO.	QUANTITY–U.M.	COMM. CLS.		
		DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.			–	–	–		
					MATERIAL SPEC.				
					–				
		FRACT± –	ANGLES ± 3'		TITLE				
		DECIMAL–INCH	METRIC		DIAGRAM, SCHEMATIC & CONNECTION				
		.00 ± .03	0.0 ±0.8mm		DESCRIPTIVE DATA				
		.000 ± .010	0.00 ±0.25mm		60CU20 AND 90CU420 TIER 3 CUMMINS				
					DESIGNED JNP	DRAWN JNP	DATE 11–20–09	SCALE NONE	
					CHECKED JTLP	APPROVED –	RELEASED 4/9/10	ITEM TYPE –	

ITW GSE GROUP U.S.A.

SIZE D | DWG. NO. 291331 | SHEET 5 OF 7

OUTSIDE DISTR.	DISTRIBUTION TABLE
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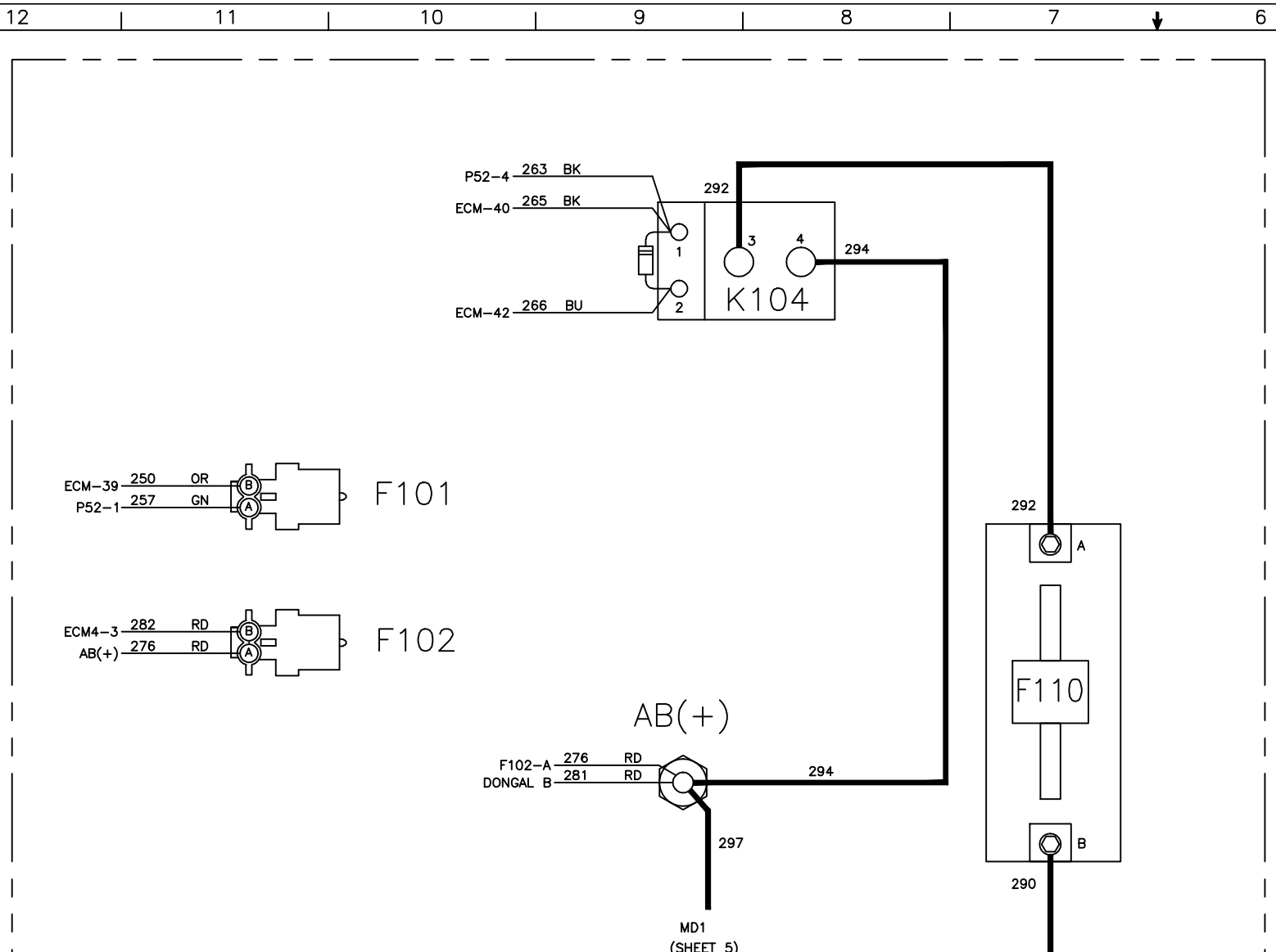
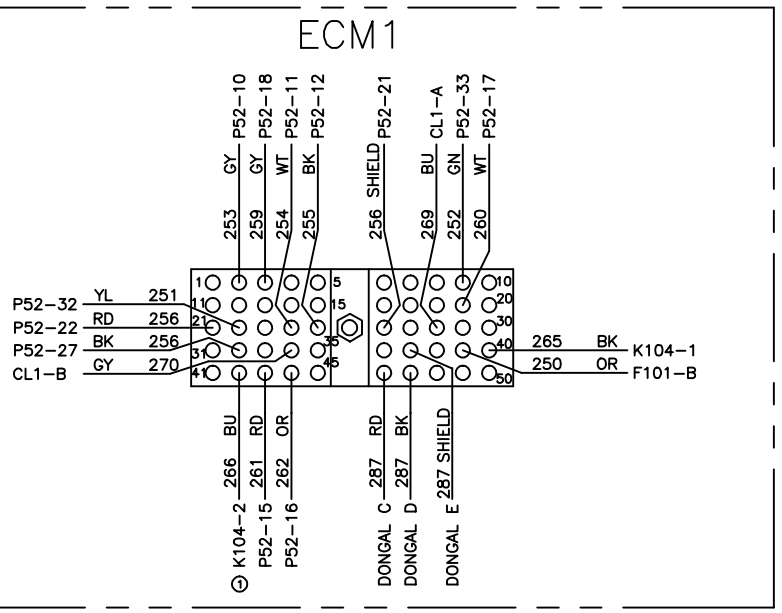


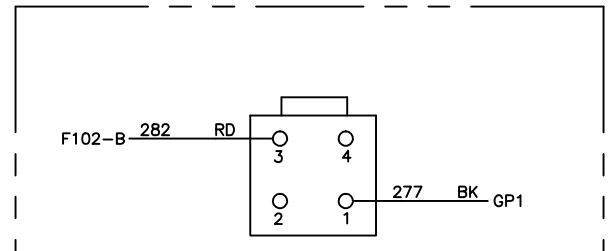
CONTACTOR FUSE PANEL

LOCATED ON LEFT SIDE OF UNIT



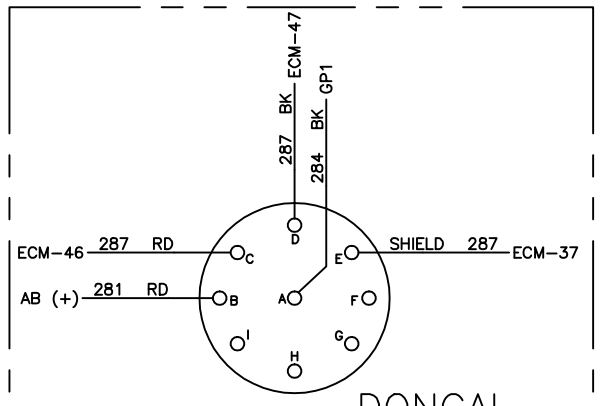
ELECTRONIC CONTROL MODULE (MAIN)

LOCATED ON LEFT SIDE OF ENGINE



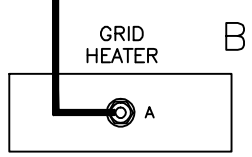
ELECTRONIC CONTROL MODULE (POWER)

LOCATED ON LEFT SIDE OF ENGINE



ELECTRONIC CONTROL MODULE (DONGAL)

LOCATED ON THE BULKHEAD



ELECTRONIC ENGINE

COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)

DIAGRAM EXPLANATION

PART DESIGNATOR (END OF WIRE)

WIRE NUMBER

WIRE COLOR

TB4 27 RD ABOVE OR LEFT OF WIRE

CHANGE RECORD					
E.C. No.	DATE	–			
1) 4676AA	01/06/11	FILE NAME	PLOT DATE	ACTIVITY	REPLACED BY
		291331S6	01/06/11	–	–
		UNLESS OTHERWISE SPECIFIED		MATERIAL NO.	QUANTITY-LI.st.
		DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.		–	–
		FRACT.-± –	ANGLES ± 3'	MATERIAL SPEC. –	
		DECIMAL-INCH	METRIC	TITLE DIAGRAM, SCHEMATIC & CONNECTION	
		.00 ± .03	0.0 ±0.8mm	DESCRIPTIVE DATA 60CU20 AND 90CU420 TIER 3 CUMMINS	
		.000 ± .010	0.00 ±0.25mm	DESIGNED JNP	DRAWN JNP
				CHECKED	APPROVED
				–	–

FINISH CODE PER 289181 NONE

ACTIVITY	REPLACED BY	REPLACES
–	–	–
MATERIAL NO.	QUANTITY-LI.st.	COMM'L CLS.
–	–	–

DATE	SCALE
11-20-09	NONE
RECORDS	ITEM TYPE
4/9/10	–

OUTSIDE DISTR.	
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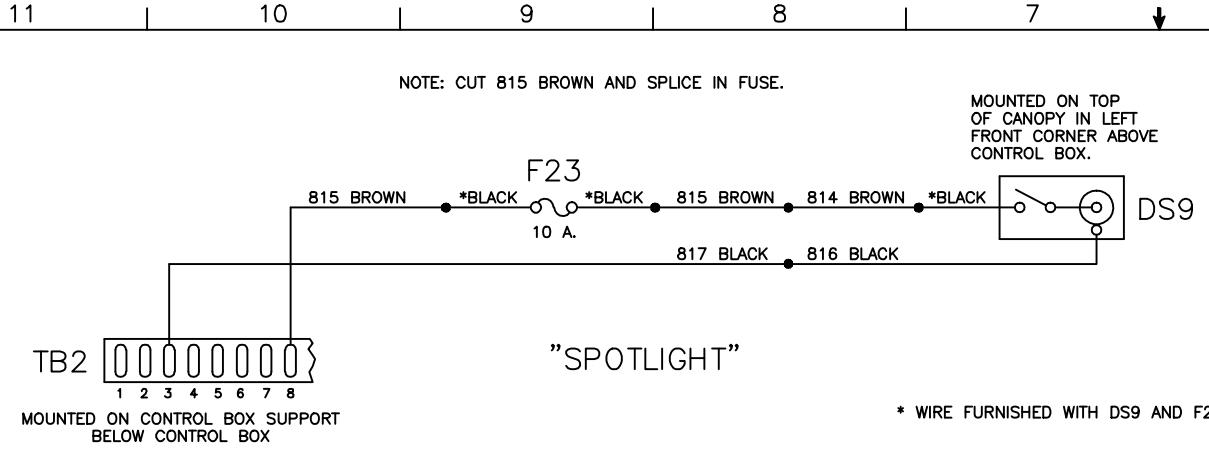
DISTRIBUTION TABLE

ITW GSE GROUP U.S.A.

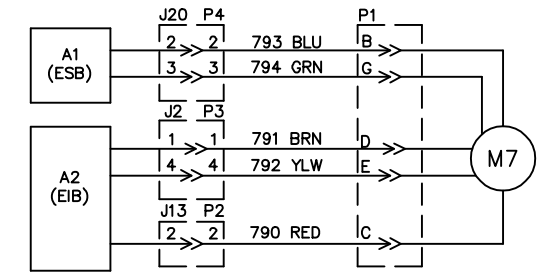
SIZE D

DWG. NO. 291331 SHEET 6 OF 7

NOTE: CUT 815 BROWN AND SPLICE IN FUSE.

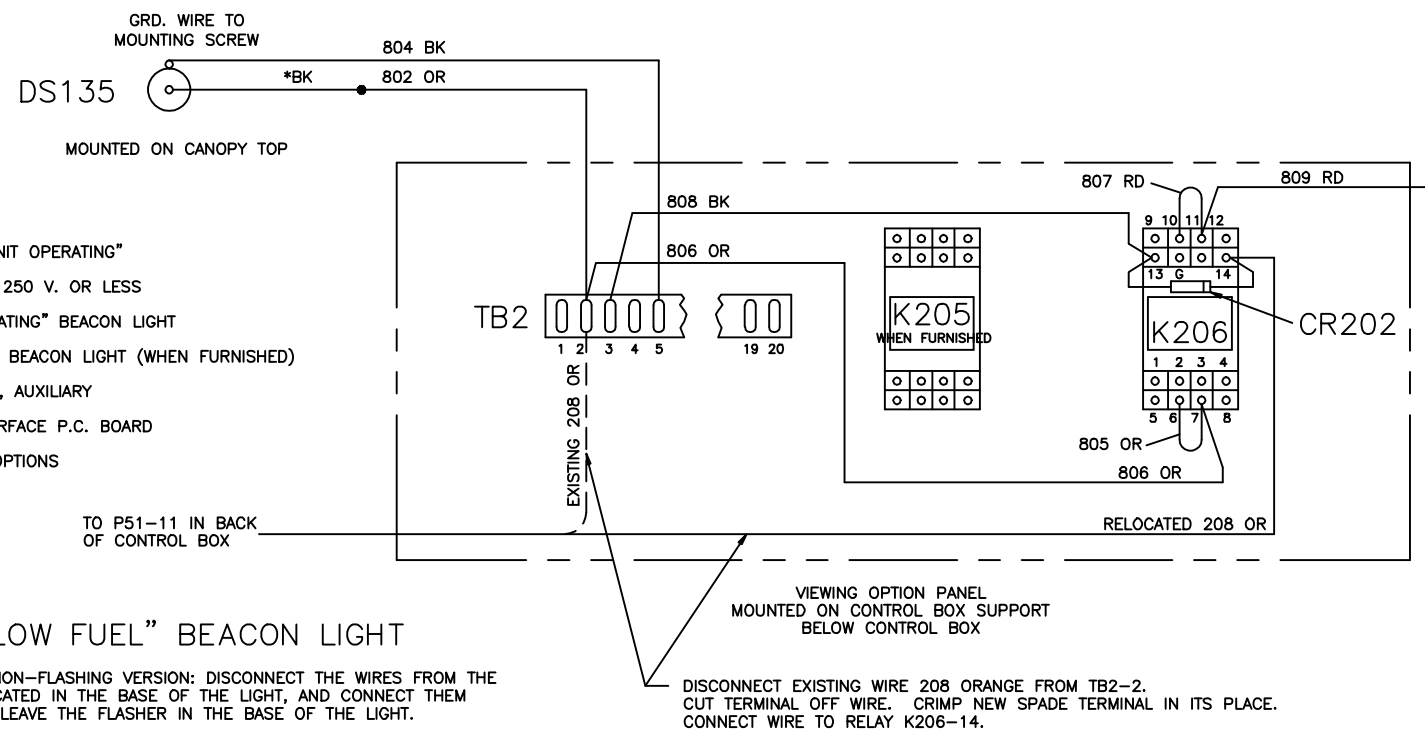


* WIRE FURNISHED WITH DS9 AND F23



CAN–BUS METER

(THIS METER WILL REPLACE M4 RUNNING TIME METER)



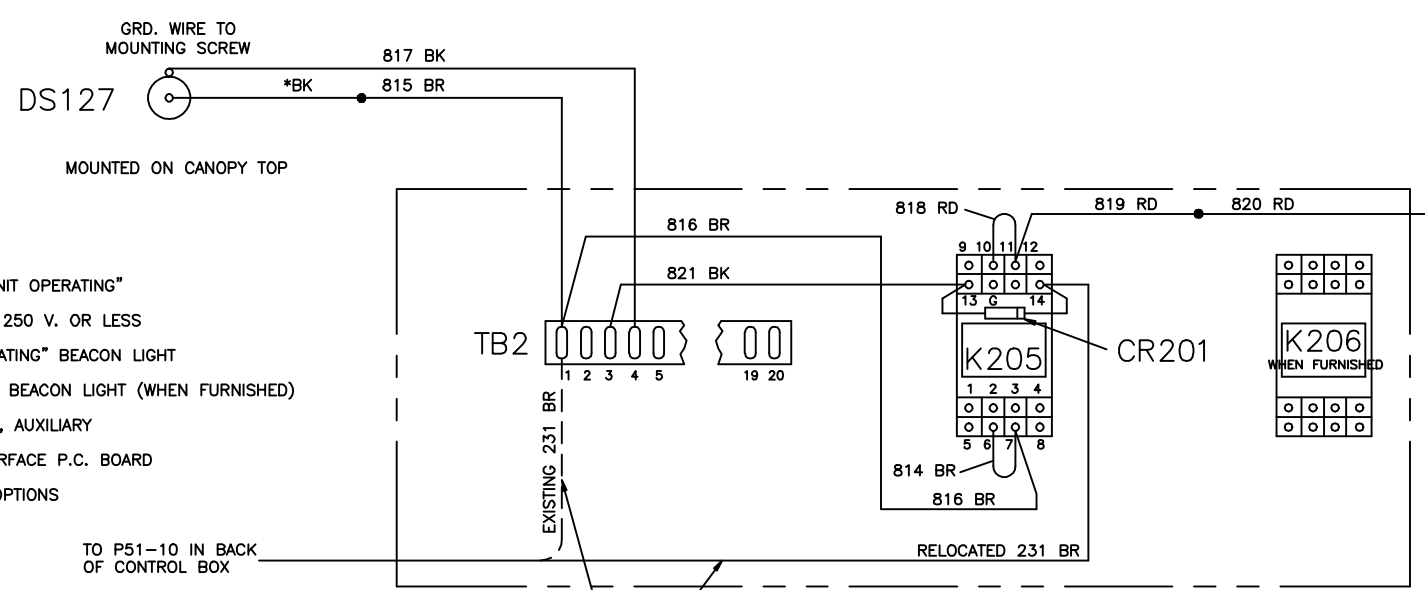
LEGEND

CR201	DIODE
DS127	LIGHT, BEACON, "UNIT OPERATING"
F201	FUSE, AGC, 10 A., 250 V. OR LESS
K205	RELAY, "UNIT OPERATING" BEACON LIGHT
K206	RELAY, "LOW FUEL" BEACON LIGHT (WHEN FURNISHED)
L10	SOLENOID, STARTER, AUXILIARY
P51	PLUG, ENGINE INTERFACE P.C. BOARD
TB2	TERMINAL BLOCK, OPTIONS

"LOW FUEL" BEACON LIGHT

NOTE: FOR NON–FLASHING VERSION: DISCONNECT THE WIRES FROM THE FLASHER LOCATED IN THE BASE OF THE LIGHT, AND CONNECT THEM TOGETHER. LEAVE THE FLASHER IN THE BASE OF THE LIGHT.

DISCONNECT EXISTING WIRE 208 ORANGE FROM TB2–2. CUT TERMINAL OFF WIRE. CRIMP NEW SPADE TERMINAL IN ITS PLACE. CONNECT WIRE TO RELAY K206–14.



"UNIT OPERATING" BEACON LIGHT

NOTE: FOR NON–FLASHING VERSION: DISCONNECT THE WIRES FROM THE FLASHER LOCATED IN THE BASE OF THE LIGHT, AND CONNECT THEM TOGETHER. LEAVE THE FLASHER IN THE BASE OF THE LIGHT.

DISCONNECT EXISTING WIRE 231 BROWN FROM TB2–1. CUT TERMINAL OFF WIRE. CRIMP NEW SPADE TERMINAL IN ITS PLACE. CONNECT WIRE TO RELAY K205–14.

DISTRIBUTION TABLE	
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OUTSIDE DISTR.	

CHANGE RECORD		–	FINISH CODE PER 289181 NONE		
E.C. No.	DATE	FILE NAME / PLOT DATE	ACTIVITY	REPLACED BY	REPLACES
1) 4676AA	01/06/11	291331S7 01/06/11	–	–	–
		UNLESS OTHERWISE SPECIFIED	MATERIAL NO. –	QUANTITY–U.M. –	COMM. CLS. –
		DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.	MATERIAL SPEC. –		
		FRACT.–INCH ± – ANGLES ± 3'	TITLE DIAGRAM, SCHEMATIC & CONNECTION		
		DECIMAL–INCH .00 ± .03 .000 ± .010 METRIC 0.0 ±0.8mm 0.00 ±0.25mm	DESCRIPTIVE DATA 60CU20 AND 90CU420 TIER 3 CUMMINS		
			DESIGNED JNP	DRAWN JNP	DATE 11–20–09
			CHECKED –	APPROVED –	RECORDS 4/9/10
			SCALE NONE	ITEM TYPE –	

ITW GSE GROUP U.S.A.

SIZE D DWG. NO. SHEET 7 OF 7 291331

USE ONLY WHEN M1, M2, & M3 METERS ARE ANALOG

A1
ENGINE SPECIFIC BRD.
(ESB)

A2
(EIB)
ENGINE INTERFACE BRD.

A404
T-R BRD.
(TR)

A4
(REG)
REGULATOR BRD.

A3
(CTRL)
CONTROL BRD.

J52 J20 J11 P11 J10 P10 PT1 J12 J1 P1 J2 J4 J3 J5 J6 J7 J401 F1 J6 P6 P3 J3 P2 J2 J1 P1 J53 P5 J5 M3 - LT. 718 BR M3 - RT. 720 OR P7 J7 J450-1 690 BR J450-3 691 OR J450-7 692 GN J450-9 693 VT F1 F2 F3 P2 J2 P3 J3 P4 J4 P6 J6 P1 J1 J51 PT1 PT2 J8 P8 J9 P9 J50 J450 PT3 J54 J7 J5 P4 J4 P1 J1 P6 J6 P3 J3 P2 J2 P14 J14 J13 J12 J11 P11 J10 P10

567 RD	A2-J10-1
568 BK	A2-J10-2
569 GN	A2-J10-3
570 WT	A2-J10-4
665 SHIELD	
664 WT	
663 GN	
662 BK	
661 RD	

657 BR	A4-J6-1
658 RD	A4-J6-2
659 OR	A4-J6-3
660 YL	A4-J6-4

524 BR	
525 RD	
526 OR	
527 YL	
528 GN	
529 BU	
530 VT	
531 GY	
532 WT	
533 BK	

651 BR	A404-J1-1
652 RD	A404-J1-2
653 OR	A404-J1-3
654 YL	A404-J1-4
655 GN	A404-J1-5
656 BU	A404-J1-6

733 BR	A5-J7-1
734 RD	A5-J7-2
735 OR	A5-J7-3
736 YL	A5-J7-4
737 GN	A5-J7-5
738 BU	A5-J7-6

545 BR	A4-J1-1
546 RD	A4-J1-2
547 OR	A4-J1-3
548 YL	A4-J1-4
549 GN	A4-J1-5
550 BU	A4-J1-6

539 BR	A3-J3-1
540 RD	A3-J3-2
541 OR	A3-J3-3
542 YL	A3-J3-4
543 GN	A3-J3-5
544 BU	A3-J3-6

551 BR	PS1- (-Vin)
552 RD	PS1- (+5V)
553 OR	PS1- (+12V)
554 YL	PS1- (+Vin)

656 BU	A2-J4-6
655 GN	A2-J4-5
654 YL	A2-J4-4
653 OR	A2-J4-3
652 RD	A2-J4-2
651 BR	A2-J4-1

574 BK	
572 BU	
CHASSIS STUD	
573 BK	

500 BR	CB7-LINE
501 RD	CB4-LINE
502 OR	CB11-LINE
503 YL	CB7-LOAD
504 GN	CB4-LOAD
505 BU	CB11-LOAD

692 GN	A4-J7-5
690 BR	A4-J7-1
691 OR	A4-J7-3
693 VY	A4-J7-7

579 BR	A3-J2-1
580 RD	A3-J2-2
581 OR	A3-J2-3
582 YL	A3-J2-4
583 GN	A3-J2-5
584 BU	A3-J2-6
585 VT	A3-J2-7
586 GY	A3-J2-8

539 BR	A2-J6-1
540 RD	A2-J6-2
541 OR	A2-J6-3
542 YL	A2-J6-4
543 GN	A2-J6-5
544 BU	A2-J6-6

579 BR	A2-J9-1
580 RD	A2-J9-2
581 OR	A2-J9-3
582 GN	A2-J9-4
583 YL	A2-J9-5
584 BU	A2-J9-6
585 VT	A2-J9-7
586 GY	A2-J9-8

710 BR	M5-I
709 BK	M24-G
708 WT	M4+
707 GY	G MTR LITE 2
706 VT	G MTR LITE 1
705 BU	E MTR LITE
704 GN	M25-I
703 YL	M5-S
702 OR	M25-S
701 RD	M13-S
700 BR	GROUND

565 WT	A4-J3-4
564 GN	A4-J3-3
563 BK	A4-J3-2
562 RD	A4-J3-1

571 SHIELD	
570 WT	A1-J11-4
569 GN	A1-J11-3
568 BK	A1-J11-2
567 RD	A1-J11-1

562 RD	A2-J11-1
563 BK	A2-J11-2
564 GN	A2-J11-3
565 WT	A2-J11-4
566 SHIELD	

557 RD	
558 BK	
559 GN	
560 WT	
561 SHIELD	

727 BK	A5-J1-1
728 WT	A5-J1-2
729 RED	A5-J1-3
730 GN	A5-J1-4
731 BR	A5-J1-5
732 SHIELD	

523 BU	
522 GN	
521 YL	
520 OR	
519 RD	
518 BK	
517 WT	
516 GY	
515 VT	
514 BU	
513 GN	
512 YL	
511 OR	
510 RD	
509 BK	
508 BR	

657 BR	A404-J6-1
658 RD	A404-J6-2
659 OR	A404-J6-3
660 YL	A404-J6-4

545 BR	A2-J5-1
546 RD	A2-J5-2
547 OR	A2-J5-3
548 YL	A2-J5-4
549 GN	A2-J5-5
550 BU	A2-J5-6

NOTE: LABEL MUST BE FACING THIS DIRECTION.

PS1 (ACON): TRIM, +5V, COM, +12, −12V; ENABLE, CASE, +VIN, −VIN, N/C

A2-J7-2 552 RD
A2-J7-3 553 OR
554 YL A2-J7-4
551 BR A2-J7-1
599 BR

CB4 CB7 CB11 — LINE / LOAD

501 RD	A2-J8-2
504 GN	A2-J8-5
500 BR	A2-J8-1
503 YL	A2-J8-4
502 OR	A2-J8-3
505 BU	A2-J8-6

FACING INSIDE OF CONTROL BOX

COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)

DIAGRAM EXPLANATION
PART DESIGNATOR (END OF WIRE)
WIRE NUMBER
WIRE COLOR
TB4 27 RD ABOVE OR LEFT OF WIRE

CHANGE RECORD	
E.C. No.	DATE
1) 3226AA	4/6/04
2) 3257AA	05/10/04

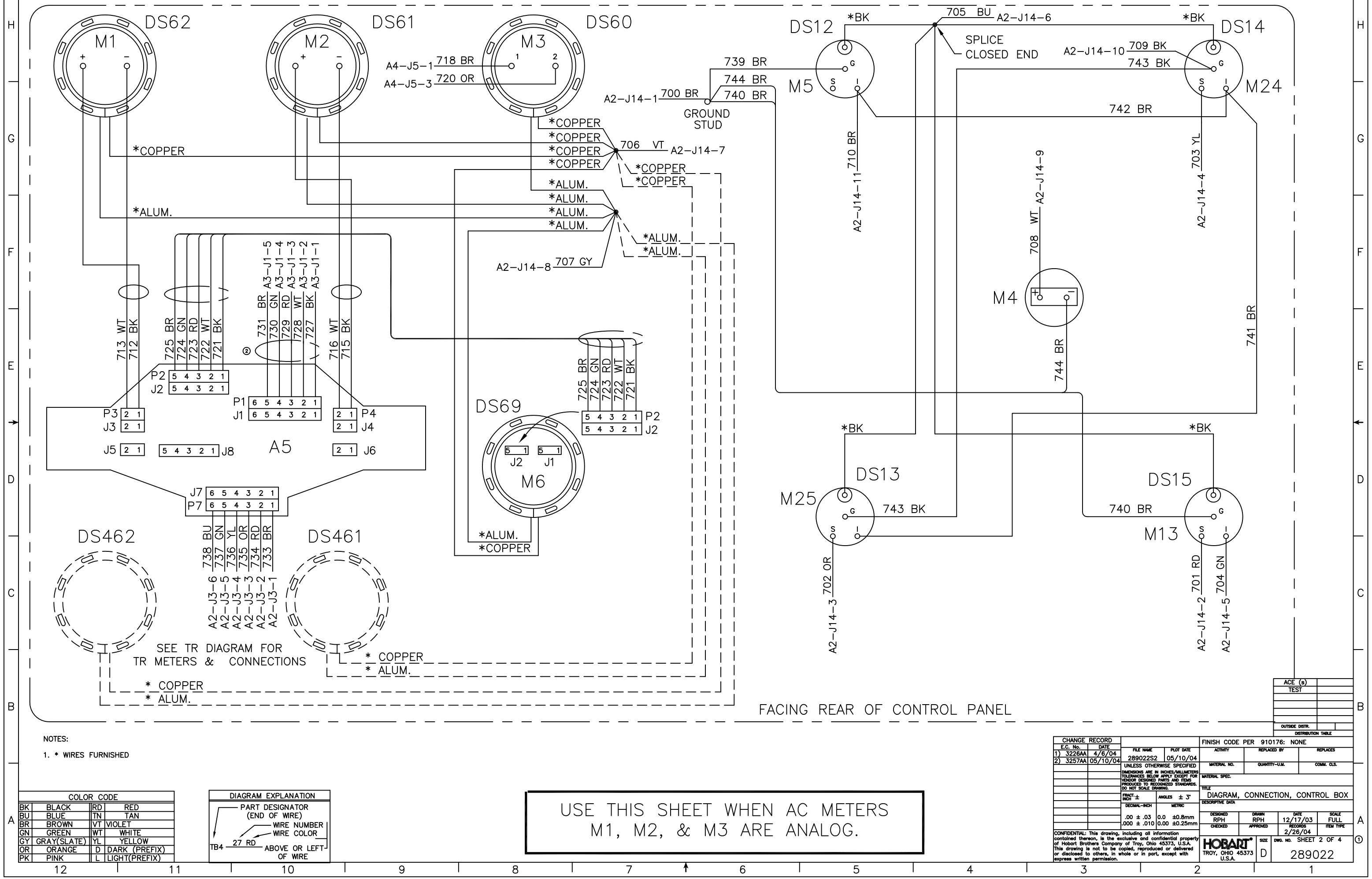
FILE NAME 289022S1 PLOT DATE 05/10/04
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS. TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.
FRACT. ± 1/64 ANGLES ± 3°
DECIMAL-INCH .00 ± .03 .000 ± .010
METRIC 0.0 ±0.8mm 0.00 ±0.25mm

FINISH CODE PER 910176: NONE
ACTIVITY | REPLACED BY | REPLACES
MATERIAL NO. | QUANTITY-U.M. | COMM. CLS.
MATERIAL SPEC.
TITLE: DIAGRAM, CONNECTION, CONTROL BOX
DESCRIPTIVE DATA

DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	12/17/03	FULL
CHECKED	APPROVED	RECORDS 2/26/04	ITEM TYPE

HOBART® TROY, OHIO 45373 U.S.A.
SIZE D DWG. NO. 289022 SHEET 1 OF 4 ①

OUTSIDE DISTR.
DISTRIBUTION TABLE



NOTES:

1. * WIRES FURNISHED

COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)

DIAGRAM EXPLANATION

PART DESIGNATOR (END OF WIRE)
WIRE NUMBER
WIRE COLOR
TB4 — 27 RD — ABOVE OR LEFT OF WIRE

USE THIS SHEET WHEN AC METERS M1, M2, & M3 ARE ANALOG.

CHANGE RECORD	
E.C. No.	DATE
1) 3226AA	4/6/04
2) 3257AA	05/10/04

FILE NAME: 289022S2 — PLOT DATE: 05/10/04

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS
TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS.
DO NOT SCALE DRAWING.

FRACT. ± INCH — ANGLES ± 3°
DECIMAL-INCH — METRIC
.00 ± .03 — 0.0 ±0.8mm
.000 ± .010 — 0.00 ±0.25mm

FINISH CODE PER 910176: NONE

ACTIVITY	REPLACED BY	REPLACES
MATERIAL NO.	QUANTITY-U.M.	COMM. CLS.

MATERIAL SPEC.

TITLE: DIAGRAM, CONNECTION, CONTROL BOX

DESCRIPTIVE DATA

DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	12/17/03	FULL
CHECKED	APPROVED	RECORDS 2/26/04	ITEM TYPE

HOBART® TROY, OHIO 45373 U.S.A.

SIZE D — DWG. NO. 289022 — SHEET 2 OF 4

ACE (s)
TEST
OUTSIDE DISTR.
DISTRIBUTION TABLE

LEGEND

A1	BOARD, P.C., ENGINE SPECIFIC (ESB)
A2	BOARD, P.C., ENGINE INTERFACE (EIB)
A3	BOARD, P.C., CONTROL (CTRL)
A4	BOARD, P.C., REGULATOR (REG)
A5	BOARD, P.C., LED (LED)
A404	BOARD, P.C., TRANSFORMER–RECTIFIER (TR) (WHEN FURNISHED)
CB4	CIRCUIT BREAKER, ENGINE ELECTRICAL, 10 A.
CB7	CIRCUIT BREAKER, CONTROL CIRCUIT, 5 A.
CB11	CIRCUIT BREAKER, MARKER LIGHTS, 10 A.
DS12	LIGHT, VOLTMETER, BATTERY (WHITE)
DS13	LIGHT, OIL PRESSURE GAUGE (WHITE)
DS14	LIGHT, TEMPERATURE GAUGE (WHITE)
DS15	LIGHT, FUEL GAUGE (WHITE)
DS60	LIGHT, STRIP, FREQUENCY METER
DS61	LIGHT, STRIP, AC AMMETER
DS62	LIGHT, STRIP, AC VOLTMETER
DS69	LIGHT, STRIP, FAULT METER
DS461	LIGHT, STRIP, DC AMMETER (WHEN FURNISHED)
DS462	LIGHT, STRIP, DC VOLTMETER (WHEN FURNISHED)
F1 ON A4	FUSE, 5 A., 250 V.
F2 ON A4	FUSE, 1 A., 250 V.
F3 ON A4	FUSE, 1 A., 250 V.
F1 ON A404	FUSE, 1 A., 250 V. (WHEN FURNISHED)
J50	RECEPTACLE, POWER
J51	RECEPTACLE, ENGINE INTERFACE (EIB)
J52	RECEPTACLE, ENGINE SPECIFIC (ESB)
J53	RECEPTACLE, REGULATOR (REG)
J54	RECEPTACLE, CONTROL (CTRL)
J401	RECEPTACLE, TRANSFORMER–RECTIFIER (WHEN FURNISHED)
J450	RECEPTACLE, REMOTE VOLTAGE SENSING (WHEN FURNISHED)
M1	AMMETER, A.C. GENERATOR
M2	VOLTMETER, A.C. GENERATOR
M3	FREQUENCY METER
M4	RUNNING TIME METER, ENGINE–GENERATOR
M5	VOLTMETER, BATTERY
M6	GAUGE, FAULT CODE
M13	GAUGE, FUEL ELECTRIC
M24	GAUGE, WATER TEMPERATURE
M25	GAUGE, OIL PRESSURE
①	
①	
PS1	POWER SUPPLY

ACE (s)	
TEST	
OUTSIDE DISTR.	

DISTRIBUTION TABLE

CHANGE RECORD	
E.C. No.	DATE
1) 3226AA	4/6/04
2) 3257AA	05/10/04

FILE NAME	PLOT DATE
289022S3	05/10/04

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS
TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS.
DO NOT SCALE DRAWING.

FRACT. INCH ±	ANGLES ± 3°
DECIMAL–INCH	METRIC
.00 ± .03	0.0 ±0.8mm
.000 ± .010	0.00 ±0.25mm

FINISH CODE PER 910176: NONE

ACTIVITY	REPLACED BY	REPLACES
MATERIAL NO.	QUANTITY–U.M.	COMM. CLS.

MATERIAL SPEC.
–

TITLE
DIAGRAM, CONNECTION, CONTROL BOX

DESCRIPTIVE DATA
90/120 DIGITAL CONTROLS

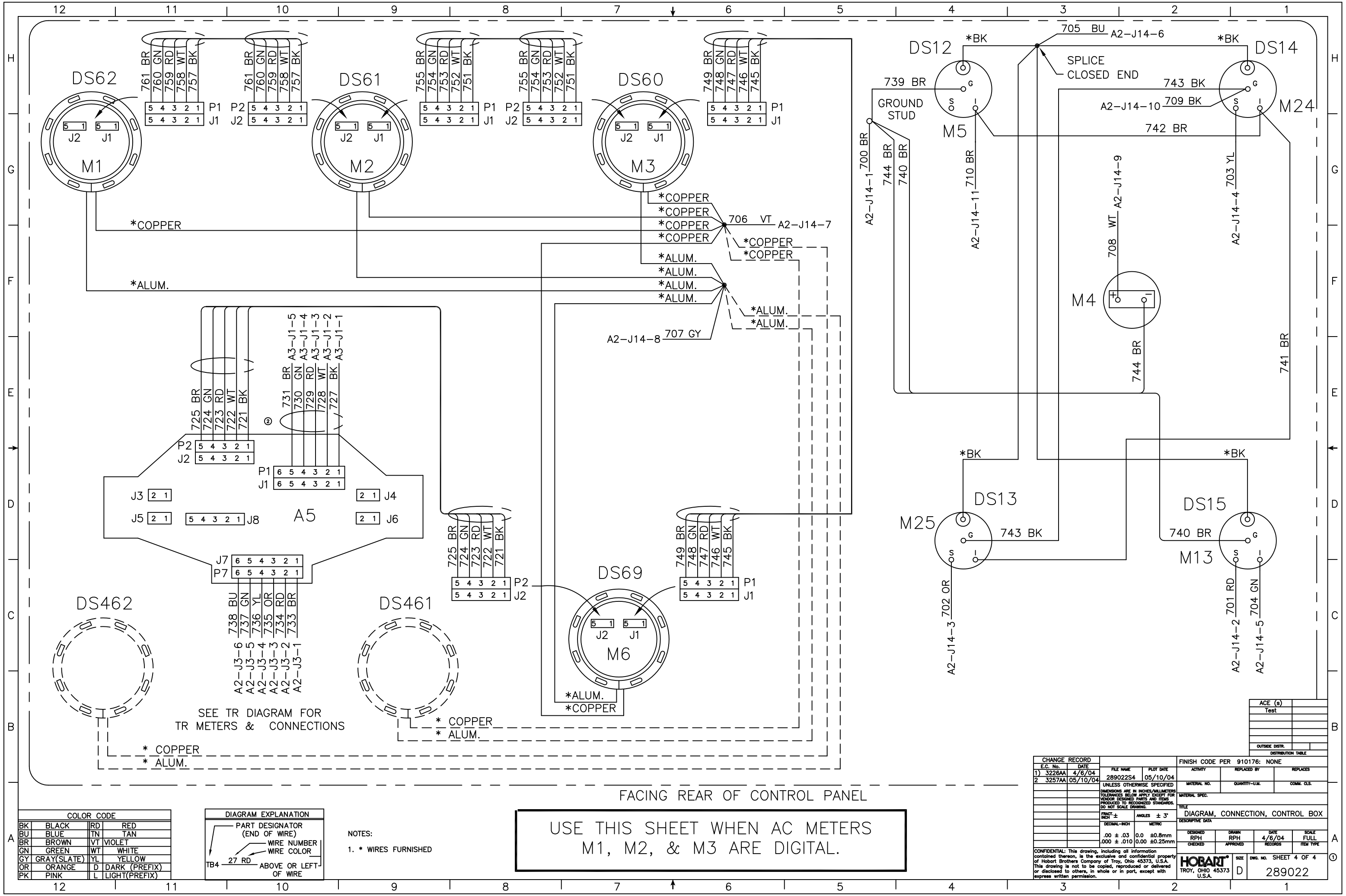
DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	2/23/04	FULL
CHECKED	APPROVED	RECORDS 2/26/04	ITEM TYPE

HOBART®
TROY, OHIO 45373
U.S.A.

SIZE C

DWG. NO. 289022 SHEET 3 OF 4

①



FACING REAR OF CONTROL PANEL

USE THIS SHEET WHEN AC METERS M1, M2, & M3 ARE DIGITAL.

COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)

DIAGRAM EXPLANATION

PART DESIGNATOR (END OF WIRE)
WIRE NUMBER
WIRE COLOR
TB4 — 27 RD — ABOVE OR LEFT OF WIRE

NOTES:

1. * WIRES FURNISHED

ACE (s)
Test
OUTSIDE DISTR.
DISTRIBUTION TABLE

CHANGE RECORD		
E.C. No.	DATE	
1) 3226AA	4/6/04	
2 3257AA	05/10/04	

FILE NAME 289022S4 PLOT DATE 05/10/04

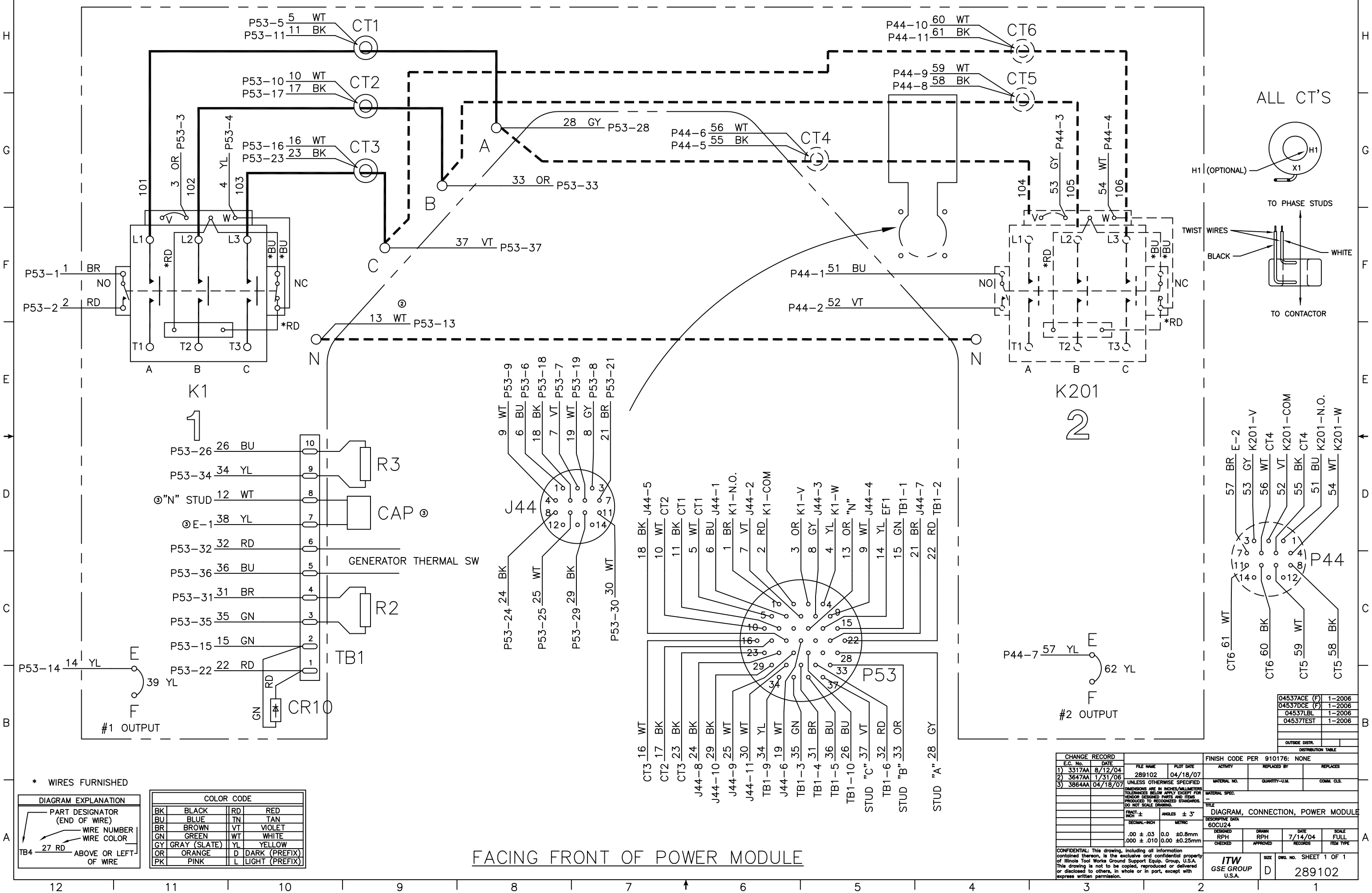
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.
FRACT. ± 1/64 INCH — ANGLES ± 3°
DECIMAL-INCH: .00 ± .03, .000 ± .010 — METRIC: 0.0 ±0.8mm, 0.00 ±0.25mm

FINISH CODE PER 910176: NONE
ACTIVITY | REPLACED BY | REPLACES
MATERIAL NO. | QUANTITY-U.M. | COMM. CLS.
MATERIAL SPEC.
TITLE: DIAGRAM, CONNECTION, CONTROL BOX
DESCRIPTIVE DATA

DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	4/6/04	FULL
CHECKED	APPROVED	RECORDS	ITEM TYPE

HOBART® TROY, OHIO 45373 U.S.A.

SIZE D — DWG. NO. 289022 — SHEET 4 OF 4



* WIRES FURNISHED

DIAGRAM EXPLANATION

PART DESIGNATOR (END OF WIRE)
WIRE NUMBER
WIRE COLOR
TB4 27 RD ABOVE OR LEFT OF WIRE

COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY (SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT (PREFIX)

FACING FRONT OF POWER MODULE

04537ACE (F)	1–2006
04537DCE (F)	1–2006
04537LBL	1–2006
04537TEST	1–2006
OUTSIDE DISTR.	

DISTRIBUTION TABLE

CHANGE RECORD		
E.C. No.	DATE	
1) 3317AA	8/12/04	
2) 3647AA	1/31/06	
3) 3864AA	04/18/07	

FILE NAME: 289102 — PLOT DATE: 04/18/07

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS
TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS.
DO NOT SCALE DRAWING.

FRACT.-INCH ± — ANGLES ± 3°
DECIMAL-INCH — METRIC
.00 ± .03 — 0.0 ±0.8mm
.000 ± .010 — 0.00 ±0.25mm

FINISH CODE PER 910176: NONE

ACTIVITY	REPLACED BY	REPLACES
MATERIAL NO.	QUANTITY–U.M.	COMM. CLS.

MATERIAL SPEC.
–

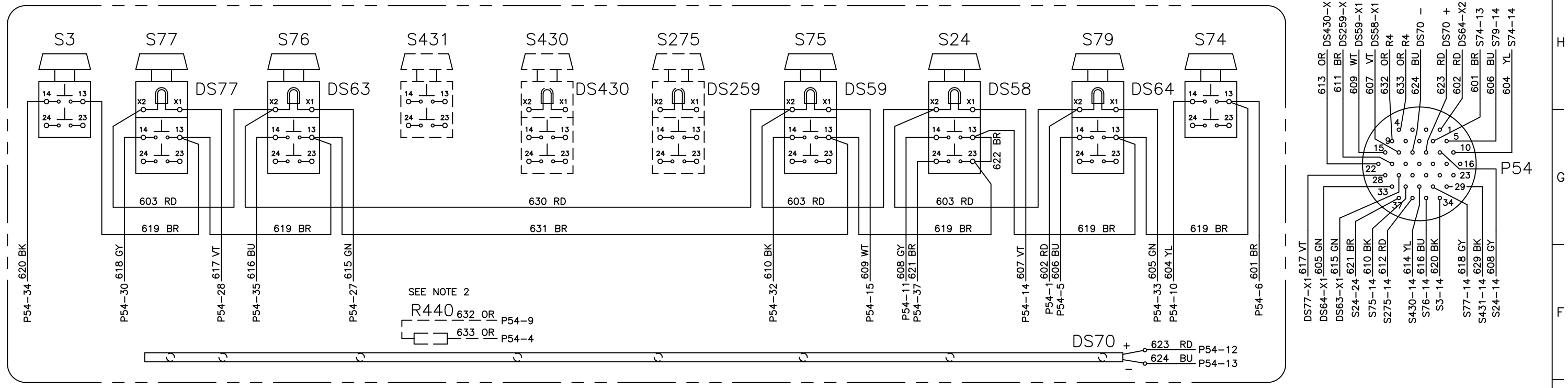
TITLE
DIAGRAM, CONNECTION, POWER MODULE

DESCRIPTIVE DATA
60CU24

DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	7/14/04	FULL
CHECKED	APPROVED	RECORDS	ITEM TYPE

ITW GSE GROUP U.S.A.

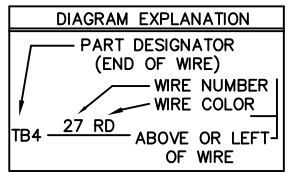
SIZE D — DWG. NO. 289102 — SHEET 1 OF 1



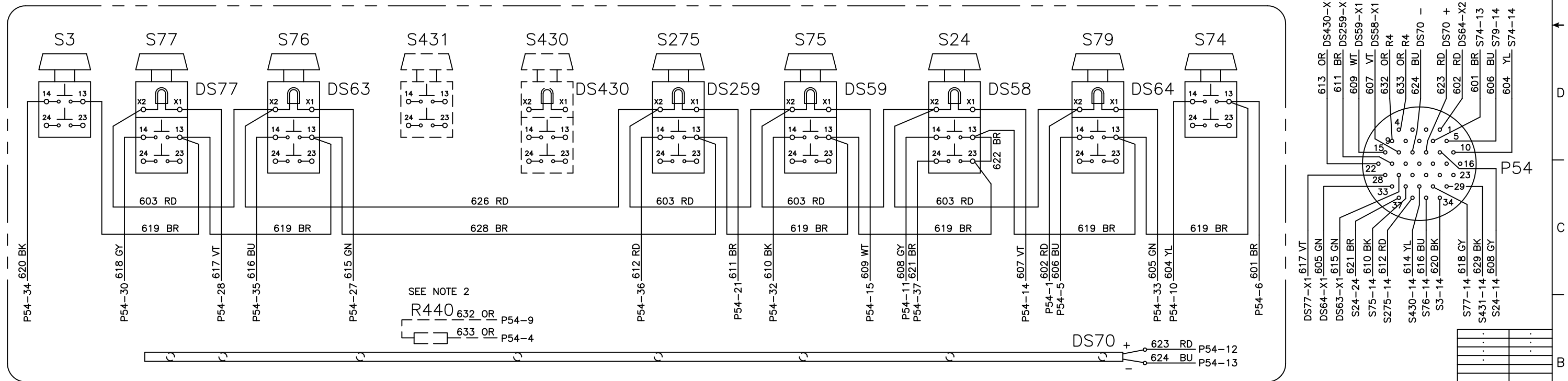
FACING REAR OF SWITCH BOX
1 A.C. OUTPUT

COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)

DIAGRAM EXPLANATION



① NOTE 2:
REMOVE RESISTOR R440 FROM HARNESS BY CUTTING WIRES 632 & 633. INSULATE ENDS OF WIRES WITH SHRINK TUBING.



FACING REAR OF SWITCH BOX
2 A.C. OUTPUTS

NOTES:

② 1. TIE ANY UNUSED WIRES INTO HARNESS AFTER REMOVING TERMINAL AND INSULATING END OF WIRE WITH SHRINK TUBING.

LEGEND

DS58	INDICATOR, PUSHBUTTON, ENGINE START (GREEN)	S3	SWITCH, METER SELECTOR
DS59	INDICATOR, PUSHBUTTON, #1 OUTPUT (YELLOW)	S24	SWITCH, ENGINE START
DS63	INDICATOR, PUSHBUTTON, DELAYED ENGINE SHUTDOWN (RED)	S74	SWITCH, PUSHBUTTON, LAMPS & FUEL CHECK
DS64	INDICATOR, PUSHBUTTON, PRE-HEATER, (ORANGE)	S75	SWITCH, PUSHBUTTON, #1 OUTPUT
DS77	INDICATOR, PUSHBUTTON, TEST/RESET, (RED)	S76	SWITCH, PUSHBUTTON, ENGINE STOP, DELAYED SHUTDOWN
DS259	INDICATOR, PUSHBUTTON, #2 OUTPUT (ORANGE) (WHEN FURNISHED)	S77	SWITCH, PUSHBUTTON, TEST/RESET
DS430	INDICATOR, PUSHBUTTON, DC OUTPUT, (BLUE), (WHEN FURNISHED)	S275	SWITCH, PUSHBUTTON, #2 OUTPUT, (WHEN FURNISHED)
		S430	SWITCH, PUSHBUTTON, DC OUTPUT, (WHEN FURNISHED)
①③R440	RESISTOR, 1K, T-R I.D.	S431	SWITCH, PUSHBUTTON, DC, STARTING CURRENT, (WHEN FURNISHED)

DISTRIBUTION TABLE	
OUTSIDE DISTR.	

CHANGE RECORD	
E.C. No.	DATE
1) RPH	2/12/04
2) 3226AA	4/6/04
3 3261AA	05/11/04

FILE NAME: 289013S1 PLOT DATE: 05/11/04

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS
TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS.
DO NOT SCALE DRAWING.

FRACT.± INCH ANGLES ± 3°
DECIMAL-INCH METRIC
.00 ± .03 0.0 ±0.8mm
.000 ± .010 0.00 ±0.25mm

FINISH CODE PER 910176: NONE

ACTIVITY	REPLACED BY	REPLACES
MATERIAL NO.	QUANTITY-U.M.	COMM. CLS.

MATERIAL SPEC.

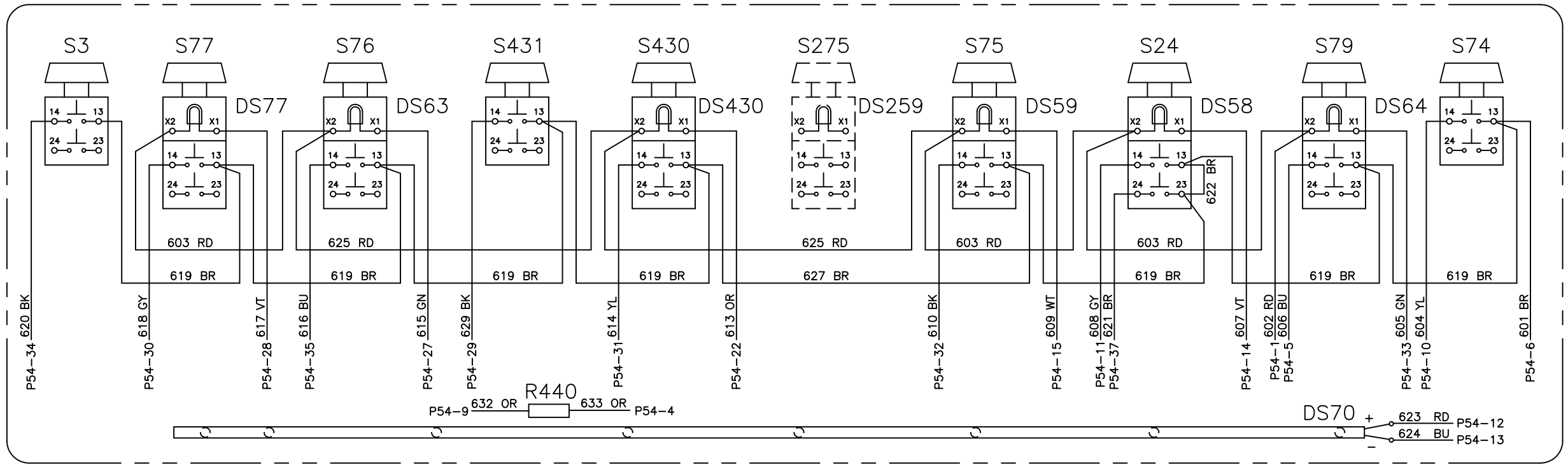
TITLE: DIAGRAM, CONNECTION, SWITCH BOX

DESCRIPTIVE DATA

DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	12/12/03	FULL
CHECKED	APPROVED	RECORDS 02/11/04	ITEM TYPE

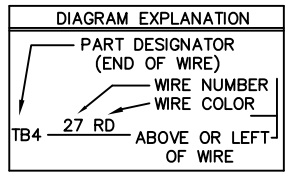
HOBART® TROY, OHIO 45373 U.S.A.

SIZE D DWG. NO. 289013 SHEET 1 OF 2

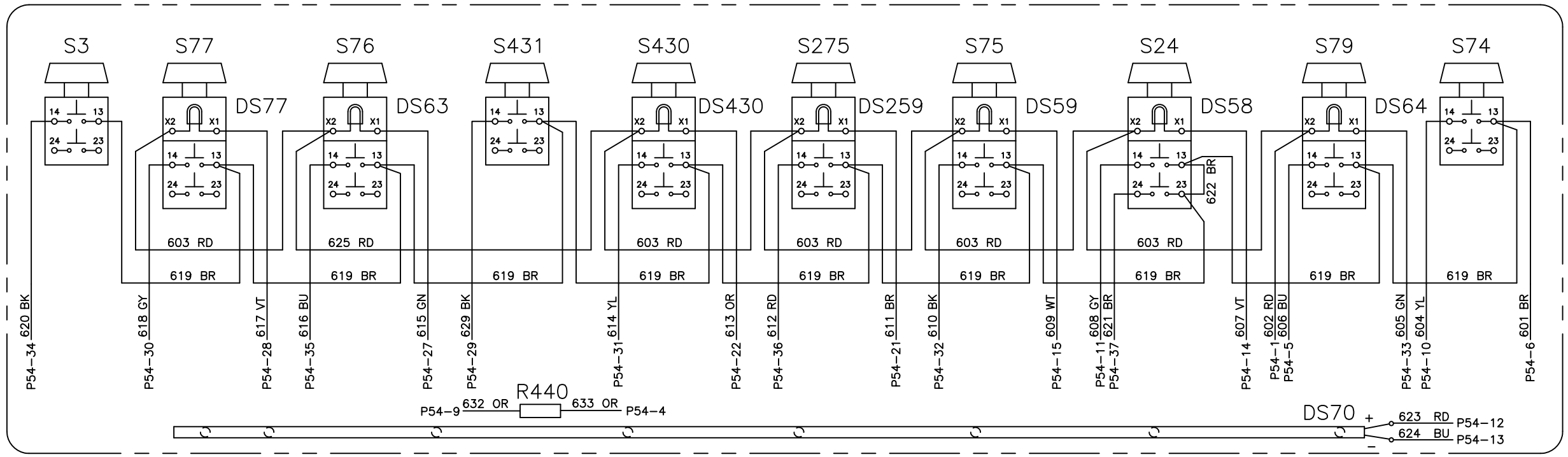


COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)

DIAGRAM EXPLANATION



FACING REAR OF SWITCH BOX
1 A.C. & 1 D.C. OUTPUT



FACING REAR OF SWITCH BOX
2 A.C. & 1 D.C. OUPUT

NOTES:

1. TIE ANY UNUSED WIRES INTO HARNESS AFTER REMOVING TERMINAL AND INSULATING END OF WIRE WITH SHRINK TUBING.

LEGEND

DS58	INDICATOR, PUSHBUTTON, ENGINE START (GREEN)
DS59	INDICATOR, PUSHBUTTON, #1 OUTPUT (YELLOW)
DS63	INDICATOR, PUSHBUTTON, DELAYED ENGINE SHUTDOWN (RED)
DS64	INDICATOR, PUSHBUTTON, PRE-HEATER, (ORANGE)
DS77	INDICATOR, PUSHBUTTON, TEST/RESET, (RED)
DS259	INDICATOR, PUSHBUTTON, #2 OUTPUT (ORANGE) (WHEN FURNISHED)
DS430	INDICATOR, PUSHBUTTON, DC OUTPUT, (BLUE), (WHEN FURNISHED)
③R440	RESISTOR, 1K, T-R I.D.
S3	SWITCH, METER SELECTOR
S24	SWITCH, ENGINE START
S74	SWITCH, PUSHBUTTON, LAMPS & FUEL CHECK
S75	SWITCH, PUSHBUTTON, #1 OUTPUT
S76	SWITCH, PUSHBUTTON, ENGINE STOP, DELAYED SHUTDOWN
S77	SWITCH, PUSHBUTTON, TEST/RESET
S79	SWITCH, PUSHBUTTON, PREHEATER
S275	SWITCH, PUSHBUTTON, #2 OUTPUT, (WHEN FURNISHED)
S430	SWITCH, PUSHBUTTON, DC OUTPUT, (WHEN FURNISHED)
S431	SWITCH, PUSHBUTTON, DC, STARTING CURRENT, (WHEN FURNISHED)

DISTRIBUTION TABLE	
04537ACE(F)	
04537DCE(F)	
04537LBL	
04537TEST	
OUTSIDE DISTR.	

CHANGE RECORD			
E.C. No.	DATE	FILE NAME	PLOT DATE
1) RPH	2/12/04	289013S2	05/11/04
2) 3226AA	4/6/04		
3) 3261AA	05/11/04		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS
TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS.
DO NOT SCALE DRAWING.

FRACT. INCH ±	ANGLES ± 3°
DECIMAL-INCH	METRIC
.00 ± .03	0.0 ±0.8mm
.000 ± .010	0.00 ±0.25mm

FINISH CODE PER 910176: NONE

ACTIVITY	REPLACED BY	REPLACES
MATERIAL NO.	QUANTITY-U.M.	COMM. CLS.

MATERIAL SPEC.

TITLE
DIAGRAM, CONNECTION, SWITCH BOX

DESCRIPTIVE DATA

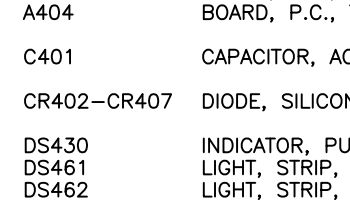
DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	12/12/03	FULL
CHECKED	APPROVED	RECORDS 02/11/04	ITEM TYPE

HOBART TROY, OHIO 45373 U.S.A.

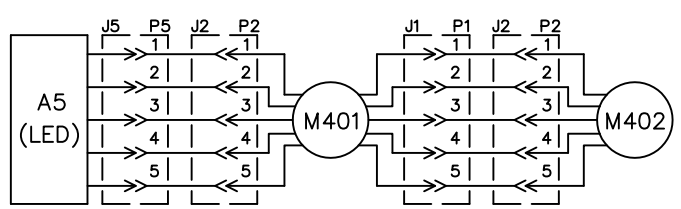
SIZE D | DWG. NO. 289013 | SHEET 2

LEGEND

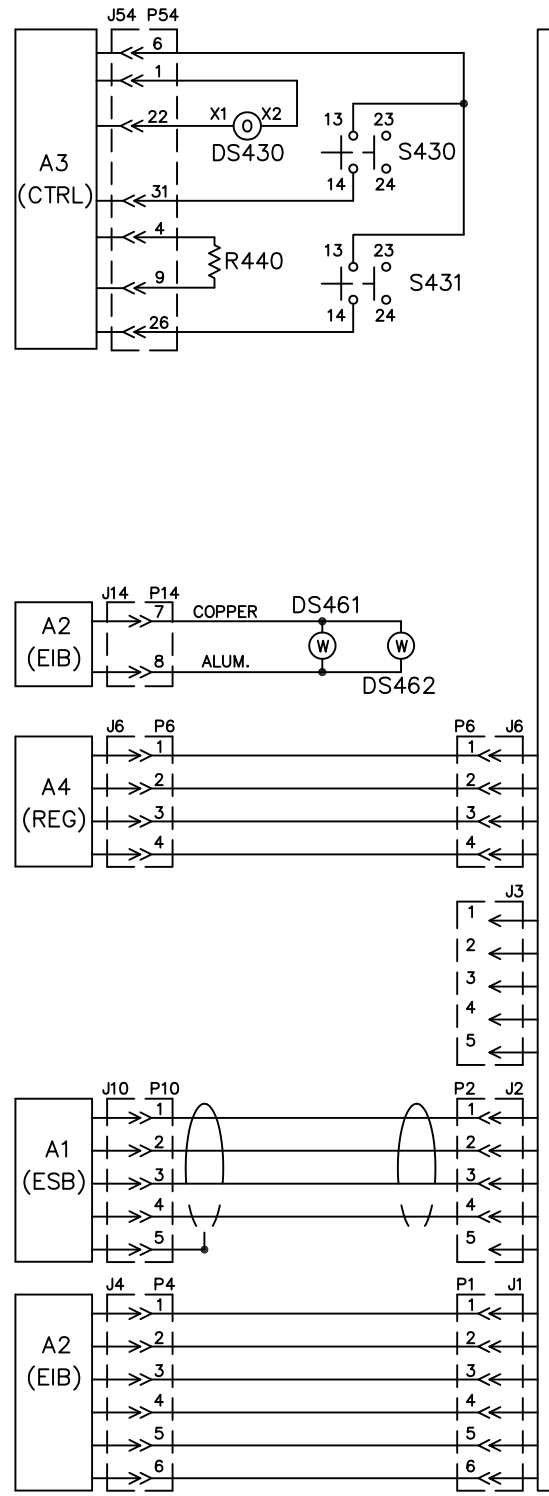
A1	BOARD, P.C., ENGINE SPECIFIC (ESB)
A2	BOARD, P.C., ENGINE INTERFACE (EIB)
A3	BOARD, P.C., CONTROL (CTRL)
A4	BOARD, P.C., REGULATOR, (REG)
A5	BOARD, P.C., LED (LED)
A401	BOARD, P.C., TR CAPACITOR (TRC)
A404	BOARD, P.C., TRANSFORMER–RECTIFIER (TR)
C401	CAPACITOR, AC CONTACTOR COIL
CR402–CR407	DIODE, SILICON, 275 A., POSITIVE BASE
DS430	INDICATOR, PUSHBUTTON, 28.5 VDC ON (BLUE)
DS461	LIGHT, STRIP, DC AMMETER (WHITE)
DS462	LIGHT, STRIP, DC VOLTMETER (WHITE)
K401	CONTACTOR, AC INPUT, TR
K402	CONTACTOR, DC OUTPUT
L401	INDUCTOR, DC
M401	AMMETER, DC
M402	VOLTMETER, DC
R401	SHUNT, HEAT SINK
R402–R404	RESISTOR, PRELOAD, 100W., 10 OHM
R405	RESISTOR, I.D. TRANSFORMER
R406	RESISTOR, AC CONTACTOR COIL
R440	RESISTOR, TR I.D. 1K OHM
RV401	VARISTOR, AC CONTACTOR COIL
S402	SWITCH, THERMAL, 28.5 VDC TRANSFORMER
S403	SWITCH, THERMAL HEAT SINK
S430	SWITCH, PUSHBUTTON, 28.5 VDC (BLUE)
S431	SWITCH, PUSHBUTTON, DC STARTING CURRENT, (BLUE)
T401	TRANSFORMER, 28.5 VDC
TB401	TERMINAL BLOCK, 28.5 VDC TRANSFORMER



ANALOG DC METER CONNECTIONS



DIGITAL DC METER CONNECTIONS



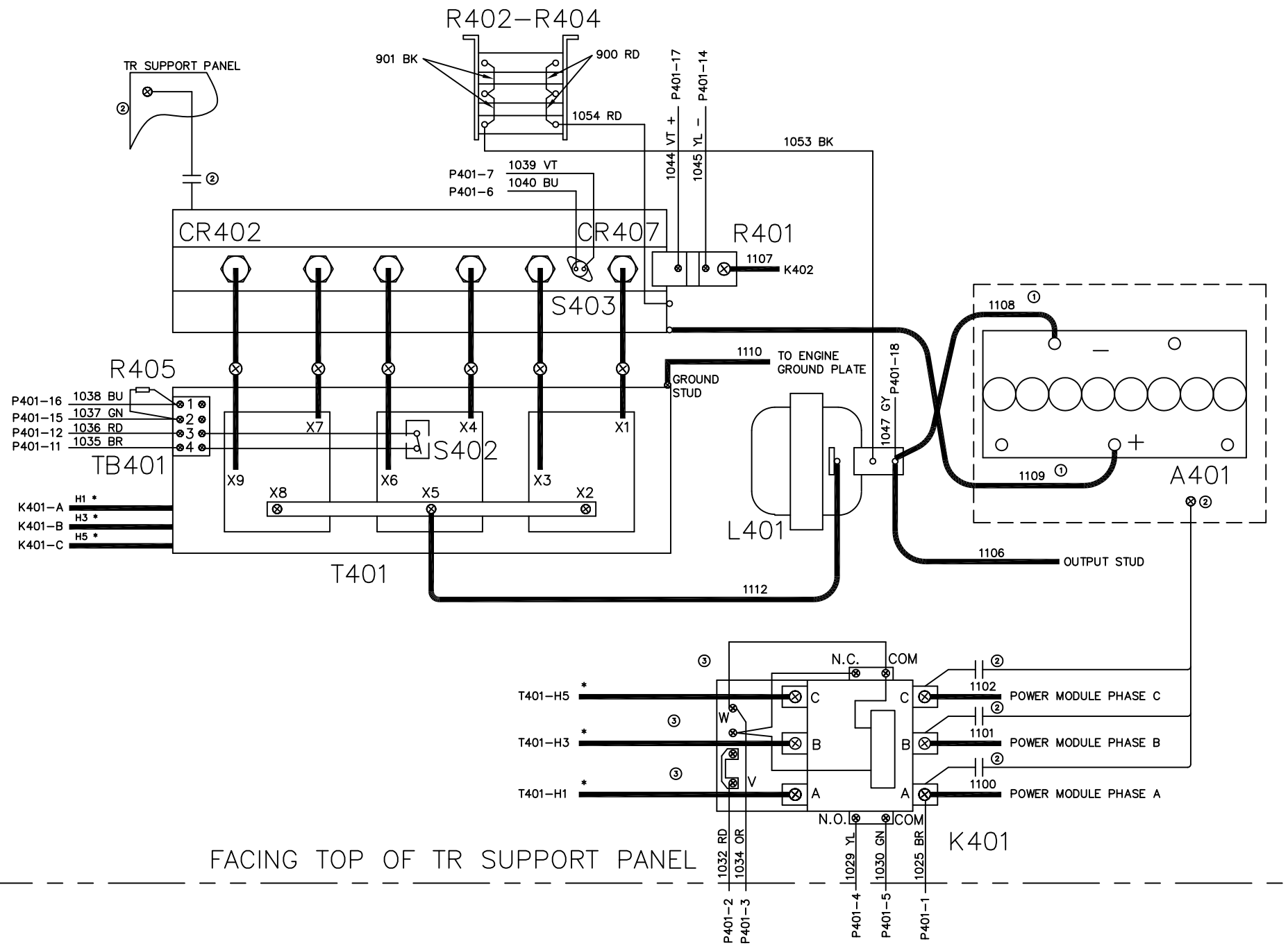
CHANGE RECORD					
E.C. No.	DATE	FILE NAME	PLOT DATE	FINISH CODE PER 289181: NONE	
1) 3469AA	3/23/05	289155S1	12/15/08	ACTIVITY	REPLACED BY / REPLACES
2) 3946AA	9/06/07	UNLESS OTHERWISE SPECIFIED		MATERIAL NO.	QUANTITY–U.M. / COMM. CLS.
3) 4209AA	12/15/08	DIMENSIONS ARE IN INCHES/MILLIMETERS. TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.		MATERIAL SPEC. –	
		FRACT.± INCH ±	ANGLES ± 3°	TITLE DIAGRAM, SCHEMATIC, & CONN., T–R	
		DECIMAL–INCH	METRIC	DESCRIPTIVE DATA 60CU24 DIGITAL CONTROLS	
		.00 ± .03	0.0 ±0.8mm	DESIGNED RPH / DRAWN RPH / DATE 6/23/04 / SCALE NONE	
		.000 ± .010	0.00 ±0.25mm	CHECKED / APPROVED / RECORDS 6/24/04 / ITEM TYPE	

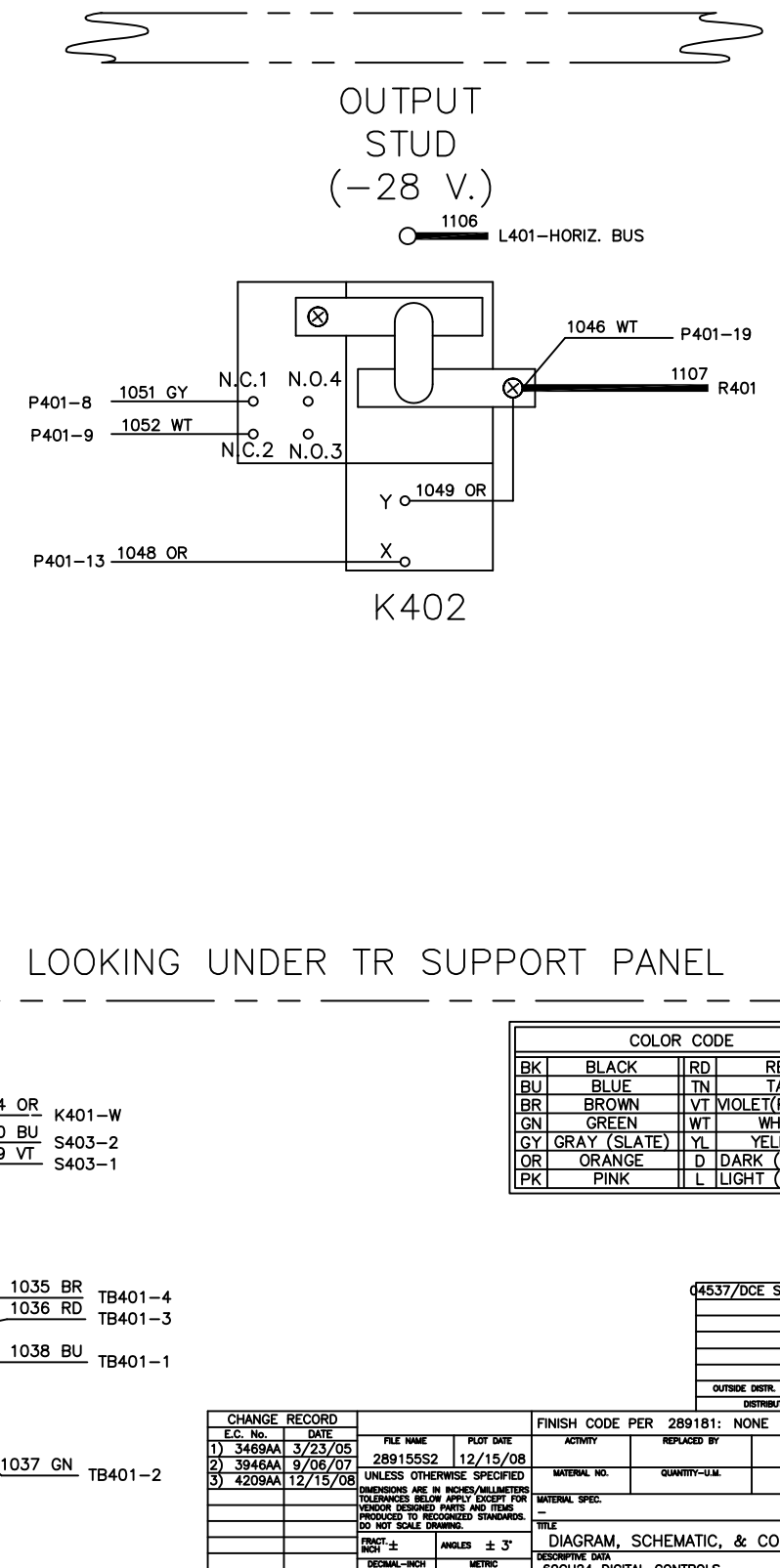
ITW GSE GROUP U.S.A.

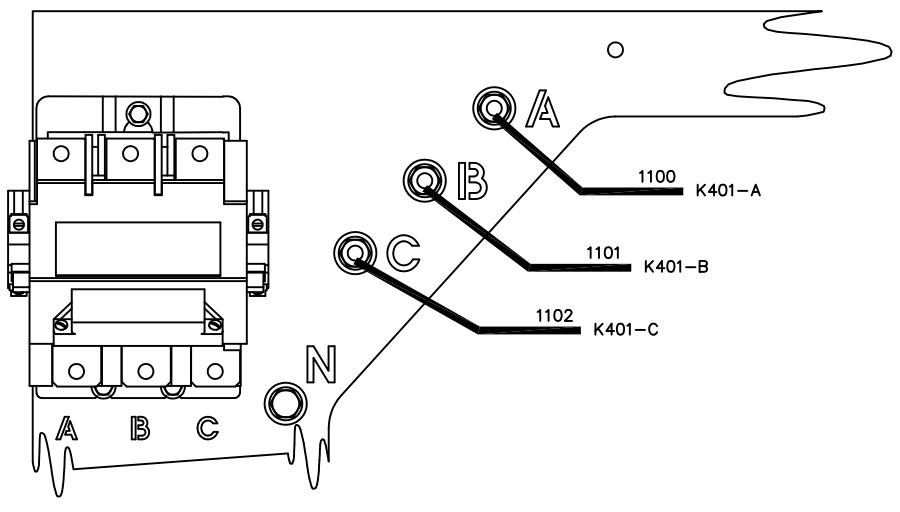
SIZE D | DWG. NO. 289155 | SHEET 1 OF 3

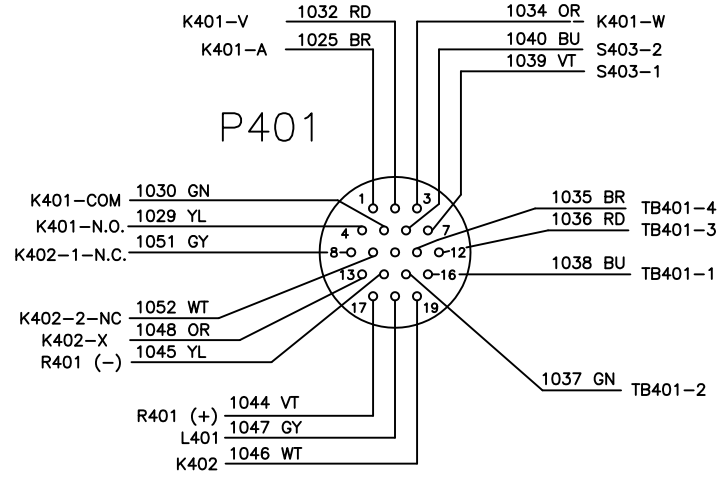
04537/DCE SUB

OUTSIDE DISTR. / DISTRIBUTION TABLE









COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET(PURPLE)
GN	GREEN	WT	WHITE
GY	GRAY (SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT (PREFIX)

04537/DCE SUB

OUTSIDE DISTR.

DISTRIBUTION TABLE

CHANGE RECORD		
E.C. No.	DATE	
1) 3469AA	3/23/05	
2) 3946AA	9/06/07	
3) 4209AA	12/15/08	

	FILE NAME	PLOT DATE
	289155S2	12/15/08

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.

FRACT. INCH ±	ANGLES ± 3°
DECIMAL–INCH	METRIC
.00 ± .03	0.0 ±0.8mm
.000 ± .010	0.00 ±0.25mm

FINISH CODE PER 289181: NONE

ACTIVITY	REPLACED BY	REPLACES
MATERIAL NO.	QUANTITY–U.M.	COMM. CLS.

MATERIAL SPEC.
–

TITLE
DIAGRAM, SCHEMATIC, & CONN., T–R

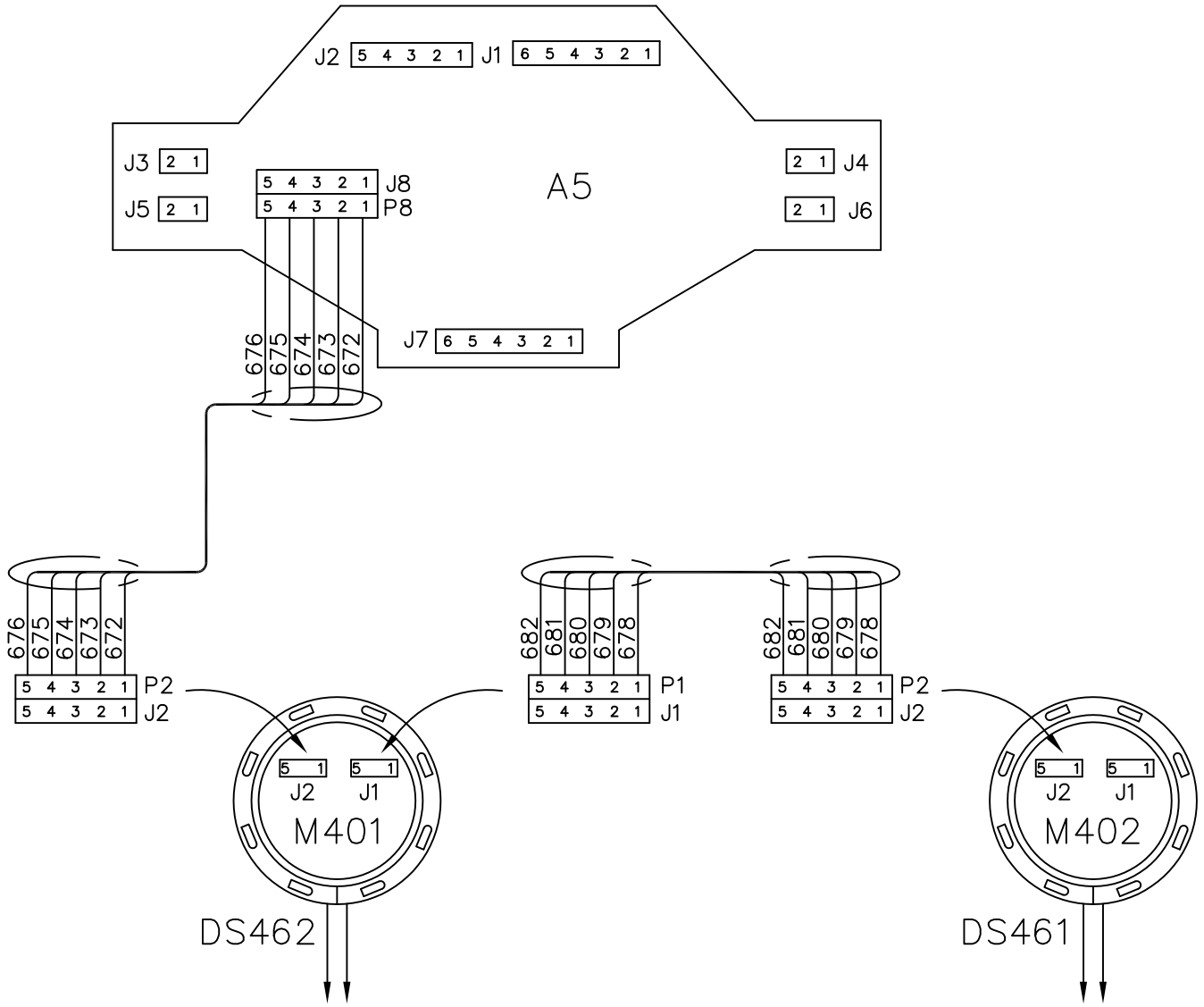
DESCRIPTIVE DATA
60CU24 DIGITAL CONTROLS

DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	6/23/04	NONE
CHECKED	APPROVED	RECORDS 6/24/04	ITEM TYPE

ITW GSE GROUP U.S.A.

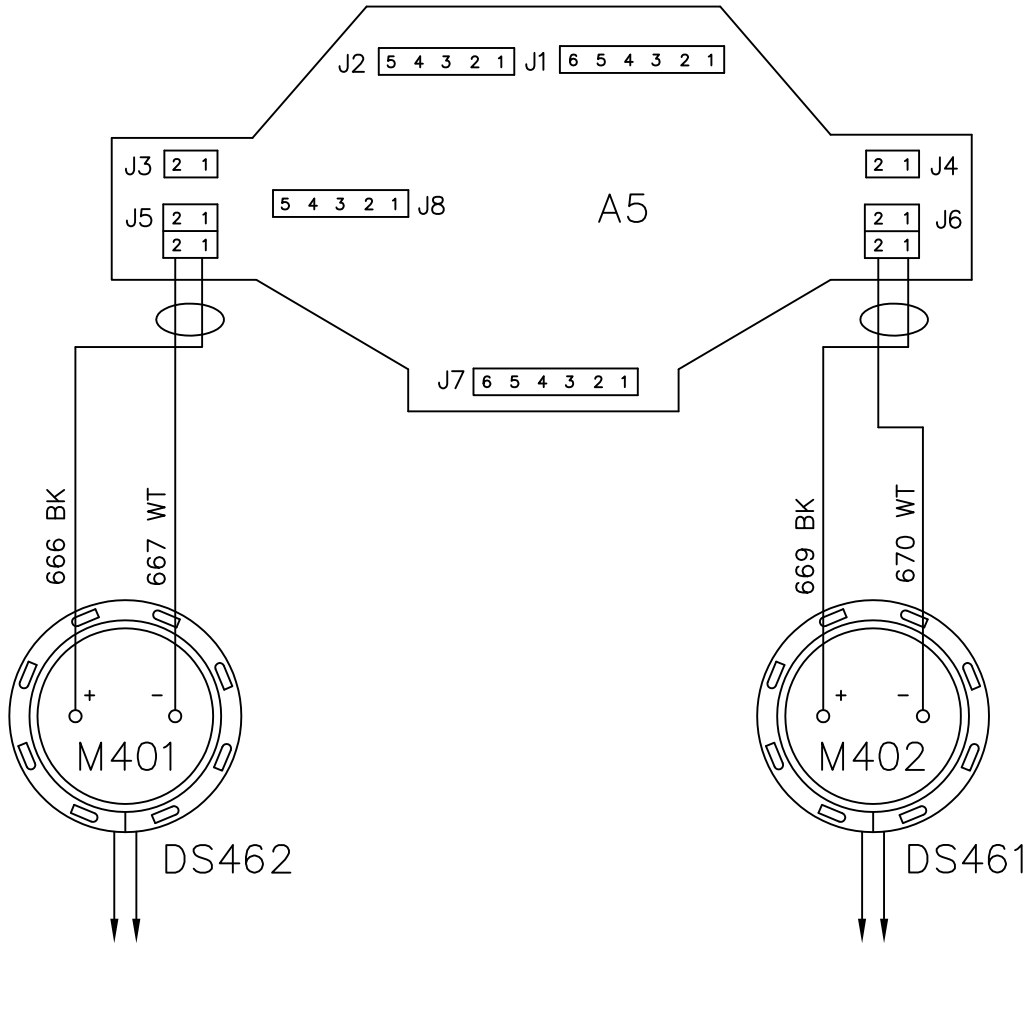
SIZE D

DWG. NO. SHEET 2 OF 3
289155



FACING REAR OF CONTROL PANEL

DIGITAL METER CONNECTIONS FOR TR METERS



FACING REAR OF CONTROL PANEL

ANALOG METER CONNECTIONS FOR TR METERS

COLOR CODE			
BK	BLACK	RD	RED
BU	BLUE	TN	TAN
BR	BROWN	VT	VIOLET
GN	GREEN	WT	WHITE
GY	GRAY(SLATE)	YL	YELLOW
OR	ORANGE	D	DARK (PREFIX)
PK	PINK	L	LIGHT(PREFIX)

DIAGRAM EXPLANATION

PART DESIGNATOR (END OF WIRE)
WIRE NUMBER
WIRE COLOR
TB4 — 27 RD — ABOVE OR LEFT OF WIRE

04537/DCE SUB

OUTSIDE DISTR.

DISTRIBUTION TABLE

CHANGE RECORD			
	E.C. No.	DATE	
1)	3469AA	3/23/05	
2)	3946AA	9/06/07	
3)	4209AA	12/15/08	

FILE NAME: 289155S3 — PLOT DATE: 12/15/08

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES/MILLIMETERS TOLERANCES BELOW APPLY EXCEPT FOR VENDOR DESIGNED PARTS AND ITEMS PRODUCED TO RECOGNIZED STANDARDS. DO NOT SCALE DRAWING.

FRACT. ± INCH ± — ANGLES ± 3°
DECIMAL—INCH: .00 ± .03; .000 ± .010 — METRIC: 0.0 ±0.8mm; 0.00 ±0.25mm

FINISH CODE PER 289181 NONE

ACTIVITY	REPLACED BY	REPLACES
MATERIAL NO.	QUANTITY—U.M.	COMM. CLS.

MATERIAL SPEC.
–

TITLE
DIAGRAM, SCHEMATIC/ CONN. T-R

DESCRIPTIVE DATA
60CU24 DIGITAL CONTROLS

DESIGNED	DRAWN	DATE	SCALE
RPH	RPH	6/23/04	NONE
CHECKED	APPROVED	RECORDS 6/24/04	ITEM TYPE

ITW GSE GROUP U.S.A.

SIZE D — DWG. NO. SHEET 3 OF 3 — 289155

Appendix A Options / Features

The following is a list of options/features available for the 60CU20, 400 Hz. Generator Set. This chart contains the description, part number, and document number (if applicable) of the option/feature. There is also a column to identify which option/feature document is contained in this Appendix.

Option/Features Available			
Description	**Part Number**	**Document Number**	**In This Section**
Kit, Battery Blanket, 120V	287917	n/a	
Kit, Beacon, Low Fuel Strobe*	289208-XXX	n/a	
Kit, Beacon, Low Fuel, Flashing/Non-Flashing*	289208-XXX	n/a	
Kit, Beacon, Unit Operating, Non-Flashing*	289210-XXX	n/a	
Kit, Block Heater, 120V	289261-001	n/a	
Kit, Block Heater, 240V	289261-002	n/a	
Kit, Cable Tray Rollers – 1 output	288987-006	n/a	
Kit, Cable Tray Rollers – 2 outputs	288987-005	n/a	
Kit, CE Certification, Trailer Mount	287589-015	n/a	
Kit, CE Certification, Fixed Mount	287589-004	n/a	
Kit, Clearance Lights	288912	TO-297	
Kit, Fire Extinguisher, 5 lb. Carbon Dioxide	283012	TO-252	
Kit, Forklift Pockets	291374	n/a	
Kit, Noise Reduction	291375	n/a	
Kit, Spotlight	289064	n/a	
Kit, Tie-Down	284706	n/a	
Kit, Transformer-Rectifier, 28 VDC	Call Factory	OM-2144	
Kit, Wheel Chocks	287609	n/a	
Kit, 28 VDC/115 VAC Interlock	291406	n/a	
T-Handle Latch (as required)	287542-002	n/a	

* – A large number of variations exist under this part number. Call the factory for details.
n/a – Not Available, call the factory for details.

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Wet-Stacking in Generator Set

1) Diesel Engines

All diesel engines operated for extended periods under light load may develop a condition commonly referred to as wet-stacking. This condition results from the accumulation of unburned fuel in the exhaust system. It is recognizable by fuel oil wetness around the exhaust manifold, pipes, and muffler, as well as, excessive soot around the exit point area. Liquid fuel, in the form of droplets, may be also be spewed from the exhaust outlet.

Wet-stacking is common, and may be expected in diesel engines operated under light load. Light loads do not allow the engine to reach the most efficient operating temperature for complete combustion of fuel. The unburned fuel collects in the exhaust system to create the wet condition known as wet-stacking.

To alleviate wet-stacking in lightly loaded engines, it is recommended that the machine be connected to a load bank after each 200 hours of use and operated under full rated load for one hour. This will burn away and evaporate the accumulation of fuel in the exhaust system. This clean-out procedure should be considered as a regular maintenance operation for machines operated under light loads. The time schedule of 200 hours may be changed as required to suit each user's particular needs and operating conditions.

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Unusual Service Conditions

This information is a general guideline and cannot cover all possible conditions of equipment use. The specific local environments may be dependent upon conditions beyond the manufacturer's control. The manufacturer should be consulted if any unusual conditions of use exist which may affect the physical condition or operation of the equipment or safety to surrounding personnel.

Among such conditions are:

1) Exposure to:

a) Combustible, explosive, abrasive or conducting dusts.

b) Environments where the accumulation of lint or excessive dirt will interfere with normal ventilation.

c) Chemical fumes, flammable, or explosive gases.

d) Nuclear radiation.

e) Steam, salt-laden air, or oil vapor.

f) Damp or very dry locations, radiant heat, vermin infestation, or atmospheres conducive to fungus growth.

g) Abnormal shock, vibration or mechanical loading from external sources during equipment operation.

h) Abnormal axial or side thrust imposed on rotating equipment shafts.

i) Low and/or high ambient temperatures.

j) High electromagnetic fields

2) Operation at:

a) Voltages above or below rated voltage.

b) Speeds other than rated speed.

c) Frequency other than rated frequency.

d) Standstill with rotating equipment windings energized.

e) Unbalanced voltages.

f) Operation at loads greater than rated.

3) Operation where low acoustical noise levels are required.

4) Operation with:

a) Improper fuel, lubricants or coolant.

b) Parts or elements unauthorized by the manufacturer.

c) Unauthorized modifications.

5) Operation in poorly ventilated areas.