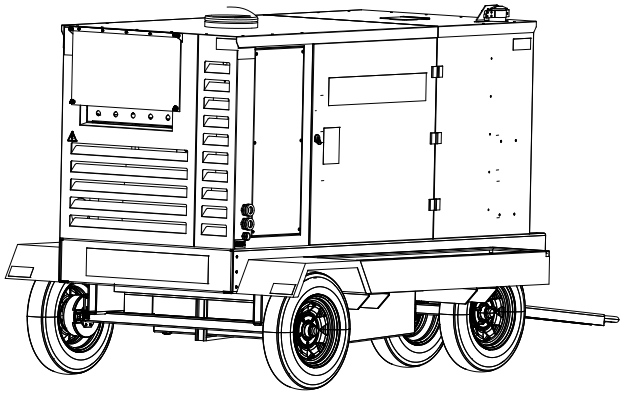
OPERATION & SERVICE MANUAL



Models:

1190400CT3, 1190400CT3SP
1190400C1T3, 1190400C1T3SP
1190400C28T3, 1190400C28T3SP
1190400C128T3, 1190400C128T3SP

400 Hertz Ground Power Unit

CE

04/2018 –– Rev. 02

Tronair, Inc.
1 Air Cargo Pkwy East
Swanton, OH 43558

Phone: (419) 866-6301 | 800-426-6301
Web: www.tronair.com
Email: sales@tronair.com

REVISION	DATE	TEXT AFFECTED
01	12/2015	Original Release
02	04/2018	Modified 9.8.1 Instrument Panel Mounting

TABLE OF CONTENTS

PAGE

This product cannot be modified without the written approval of Tronair, Inc. Any modifications done without written approval voids all warranties and releases Tronair, Inc., it suppliers, distributors, employees, or financial institutions from any liability from consequences that may occur. Only Tronair OEM replacement parts shall be used.

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Ground Power Unit
Model Number: 1190400CXXXT3XX
Equipment Type: Diesel Powered GPU, 115 VAC 400Hz and (Optional) 28.5 VDC Output

1.2 COMPLETE MODEL & SERIAL NUMBER

Reference nameplate on unit.

1.3 MANUFACTURER

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

1.4 FUNCTION

The Ground Power Unit (GPU) is a diesel-powered unit designed to serve as a 115-Volt AC 400Hz and 28.5-Volt DC power source for parked aircraft. It can provide up to 216-amps AC power only or in combination with up to 600 amps DC continuous output for aircraft servicing, and up to 2000 amps DC peak for starting. The Current Limit (Soft Start) feature allows the user to select DC current limits for operations requiring current limit below the maximum output.

1.5 REQUIREMENTS

The GPU can run on Diesel or Jet-A Fuel. (Check to see if local restrictions allow the use of Jet A for ground service equipment.) The fuel filter is a disposable lubricity additive type designed to supply adequate lubrication to the fuel pump when running on Jet A. The filter **MUST BE CHANGED EVERY 500 HOURS** of running time or every six (6) months.

2.0 SAFETY INFORMATION

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

2.1 USAGE AND SAFETY INFORMATION

The GPU provides 115 Volts 400Hz AC and/or 28.5 Volts DC for performing aircraft service and maintenance.

To insure safe operations please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information. This manual contains safety precautions, which are explained below. Please read carefully.

WARNING! — Warning is used to indicate the presence of a hazard that ***can cause severe personal injury, death, or substantial property damage*** if the warning notice is ignored.

CAUTION! — Caution is used to indicate the presence of a hazard that ***will or can cause minor personal injury or property damage*** if the caution notice is ignored.

2.2 EXPLANATION OF WARNING & DANGER SIGNS

WARNING! Accidental Starts! Always turn off and lock out the battery switch before servicing this GPU. Only qualified service personnel may service this equipment. Read and understand the technical manual before servicing this equipment.

WARNING! Rotating Parts! Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the GPU with doors open or panels and guards removed.

WARNING! Electrical Shock! Caution: This GPU produces voltages and current sufficient to cause burns and death by electric shock! Always inspect cables and plugs for damage before use. Do not use if damaged. Always turn DC power to off before connecting or disconnecting cables. The human body has decreased resistance when wet; keep hands, feet and clothes dry when operating electrical equipment. Do not open doors or remove panels while the GPU is running. High current electrical components will be exposed. Always turn off and lock out the battery switch before servicing this GPU.

2.2 Explanation of warning and danger signs continued on following page

2.2 EXPLANATION OF WARNING & DANGER SIGNS *(continued)*

WARNING! Hot Surfaces! Engine components such as turbo chargers, exhaust pipes, and mufflers will remain hot after the engine has been shut down. Allow engine to cool before servicing.

WARNING! Batteries! Batteries give off flammable hydrogen gas and can explode if ignited. When servicing, do not allow arcing, sparks, or open flame near the battery. Acid and arcing from a ruptured battery can cause fires and additional damage.

WARNING! Fuel Hazard! Use only approved containers for transferring fuel. Shut down GPU before refueling. Fires and explosions can occur if the fuel tank is not grounded. Ground fuel tank before and during fuel transfer. Clean up all fuel spills immediately.

WARNING! Carbon Monoxide! Engine exhaust fumes can kill. If indoors, always pipe or vent exhaust fumes to a suitable exhaust duct. Never locate engine exhaust near air conditioner intake ducts.

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

No Access for Unauthorized Persons! Only qualified personnel may service this equipment.

Read Operation Manual! Read and understand the operation manual before using this equipment. Failure to follow operating instructions could result in death or serious injury.

Read Technical Manual! Read and understand technical manual before servicing.

Lockout! Shut down engine. Turn off and lockout battery switch before servicing. If working near the batteries or the battery switch, also disconnect the negative battery cable, at the battery, on the fuel pump side of the engine.

Loud Noise Hazard! Ear protection must be worn while operating this equipment.

2.3 COMPONENT SAFETY FEATURES

- Fan guard
- Muffler guard
- Sheet metal panels
- Circuit breakers
- Hand actuated rear drum brakes

2.4 FUNCTIONAL SAFETY FEATURES

- Emergency shut off switch
- Timed engine shut down
- Over current protection circuit
- Over voltage protection circuit
- Cable interlock protection circuit
- Battery shut off switch

2.5 PERSONAL PROTECTION EQUIPMENT

- Safety glasses and ear protection must be worn when operating the GPU.
- Additional equipment required by employer (gloves, vest, etc).

2.6 SAFETY GUIDELINES

- Operator **MUST BE PROPERLY TRAINED** prior to operating the GPU.
- Pre-operation check must be performed before each use. (Refer to operating instructions)
- AC and DC power switches must be OFF when connecting and disconnecting the cable from the aircraft.
- Use emergency stop for emergency only. Normal shut down is accomplished by selecting engine idle, then engine power off. This allows the engine to cool for one minute at idle speed before shutting off.
- Always shut the unit off, allow to cool, and turn the battery switch to OFF before performing service or maintenance. If working near the batteries or the battery switch, also disconnect the negative battery cable, at the battery, on the fuel pump side of the engine.

2.7 GENERAL COMMENTS

The GPU is intended to be operated by personnel trained in the proper use in conjunction with the aircraft maintenance and operation manuals.

The GPU must be used in accordance with the Technical and Operator Manuals and the intended aircraft.

3.0 PREPARATION PRIOR TO FIRST USE

3.1 GENERAL

Prior to operating the GPU, the user must become familiar with this Operator Manual.

3.2 PRE-USE INSPECTION

CAUTION!

A pre-use inspection must be carried out prior to each use to ensure safe operation of the GPU. Failure to carry out these procedures listed below may result in severe damage to the GPU or prevent efficient operation.

1. Unit..... Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance.
2. Radiator ..... Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required.
3. Engine Hoses..... Check integrity of hoses and clamps for tightness.
4. Fuel Level ..... Turn power on and check fuel level on fuel gauge. Top up as required with fuel.
5. Engine..... Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block oil pan and valve covers for oil leakage.
6. Oil Level ..... Remove dipstick to ensure oil level is at full mark. Replenish as required.
7. Fan Belt..... Check belt for correct tension. Look for wear.
8. Air Intake Filter..... Ensure that plugged filter indicator shows clean, if not, replace air filter. Check again once unit is running.
9. Tires ..... Check integrity of tires and tread wear and pressure
10. Brakes..... Check for proper operation

4.0 TRAINING

4.1 TRAINING REQUIREMENTS

The employer of the operator is responsible for providing a training program sufficient for the safe operation of the GPU.

4.2 TRAINING PROGRAM

The employer-provided operator training program should cover safety procedures concerning use of the GPU in and around the intended aircraft at the intended aircraft servicing location.

4.3 OPERATOR TRAINING

The operator training should provide the required training for safe operation of the GPU.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

5.0 OPERATION

5.1 OPERATING PARAMETERS

- The user shall use the GPU in accordance with the Aircraft Manufacturer's Instructions.
- The user shall operate the GPU in accordance with the Operation & Service Manual.
- The employer of the operator shall provide all necessary training.

5.2 NUMERICAL VALUES

Model: 1190400CXXXT3XX (See nameplate on GPU for correct model number)
Serial Number: (See Nameplate on GPU)

5.2.1 Physical

- Weight (Dry)**:** 4800 lbs. (2177 kg)
- Dimensions**:** Width 79 in (200 cm)
  Height 67 in (170 cm)
  Length 106 in (269 cm)
- AC Output Cable: 37 ft. (11.2 m), DC Output Cable: 30 ft. (9.14 m) long

5.2 Numerical values continued on the following page.

5.2 NUMERICAL VALUES *(continued)*

5.2.2 ENGINE

- Cummins QSB4.5TA..... 4.5 Liter turbocharged after cooled, 4 cylinder, 4 stroke diesel engine
- Horsepower..... 155 hp (116 KW) at 2000 rpm
- Weight..... 745 lb (338 kg) engine only
- Idle Speed..... 750 rpm +/- 50 rpm
- Electrical System..... 24 volt DC, negative ground
- Capacities
  - Lubricating oil..... 11.5 quarts (10.9 liters) w/filter
  - Coolant ..... 12 quarts (11.4liters)

5.2.3 CHASSIS

Capacity ..... 5000 lbs (2267kg) GVW

5.2.4 Alternator

- Marathon..... MagnaPlus 430PSL1315
- Output Voltage ..... 115/200 volts AC
- Poles 24
- Phase 3, Wye star connected
- Output Power ..... 72 KW, 90 KVA
  - Power Factor..... 0.8
  - Ambient Temp °C..... 40
  - Temperature Rise °C 105
  - Speed ..... 2000 RPM
  - Frequency..... 400HZ
  - Excitation ..... Externally regulated 63 volts DC, 12 amps
  - Insulation..... Class F
  - Single Bearing..... Sealed, pre-lubricated
- Weight..... 1200 lb (544 kg)

5.0 OPERATION (continued)

5.3 LOCATION & LAYOUT OF CONTROLS

5.3.1 Control Panel (External)

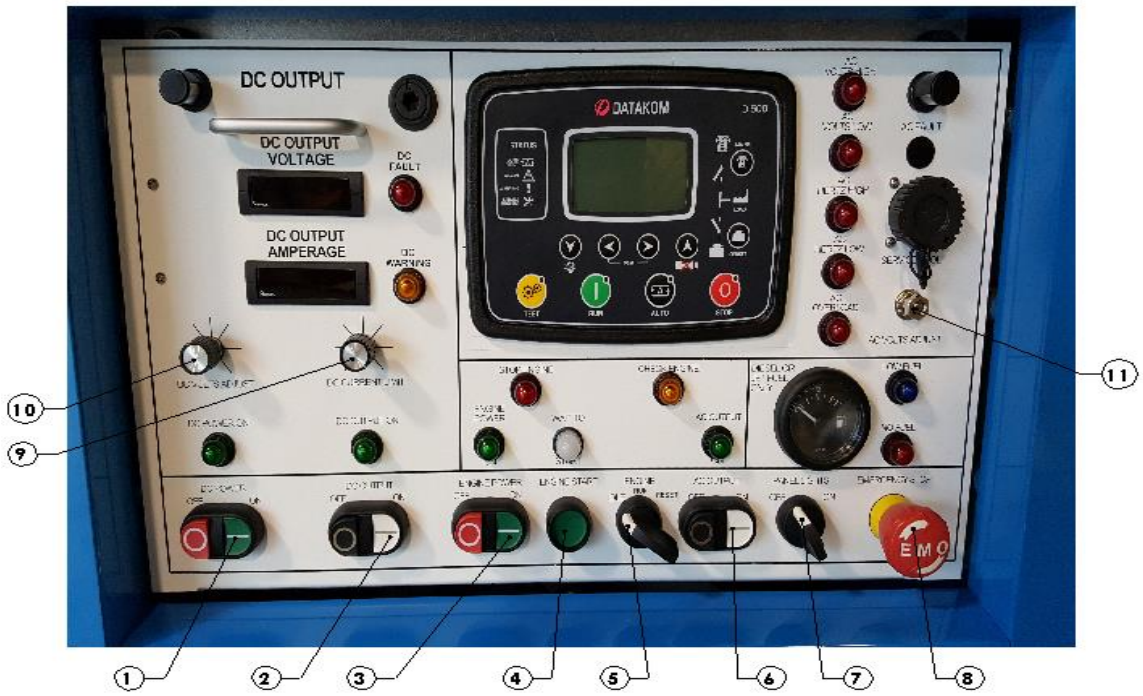


FIGURE 1

OPERATOR SWITCHES		
Item	**Description**	**Function**
1	DC Power OFF Switch (Res)	Disconnects AC power from the DC power transformer. Shuts down the DC System
	DC Power ON Switch (Green)	Connects AC power to the DC power transformer. Turns ON the DC System
2	DC Output OFF Switch (Black)	Disconnects the DC output cable from the aircraft. Turns OFF the DC output System
	DC Output ON Switch (White)	Connects the DC output cable to the aircraft. Turns ON the DC output System
3	Engine Power OFF (Red)	Turns OFF 24 VDC power from battery. Allows engine to run for 1 minute at idle before stopping and shutting OFF power
	Engine Power ON (Green)	Turns ON 24 VDC power from battery. Allows GPU to power ON
4	Engine Start Switch	Starts engine (automatically bypasses low oil pressure switch for 10 seconds) engine will idle only. (Will only operate with Idle/Run selector set at idle)
5	IDLE Selector (Left/Idle)	Allows engine START switch to function. Returns engine to IDLE from RUN mode
	IDLE Selector (Middle/Run)	Brings engine to RUN mode and turns on the AC system
	IDLE Selector (Right/Reset)	Resets ALL AC systems faults. (Hold ON for 1 Second to reset system)
6	AC Output OFF Switch (Black)	Disconnects the AC output cable from the aircraft
	AC Output ON Switch (White)	Connects the AC output cable to the aircraft
7	Panel Lamp Switch	Turns ON and OFF Panel Lamp
8	Emergency STOP Switch	Will immediately shut off power to the GPU and GPU will STOP **FOR EMERGENCY USE ONLY, DO NOT USE FOR ROUTINE STOPS**
9	Current Limiter Switch	Adjusts peak current by percent's of 2000 amps (i.e. 50% is 1000 amps)
10	DC Volts Adjust Switch	Adjusts the DC Output Voltage.
11	AC Volts Adjust Switch	Adjusts the AC Output Voltage

5.3.1 Control panel (external) continued on following page.

5.3.1 Control Panel (External) (*continued)*

FIGURE 2

POWER OUTPUT METERS		
Item	**Description**	**Function**
12	DC Output Voltmeter	Indicates DC power voltage (28.5 VDC)
13	DC Output Ammeter	Indicates DC AMPS power output

ALTERNATOR and ENGINE GAUGES		
Item	**Description**	**Function**
14	Fuel Gauge	Indicates fuel remaining in tank and low fuel indicator lamp
15	The Alternator/Engine Display and Diagnostic Controller	Displays Alternator/Engine Parameters and Information See User's Guide for more information
16	Service Tool Connector	Used for Cummins engines service diagnostic tool

INDICATOR LAMPS		
Item	**Description**	**Function**
17	DC Output ON Lamp (Green)	Indicates DC Output Contactor is "ON"
18	Stop Engine (Red)	The engine ECM turns ON when a serious engine fault is detected
19	Wait To Start (White)	The engine ECM turns ON when you need to wait for engine Grid-Heater pre-heat
20	Check Engine (Amber)	The engine ECM turns ON for maintenance faults and water in fuel
21	DC Fault Lamp (Red)	Turns ON or Blinks with different fault conditions
22	AC High Volts Lamp (Red)	Turns ON when AC volts exceeds 119
23	DC Warning Lamp (Amber)	Turns ON or Blinks with different warning conditions
24	AC Low Volts Lamp (Red)	Turns ON when AC volts are below 110
25	AC High Hertz Lamp (Red)	Turns ON when AC frequency exceeds 405 Hz
26	AC Low Hertz Lamp (Red)	Turns ON when AC frequency is below 390 Hz
27	AC Overload Lamp (Red)	Turns ON when AC current exceeds 316 amps
28	Low Fuel Lamp (Blue)	Turns ON when the fuel level is approximately ¼ tank or below

5.3.1 Control Panel (External) (*continued)*

INDICATOR LAMPS		
Item	**Description**	**Function**
29	No Fuel Lamp (Red)	Turns ON when the fuel level is approximately ⅛ tank or below
30	AC Output ON Lamp (Green)	Turns ON when AC Output Contactor is ON
31	Panel Lamps (White)	Turns ON when Panel Lamp switch is ON
32	Engine Power ON Lamp (Green)	Turns ON and remains ON while power is ON. Turns OFF when Power OFF switch is pressed. (During engine 1 minute delay shutdown timer)
33	DC Power ON Lamp (Green)	Indicates DC System is ready for use
34	AC Ready Lamp (Green)	Indicates AC System is ready for use

5.3.2 Control Panel (Internal)

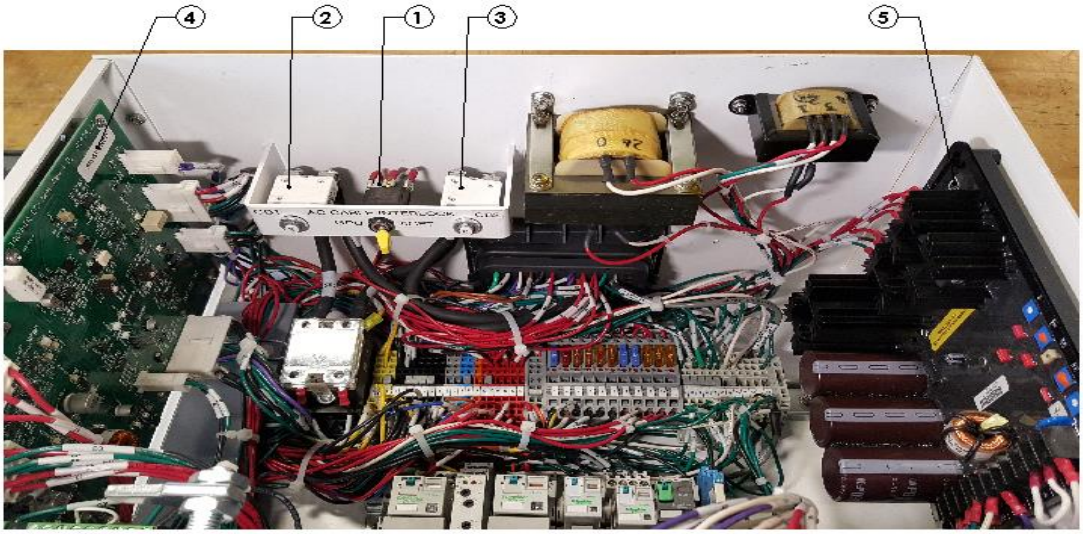


FIGURE 3

CIRCUIT BREAKERS and PRINTED CIRCUIT CONTROL BOARDS		
Item	**Description**	**Function**
1	Aircraft Interlock (AC Cable)	Places interlock at GPU (for testing only) or at Aircraft Plug (normal)
2	70 AMP Circuit Breaker	Protects engine alternator charging circuit
3	70 AMP Circuit Breaker	Protects 24 volt battery circuit
4	DC System Interface Control PCB	Controls and monitors the DC operating system and the SCR Firing PCB
5	AC system Automatic Voltage Regulator. (AVR)	Controls the AC Alternator Output

5.3.2 Control panel (internal) continued on the following page.

5.3.2 Control Panel (Internal) *(continued)*

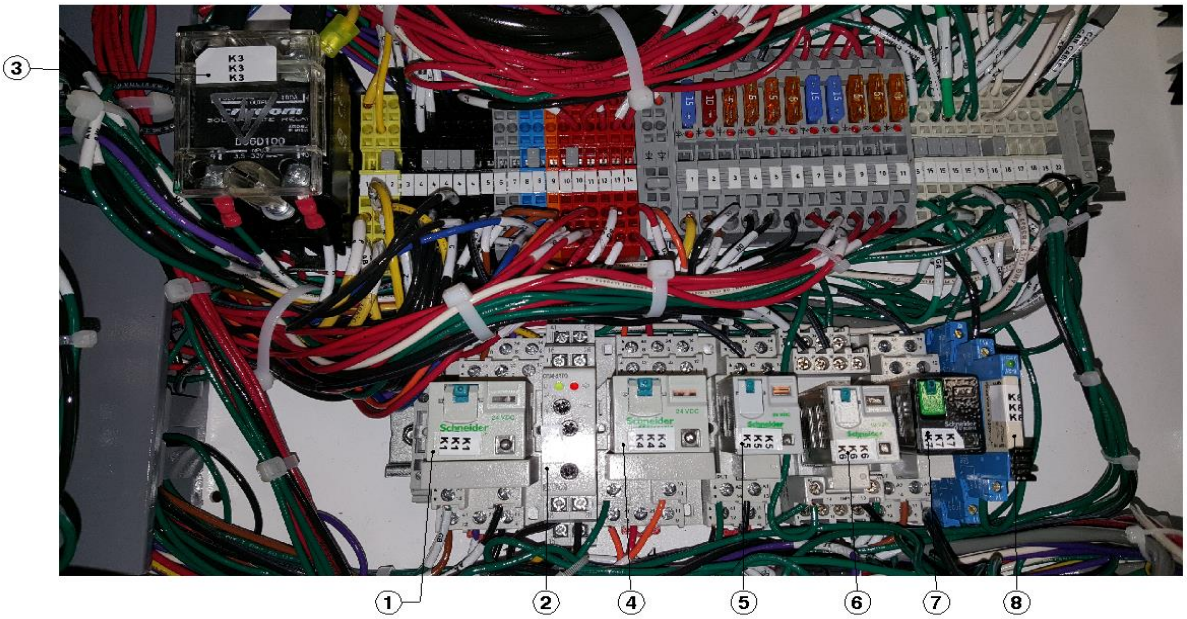


FIGURE 4

CONTROL RELAYS		
Item	**Description**	**Function**
1	K-1 Power ON Latch Reay	Latches the engine power ON when the Engine green Power ON switch is pressed
2	K-2 Shutdown Delay Timer Relay	Shuts down the GPU after a 1 minute delay after the (RED) Engine Power OFF switch is pressed
3	K-3 Battery Charge Relay	Connects the battery and the engine alternator when power is ON
4	K-4 AC Output Cable Control Relay	Controls the AC cable output Contactor
5	K-5 DC Output Cable Control Relay	Controls the DC cable output Contactor
6	K-6 No Fuel Relay	Turns ON when the fuel level is approximately 1/8 tank or below. Shuts down the engine and turns on the (Red) NO Fuel lamp and (Blue) Stack Light
7	K-7 Engine Running Relay	Turns ON while the engine is running. Turns ON the (Green) Stack Light
8	K-8 Engine Start Relay	Turns ON when the engine Start switch is pressed. Sends a signal to the Alternator/Engine Display and Diagnostic Controller to start the engine

5.3 LOCATION & LAYOUT OF CONTROLS *(continued)*

5.3.3 Controls, Engine Compartment

FIGURE 5

Item	Description	Function
1	Battery Switch	Connects and disconnects Pos. 24 Volt and Pos. 12 Volt battery cables. Must be in the ON position for unit to run. GPU is shipped with switch in the OFF position
2	Clogged Filter Indicator	Indicator will show red when air filter becomes dirty. Check daily. Reset after filter has been changed

5.4 START UP PROCEDURES

5.4.1 Pre-Use Inspection

CAUTION!

A pre-use inspection must be carried out prior to each use to ensure safe operation of the GPU. Failure to carry out these procedures listed below may result in severe damage to the GPU or prevent efficient operation.

1. Unit..... Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance
2. Tires ..... Check treads for wear and tires for pressure
3. Radiator Coolant ..... Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required
4. Engine Hoses..... Check integrity of hoses and clamps for tightness
5. Fuel Level ..... Turn power on and check fuel level on fuel gauge. Top up as required with fuel
6. Engine..... Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block oil pan and valve covers for oil leakage
7. Oil Level ..... Remove dipstick to ensure oil level is at full mark. Replenish as required
8. Fan Belt..... Check belt for correct tension. Look for wear
9. Air Intake Filter..... Ensure that plugged filter indicator shows clean, if not, replace air filter. Check again once unit is running
10. Brakes..... Check for proper operation

5.4.2 Starting Sequence

The following sequence **must be followed** in the order shown: Refer to figures 1 thru 5.

1. The GPU battery disconnect switch (1) must be selected to the ON position. (Fig-5)
2. Ensure that the Emergency Stop switch is not pushed in.
3. Press Engine Power ON Switch (3 Green) at the control panel. This will turn on the 24 Volt DC power from the GPU battery. The Green Power On Lamp (32) will light and the Alternator/Engine Display and Diagnostic Controller (15) will come on.
4. The Stop Engine and Check Engine lamps will come on briefly. Depending on air temperature, the Wait To Start lamp (19 white) may stay on. **DO NOT START ENGINE WHEN LAMP IS ON**. (Fig-1 & 2)
5. Set IDLE/RUN switch (5) to IDLE. NOTE: An automatic interlock will inhibit a start when this switch is in the RUN position.

CAUTION!

Both batteries must be fully charged to supply sufficient voltage for starting.

6. Push and release Start Switch (4). The Alternator/Engine Display and Diagnostic Controller will start the engine. Engine will idle at 750 ± 50 rpm.

CAUTION!

Ensure that the Engine Stop Lamp is not on. This could indicate Low oil pressure. Push the Emergency Stop Switch in to Power OFF immediately. Failure to shut down engine with low or zero oil pressure could result in severe engine damage.

7. Oil pressure will read 10 psig minimum while engine is idling.

CAUTION!

Check that battery reads above 24 volts.

8. Check engine temperature. It should read between 170-195º F (77 to 91º C) when engine is warm.

CAUTION!

Prolonged running at idle could result in engine damage. Two to four minutes should be sufficient to warm the engine (Depending on outside air temp.)

9. All lamps except Engine Power ON (32) should now be off. (After prolonged idling, the Low Volt and the Low Hertz Lamps may come ON).
10. Bring engine up to operating speed by rotating IDLE/RUN switch (5) clockwise to RUN position. After engine RPM has stabilized, rotate and hold switch to the RESET position for 1 second. The Genset (Amber) LOAD LED on the Alternator/Engine Display and Diagnostic Controller and the AC Ready lamp (34 Green) should come on in. This indicates the GPU is ready for power output.
11. Check Alternator/Engine Display and Diagnostic Controller screen for proper voltage and frequency indication.

5.4 START UP PROCEDURES *(continued)*

5.4.3 Supplying Power To The Aircraft

Reference *Figures 1 and 2 Control Panel (Exterior)*

AC POWER
(NOTE: THE GPU CAN SUPPLY BOTH AC AND DC POWER AT THE SAME TIME)

1. Connect the AC Output Power Cable to the aircraft. Make sure that power plug is fully and correctly inserted into the aircraft receptacle.
2. Check that IDLE/RUN switch is set to Run. If the Genset load LED is not ON, rotate and hold switch to the RESET position for 1 second. The Genset (Amber) LOAD LED on the Alternator/Engine Display and Diagnostic Controller and the AC Ready lamp (34 Green) should come on in. This indicates the GPU is ready for power output.
3. Push AC Output ON switch (6 White). AC Output ON Lamp (30 Green) will light and the AC Output cable Contactor will remain on while power to the aircraft is supplied.
4. Monitor Alternator/Engine Display and Diagnostic Controller for correct indication during aircraft operation.
5. To shut down the GPU, push AC Output OFF switch (6 Black). The AC Output ON Lamp (30 Green) and the AC Output cable Contactor will turn off.
6. Return IDLE/ RUN switch (5) to IDLE.
7. Shut down GPU by pushing the Power OFF switch (3 Red). GPU will run at idle for 1 minute to cool down before shutting off. **DO NOT USE EMERGENCY STOP SWITCH**. **FOR EMERGENCY USE ONLY, DO NOT USE FOR ROUTINE STOPS.**
8. Stow AC plug and cable in cable tray.

DC POWER
(NOTE: THE GPU CAN SUPPLY BOTH AC AND DC POWER AT THE SAME TIME)

1. Connect the 28.5 VDC Output Power Cable to the aircraft. Make sure that power plug is fully and correctly inserted into the aircraft receptacle.

CAUTION!

Ensure that the current limit switch (9), is set in the correct position for the aircraft to be started. CONSULT AIRCRAFT OPERATION MANUAL FOR PROPER SWITCH SETTING. Severe aircraft engine damage can occur if incorrect setting is used. FOR MOST AIRCRAFT LEAVE SWITCH AT 100%.

Current limit control, located on instrument panel, is only to be adjusted by competent operator/maintenance personnel. Helicopters and some small jets and turbo prop aircraft may require a "limit" on peak power. Half peak = 50%. Do not use soft start on hard start engines. Insure aircraft interlock switch is in the aircraft plug position.

2. Check that IDLE/ RUN switch is set to Run. If the Genset (Amber) LOAD LED and the AC Ready lamp (34 Green) is not ON, rotate and hold switch to the RESET position for 1 second. The Genset (Amber) LOAD LED on the Alternator/Engine Display and Diagnostic Controller and the AC Ready lamp (34 Green) should come ON. This indicates the GPU is ready for power output.
3. Push DC Power ON Switch (1 Green). DC Power ON Lamp (32 Green) will light and remain on while the DC system is ON.
4. Push the DC Output ON switch (2 White).The DC Output ON Lamp (17 Green) and the DC Output Contactor will remain ON while power to the aircraft is supplied.
5. The aircraft may now use DC power. During a start cycle, the DC Voltmeter (12) may fluctuate above and below 28.5 VDC. THIS IS NORMAL. The GPU will automatically compensate for the voltage drop in the cable to supply the starting voltage within specification at the aircraft receptacle. During the start, the Ammeter (13) will show high amps initially and then quickly decay to show the continuing current draw.
6. Check all gauges for correct operation during the engine start cycle.
7. To shut down the GPU, push DC Output OFF switch (2 Black). DC Output ON Lamp (17 Green) and the DC Output Contactor will turn off.
8. Push the DC Power Off switch (1 Red)
9. Return IDLE/ RUN switch (5) to IDLE.
10. Shut down GPU by pushing the Engine Power OFF switch (3 Red). GPU will run at idle for 1 minute to cool down before shutting off. **DO NOT USE EMERGENCY STOP SWITCH**. **FOR EMERGENCY USE ONLY, DO NOT USE FOR ROUTINE STOPS.**
11. Stow DC plug and cable in cable tray.

5.4 Start up procedures continued on the following page.

5.4 START UP PROCEDURES *(continued)*

5.4.4 EMERGENCY SHUT DOWN PROCEDURE

In the event an emergency shut down is necessary, press the emergency stop switch located on the electrical panel. The EMERGENCY STOP BUTTON IS FOR EMERGENCIES ONLY.

CAUTION!

DO NOT USE for normal shut down. The Emergency Stop bypasses the timed cool down circuit and may cause engine damage due to overheating.

5.5 DESCRIPTION OF ALARM SYSTEMS

Reference *Figures 1 and 2 Control Panel (Exterior)*

5.5.1 DC Fault Lamp

The DC Fault lamp (21 Red) lights or blinks when there is a fault. (See troubleshooting table for conditions)

5.5.2 DC Warning Lamp

The DC Warning lamp (23 Amber) lights or blinks when there is a warning. (See troubleshooting table for conditions).

5.5.3 DC Power ON Lamp

The DC Power ON lamp (32 Green) lights when the DC system is ON, it also blinks when there is a fault or warning. (See troubleshooting table for conditions).

5.5.4 Stop Engine Lamp

The Engine Stop Lamp (18 Red) lights when a serious fault has been detected or when Approaching Engine Protection Shutdown Limits. (Note: the lamp is controlled by the engine's ECM.

5.5.5 Wait To Start Lamp

The Wait To Start Lamp (19 White) lights for a relevant period of time to inform the operator that the GPU SHOULD NOT BE STARTED. The most common reason for this is to wait for the Intake Air Grid Heater to complete a preheat cycle during cold ambient conditions. (Note: The lamp and the Air Grid Heater are controlled by the engine's ECM.

5.5.6 Check Engine Lamp

The Check Engine Lamp (20 Amber) lights when prompt operator attention is needed. The engine ECM will turn on the lamp for a Non-Critical Active Engine Fault, Maintenance Timers, Diagnostic Messages and Water In-Fuel.

5.5.7 AC High Volt Lamp

The AC High Volt lamp (22 Red) lights when the alternator output is above 120 volts specification.

5.5.8 AC Low Volt Lamp

The AC Low Volt Lamp (24 Red) lights when the alternator output is below 110 volts specification.

5.5.9 AC High Hertz Lamp

The AC High Hertz Lamp (25 Red) lights when the alternator frequency is above 405Hz specification.

5.5.10 AC Low Hertz Lamp

The AC Low Hertz Lamp (26 Red) lights when the alternator frequency is below 390Hz specification.

5.5.11 AC Overload Lamp

The AC Overload Lamp (27 Red) lights when the alternator current is above 316 amps specification.

5.6 SAFETY SHUTDOWN AND INTERLOCK CIRCUITS

- The GPU contains safety circuits controlled by the Alternator/Engine Display and Diagnostic Controller (A/EDC), Automatic Voltage Regulator (AVR), the DC Interface Board and the engine's Electronic Control Module (ECM).
- The A/EDC starts the engine, monitors the Engine and alternator systems, enables the AC and DC power output systems and lights the AC fault lamps.
- The AVR (microprocessor located inside the control panel) is responsible for AC alternator voltage regulation and line drop compensation.
- The DC Interface Board (microprocessor located inside the control panel) is responsible for DC voltage regulation, line drop compensation, fault monitoring, and DC Output contactor control.

5.6 SAFETY SHUTDOWN AND INTERLOCK CIRCUITS *(continued)*

5.6.1 Start Circuit

External circuitry ensures that the starter can only be engaged when idle mode is selected. A 10 second delay allows time for the oil pressure to build up before the engine shutdowns are activated.

5.6.2 Stop Circuit

This circuit detects operation of the Engine Power OFF switch and forces the system into idle mode for 1 minute before turning the power off and stopping the engine.

5.6.3 Engine Fault Circuits

These circuits are initiated by engine sensors and routed through the engine ECM to perform engine shutdown.

- Low oil pressure- detects oil pressure is below 10 PSI.
- Engine coolant over temperature- detects engine coolant is above 225° F.
- Low coolant - detects low coolant level in the upper tank of the radiator.

5.6.4 DC Load Monitoring Circuits

These circuits monitor DC loads using comparative values in the DC Interface Board.

- DC over voltage- causes DC output contactor to open. Engine continues to run.
- DC over current- causes DC output contactor to open. Engine continues to run.
- DC under voltage- lights warning lamp only.

5.6.5 DC Fault Circuits

SCR thermostat- Opens DC output contactor when SCR Heat Sink rises above 90° C.
DC aircraft cable interlock- Allows DC Power On to be enabled only when the aircraft cable is plugged into the aircraft.

Note: The GPU/AIRCRAFT PLUG toggle switch inside the control panel overrides this feature for test purposes only.

CAUTION!

The DC aircraft cable interlock is enabled when the third and smallest pin on the aircraft receptacle completes the circuit in the split pin connector. Under no circumstances should the split pin be bridged in order to switch on the DC.

CAUTION!

When the GPU / AIRCRAFT PLUG toggle switch is in the GPU position, the DC output cable will be live. Only trained, authorized personnel should use the equipment in this condition.

5.6.6 Alternator/Engine Display and Diagnostic Controller (Datakom D-500)

See User's Guide for more information

5.6.7 Automatic Voltage Regulator (Basler AVC63-12-B2)

See User's Guide for more information

6.0 PACKAGING AND STORAGE

6.1 PACKAGING REQUIREMENTS

a. Turn battery switch to OFF position
b. Drain fuel
c. Ensure fuel cap is secure
d. Securely fasten doors and instrument panel drawer
e. Wrap for paint protection
f. Strap unit in truck or shipping container using 4 cargo straps. Hook one strap through each tie-down ring on the front

NOTE: Use at least four (4) straps with a minimum 3,000 lb (136 kg) capacity each.

6.2 HANDLING

The unit is designed to be lifted using a forklift.

6.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required for shipments within the continental United States.

6.4 LABELING OF PACKAGING

Packaging should be labeled as follows: **DO NOT DROP**
THIS SIDE UP
DO NOT STACK

6.5 STORAGE COMPATIBILITY

6.5.1 Short Term Storage (less than 3 months)

The following steps are recommended if the unit is to be placed out of services for three months or less. The unit should be prepared for storage as soon as possible after being removed from service.

1. Make sure that the mixed coolant is adequate for the lowest anticipated temperatures during time of storage.
2. Add oil to the FULL mark level on dip stick.
3. Drain a small portion of fuel from fuel tank by removing drain plug at of tank. This will remove any water that may have accumulated on the fuel tank.

NOTE: Do not drain the fuel system or crankcase.

4. Install new fuel filters.
5. Fill fuel tank to capacity. A full fuel tank prevents moisture laden air from entering the tank during the cool periods.
6. Close all access doors to minimize build-up of foreign particles in the unit.
7. Store unit in a building that is dry.
8. If the storage area has high humidity levels, place moisture absorbing chemicals inside the unit.

6.5.2 Long Term Storage

Special precautions are necessary to protect the GPU from rust and corrosion. It is recommended that the unit be stored in a building that is heated during winter months. Moisture absorbing chemicals should be placed inside the unit in climates where there is excessive dampness. Parts of the diesel requiring special attention are given below. The unit should be prepared for storage as soon as possible after being removed from service.

1. Drain the cooling system. Flush with clean water. Refill with 50/50 mix of water and antifreeze or mix according to ratio for temperature as recommended in the Cummins Operation and Maintenance Manual section V.
2. Circulate the coolant by operating the engine until the normal operating temperature is reached.
3. Stop the engine.
4. Drain the engine crankcase. Reinstall the drain plug. Install new lubricating oil filter element. Refill with high quality lubricating oil as recommended in the Cummins Operation and Maintenance Manual section V.
5. Drain the fuel tank of contaminants, fuel/water. Add additives, fill with fuel, and operate the engine for about ten minutes.

NOTE: Where biological contamination may be a problem, add a biocidal such as Biobor JF or equivalent to the fuel. Follow the biocidal manufacturer's concentration recommendations and observe all warnings and cautions.

6. Remove the spin-on fuel filters, discard, fill new filters with fuel and reinstall on the engine.
7. Remove and clean battery terminals and cables with baking soda-water solution, rinse with fresh water. Do not allow the soda water to enter the battery. Add distilled water to the electrolyte, if necessary fully charge the battery. Store the battery in a cool dry place (never below 32ºF, or 0 degrees C). Keep the battery fully charged and check the specific gravity of the electrolyte regularly.
8. Seal all engine openings, including the exhaust outlets with moisture resistant tape. Use cardboard, plywood, or metal covers where practical.
9. Tag engine Control Panel "DO NOT RUN, READY FOR STORAGE".

7.0 TRANSPORTATION

1. Do not stack.
2. Unit is designed to be lifted with a fork lift.
3. Strap unit in truck or shipping container using 4 cargo straps. Hook one strap through each tie-down ring on the front. Hook one strap through each axle spacer on the rear. Raise tow-bar into latch. Set parking brake and block wheels.
4. Weight**:** 4800 lbs (2177 kg)

8.0 SERVICING

As with all Ground Support Equipment, it is very important to provide proper preventative maintenance and service. This will increase the service life of the diesel engine, which can be expected to operate for 30,000 hours without a major overhaul (this may vary according to local operating conditions.) The following specifies consumable service requirements:

Fuel: Ensure that the correct diesel fuel ASTM D 975 is used. (If using Jet A Fuel, the Fuel/Lubricity Filter **MUST** be changed at **450 – 500 HOUR** intervals or every six (6) months). Refer to section V of the Cummins Operation and Maintenance Manual (provided as a supplement to this manual) for other allowable fuels.

Engine Oil: 15W-40 (API CH-4) is suitable for most operating temperatures. However, lower viscosity oils can be used to aid starting at temperatures below -5° C (23° F). Refer to section V of the Cummins Operation and Maintenance Manual (provided as a supplement to this manual) for oil and viscosity recommendations.

CAUTION!

Do not over fill the engine as damage may occur. Always use the engine oil level dipstick to ensure the correct level. Always use the same brand of engine oil. When topping up the oil level always prevent dirt from entering by cleaning around the oil filler prior to filling. The engine oil level should be checked every 10 hours of operation.

Cooling System: Use 50/50 ethylene glycol mixture for temperatures above -36° C (-33° F). Refer to section V of the Cummins Operation and Maintenance Manual (provided as a supplement to this manual) for anti-freeze and water quality recommendations.

Filters: Fuel lubricity filter ..... Change every 500 hours or 6 months
Engine oil filter..... Change every 500 hours or 6 months with oil change
Air cleaner filter ..... Check daily. Change when clog indicator shows clogged

8.1 GENERAL (DAILY CHECKS)

1. Unit..... Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance
2. Radiator ..... Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required
3. Engine Hoses..... Check integrity of hoses and clamps for tightness
4. Fuel Level ..... Turn power on and check fuel level on fuel gauge. Top up as required with fuel
5. Engine..... Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block oil pan and valve covers for oil leakage
6. Oil Level..... Remove dipstick to ensure oil level is at full mark. Replenish as required
7. Fan Belt..... Check belt for correct tension. Look for wear
8. Air Intake Filter..... Ensure that plugged filter indicator shows clean, if not, replace air filter. Check again once unit is running
9. Doors ..... Check that all doors and instrument panel drawer are securely latched before driving or starting

8.0 Servicing continued on following page.

8.0 SERVICING *Continued*

8.2 SHORT TERM PREVENTIVE MAINTENANCE SCHEDULE

It is recommended to change the engine oil and filter after the first 50 hours of operation.

The following table is provided as a guide to for frequent service intervals. The Cummins Operation and Maintenance Manual (provided as a supplement to this manual) provides engine service interval information for daily, 250 hour, 500 hour, 1000 hour and 2000 hour intervals. See the Cummins Operation and Maintenance Manual sections 2 thru 7.

INSPECTION AND SERVICE SCHEDULE (HOURS)

COMPONENT	DAILY	250	500	6 Months
ENGINE OIL				
Check Level	X			
Change Oil			X	X
Change Filter			X	X
Check Oil Pressure	X			X
COOLANT				
Inspect Hoses and Clamps	X			
Check Level (Cold)	X			
Inspect Fan Belt	X			
Check Coolant Concentration		X	X	X
Flush and Change Coolant			2000	
FUEL				
Change Lubricity Filter			X	X
Change Fuel Filter			X	X
Check Fuel Level	X			
Inspect Hoses and Clamps	X			X
Inspect for Leaks	X			X
Drain Water Separator	X			
EXHAUST				
Inspect	X			
Tighten Clamps		X		X
AIR INTAKE				
Inspect Hoses and Clamps	X			
Check Clog Indicator	X			
New Filter (When Clogged)			X	
24 VDC				
Check Battery Fluid (If Applicable)			X	X
Check Battery Terminals	X			X
CHASSIS				
Check for Loose Hardware	X			X

8.2 SHORT TERM PREVENTIVE MAINTENANCE SCHEDULE *(continued)*

INSPECTION AND SERVICE SCHEDULE (HOURS)

COMPONENT	DAILY	250	500	6 Months
DC SYSTEM				
Check SCR Connections			X	X
Check Transformer connections			X	X
Check DC Cable and Plug	X			X
Check Terminals			X	X
Check Insulation	X			X
Check Contactor			X	X
AC SYSTEM				
Check Alternator Connections			X	X
Check Power terminal block connections			X	X
Check AC Cable and Plug	X			
Check Cable Terminals			X	X
Check Cable Insulation	X			
Check Output Contactor			X	X
ELECTRONICS				
No Action				
INSTRUMENT PANEL				
Check Gauges	X			X
Warning Lamps	X			X
Inspect Switches			X	X
Calibration			X	X

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS

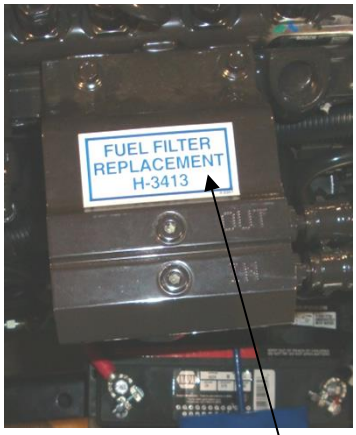
9.1 GENERAL (Daily Checks)

1.	Unit	Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance.
2.	Radiator	Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required.
3.	Engine Hoses	Check integrity of hoses and clamps for tightness.
4.	Fuel Level	Turn power on and check fuel level on fuel gauge. Top up as required with fuel.
5.	Engine	Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block oil pan and valve covers for oil leakage.
6.	Oil Level	Remove dipstick to ensure oil level is at full mark. Replenish as required.
7.	Fan Belt	Check belt for correct tension. Look for wear.
8.	Air Intake Filter	Ensure that plugged filter indicator shows clean, if not, replace air filter. Check again once unit is running.
9.	Doors	Check that both doors are securely latched before driving or starting

Reference Sections **9.2 – 9.14** for Parts Lists, Descriptions and Illustrations

9.2 FILTERS

NOTE: The lubricity fuel filter plays a dual role in filtering the fuel and adding a lubricant. The lubricant is necessary when using Jet A fuel. Change the filter every 500 hours of running time or every six months. To change filter loosen filter first and then remove filter assemble from mounting bracket. To drain engine oil move lever on oil drain valve down.



Engine Oil Drain Valve

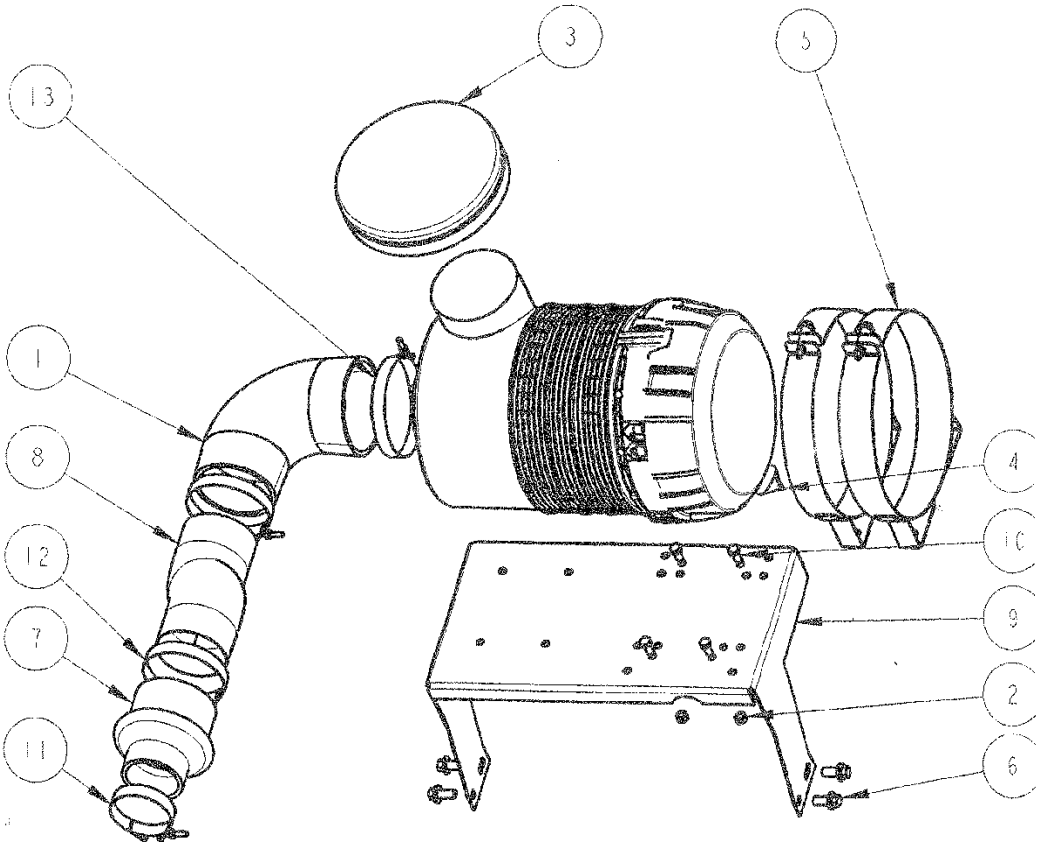
1 **2** **3**

Item	Part Number	Description	Qty
1	H-3414	Lubricity Filter	1
2	H-3413	Fuel Filter	1
3	H-3412	Oil Filter	1

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS *(continued)*

9.3 AIR CLEANER

25g/CFM, Open, SAE #3



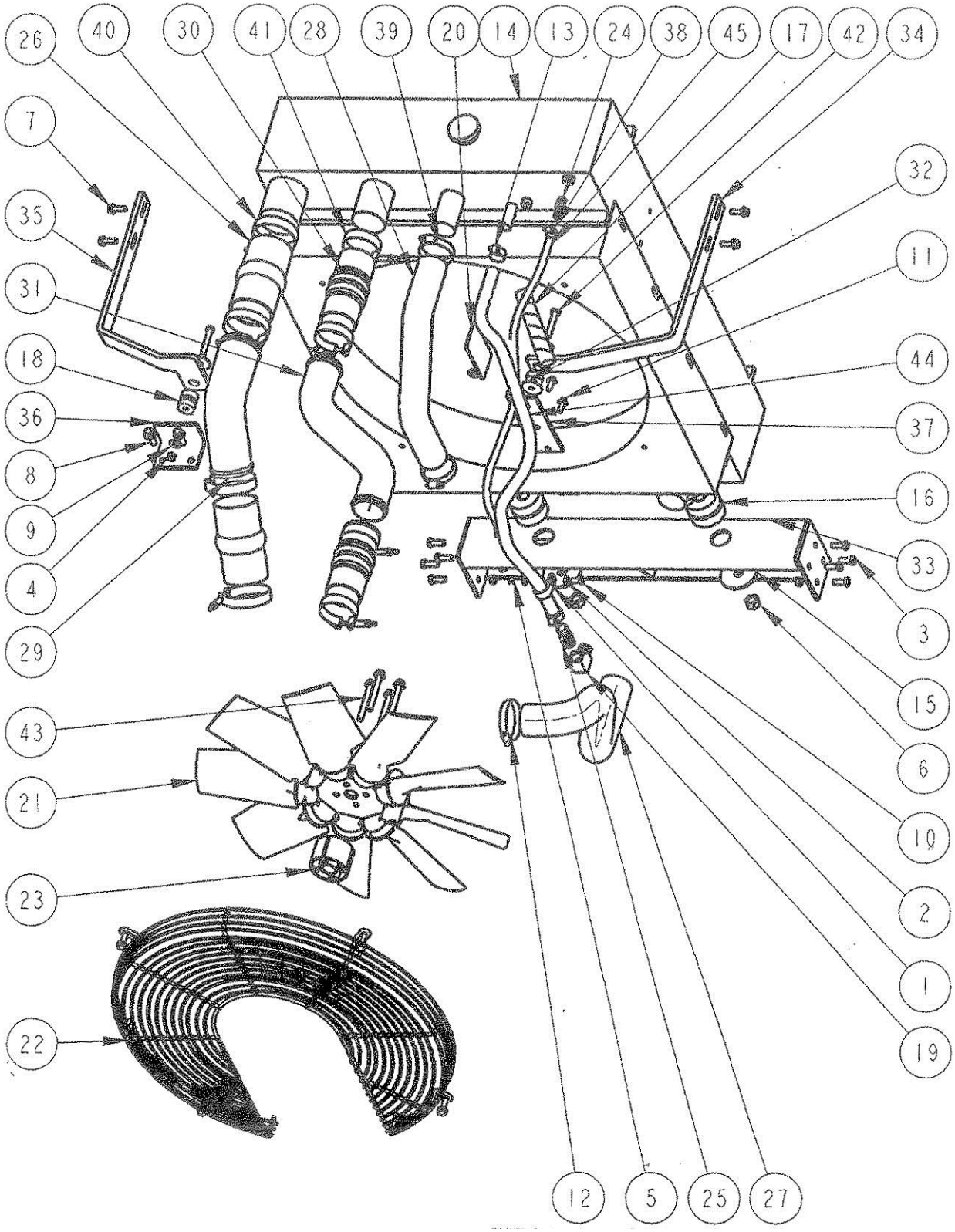
Item	Part Number	Description	Qty
1	5100342	Hose, Elbow	1
2	8100019	Nut, Lock, 3/8 – 16	4
3	10000049	Cap, Rain	1
4	10000849	Air Cleaner Assembly	1
5	11000615	Clamp, Air Cleaner	2
6	33901249	Bolt, HH Flange, M12 – 1.75 x 25 mm	4
7	50000750	Hose, Hump Reducer	1
8	50000889	Tube, Formed Intake	1
9	70021940	Bracket, Air Cleaned	1
10	80000317	Bolt, HH, 3/8 – 16 x ¾	4
11	80000385	Clamp, T-Bolt, 3.50	1
12	80000388	Clamp, T-Bolt, 4.50	2
13	80000390	Clamp, T-Bolt, 5.50	1
Not Shown	50001253	Rain Cap Connector	1

9.0 Maintenance/illustrated parts list continued on following page

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS *(continued)*

9.4 ENGINE COOLING SYSTEM

NOTE: Use good quality ethylene glycol antifreeze mixed 50/50 or mixed for colder climate conditions using antifreeze manufacturer's chart.



9.4 ENGINE COOLING SYSTEM *(continued)*

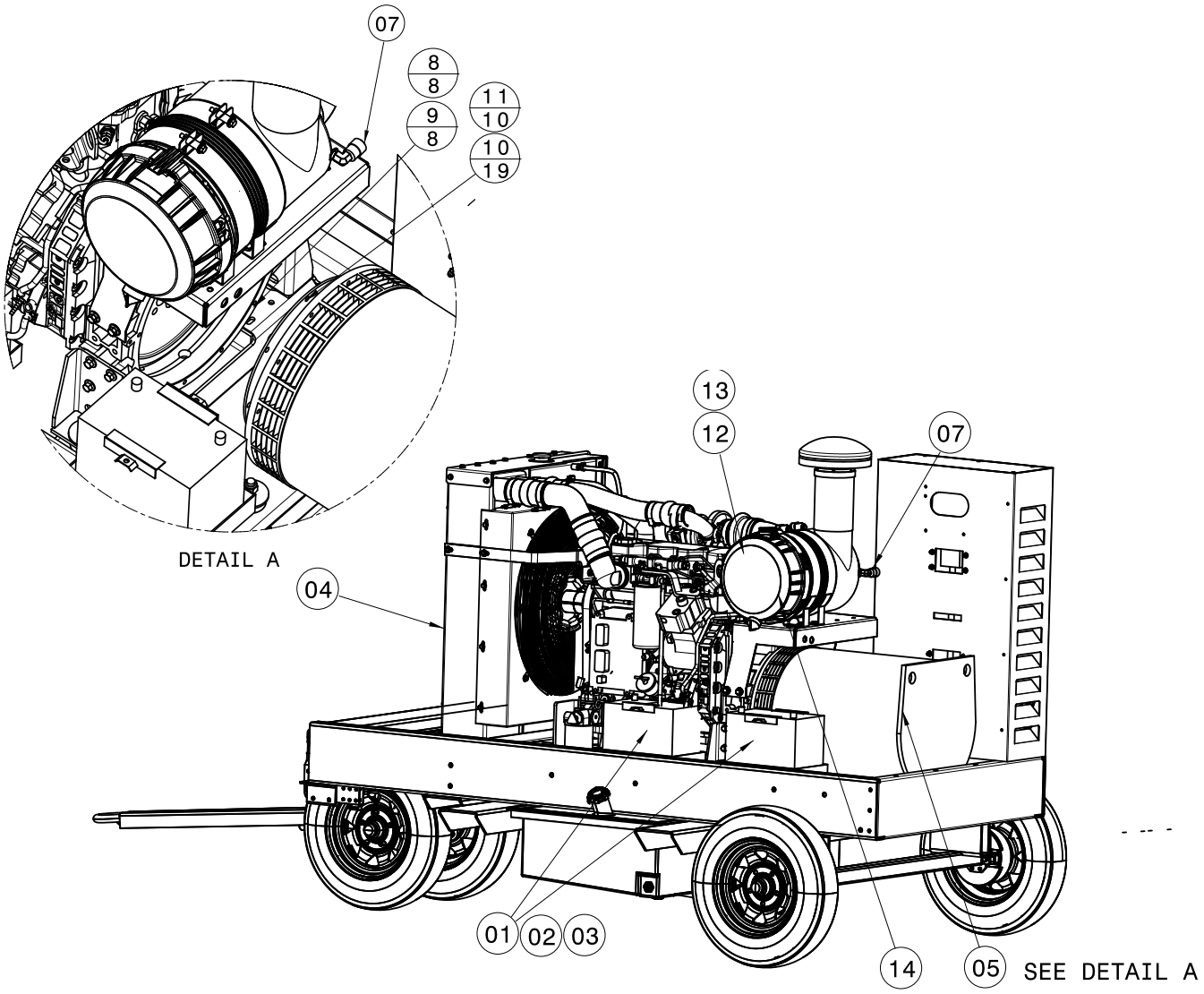
Cooling system blower, 125 LAT, w/CAC

Item	Part Number	Description	Qty
1	3107460	P-Clamp	1
2	3146160	Washer, Flat, 5/16	2
3	8100016	Bolt, HH, 3/8 – 16 x 1	8
4	8100019	Nut, Lock, 3/8 – 16	10
5	8100022	Nut, Lock, 5/16 - 18	1
6	8100047	Nut, Lock, 5/8 – 11	8
7	8100096	Bolt, HH Flange, 5/16 – 18 x 1	8
8	8100187	Bolt, HH Flange, M10 – 150 x 25 mm	2
9	8100236	Washer, Flat, 3/8	2
10	8100250	Bolt, HH, 5/16 – 18 x ¾	1
11	8100252	Bolt, HH Flange, M8 – 1.25 x 20 mm	2
12	8100270	Clamp, Hose #40	2
13	8100273	Clamp, Hose #10	2
14	10000841	Radiator assembly w/CAC	1
15	1100038	Washer, Cinch, .66 ID, 2.75 OD, .19 THK	2
16	11000102	Isolator	2
17	11000125	Guard, Plastic Coil	1
18	11000182	Isolator	2
19	11000378	Fitting, Elbow ¾ NPT-M x ¾ NPT-F	1
20	11000506	Guard, Hose	1
21	11000737	Fan, Blower	1
22	11000827	Guard, Fan	1
23	33910130	Spacer, Fan, 2”	1
24	33910142	Fitting, Hose Barb, ¼ NPT-M x 3/8	1
25	50000185	Fitting, Hose Barb, ¾ NPT-M x ¾	1
26	50000437	Hose, CAC	2
27	50000605	Tube, Formed Radiator	1
28	50000606	Tube, Formed Radiator	1
29	50000887	Tube, Formed CAC	1
30	50001097	Hose, Air Intake, CAC	2
31	50001115	Tube, Formed CAC	1
32	70003210	Washer, Cinch	2
33	70025210	Cross Member Assembly	1
34	70025270	Bracket, Radiator	1
35	70025280	Bracket, Radiator	1
36	70025290	Bracket, Radiator	1
37	70025300	Bracket, Strut	1
38	80000044	Clamp, Hose #6	2
39	80000207	Clamp, Hose #32	2
40	80000220	Clamp, Constant Torque	4
41	80000435	Clamp, Constant Torque	4
42	80000590	Bolt, HH, 3/8 – 16 x 2 ¼	2
43	80000749	Bolt, HH Flange, M10 – 1.5 x 80 mm	4
44	50000491-30	Hose, Bulk	1

9.0 Maintenance/illustrated parts list continued on following page

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS *(continued)*

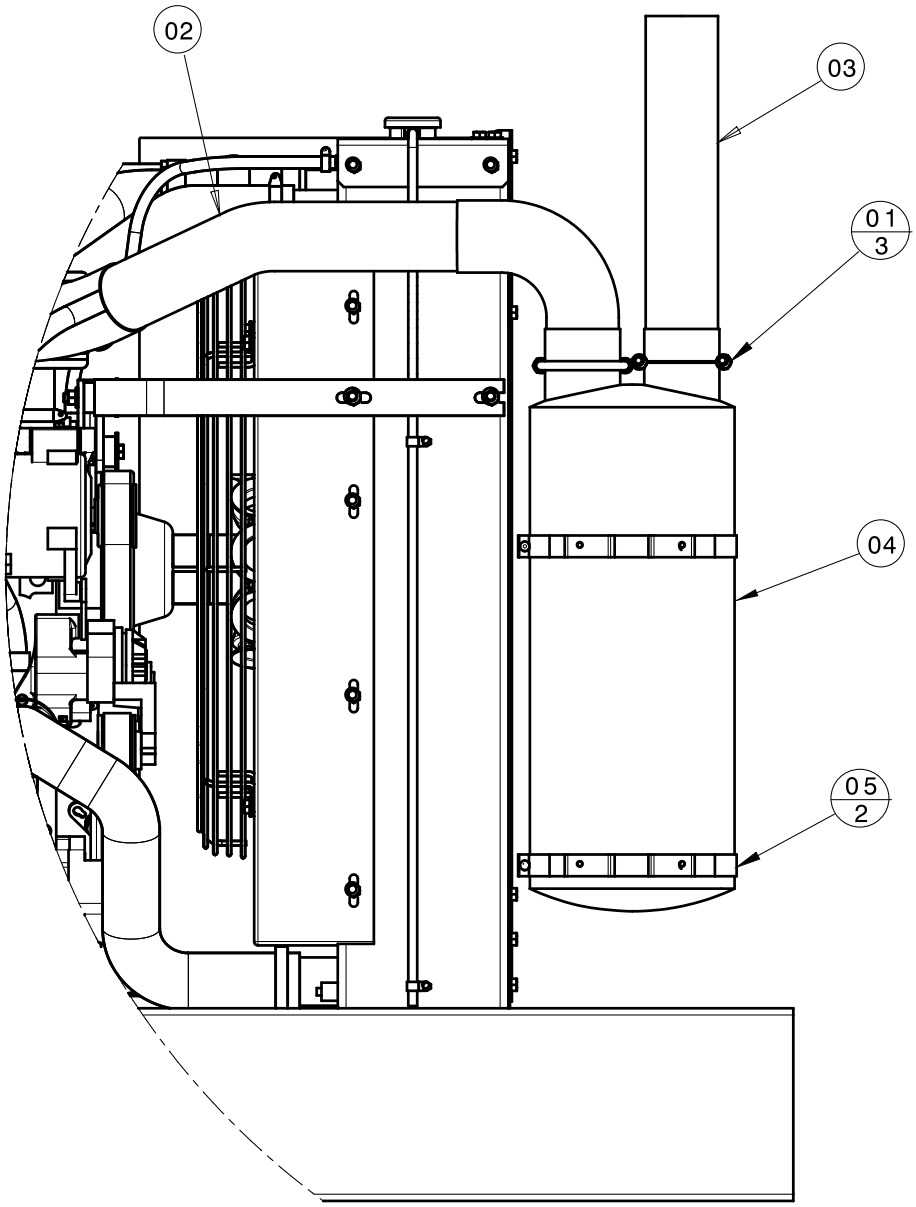
9.5 ENGINE/ALTERNATOR/ENGINE MOUNTING



Item	Part Number	Description	Qty
1	Z-8828	Tray, Battery	2
2	09032	12VDC Battery	2
3	K-4580	Kit, Battery Hold Downs	2
4	H-3832	Engine, Cummins B4.5 Power Unit	1
5	69005	72 KW 90 KVA Alternator	1
6	J-5989-01	Member, Rear Cross	1
7	09003	Filter Indicator	1
8	G-1420-107010	Bolt, 3/8-16 x 1 in. Hex Head Gr. 8	8
9	G-1513-1070N	3/8 Hardened Flat washer	8
10	G-1514-M100R	Lock Washer M10	19
11	G-1533-100035	Bolt, M10 x 35MM Hex Head	10
14	H-3404	Assembly, Air Filter	1
	K-4524	**Kit, Replacement Air Filter;** *consists of:*	
12	H-3402	Replacement, Primary Filter Element	1
13	H-3403	Replacement, Secondary Filter Element	1

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS *(continued)*

9.6 EXHAUST SYSTEM



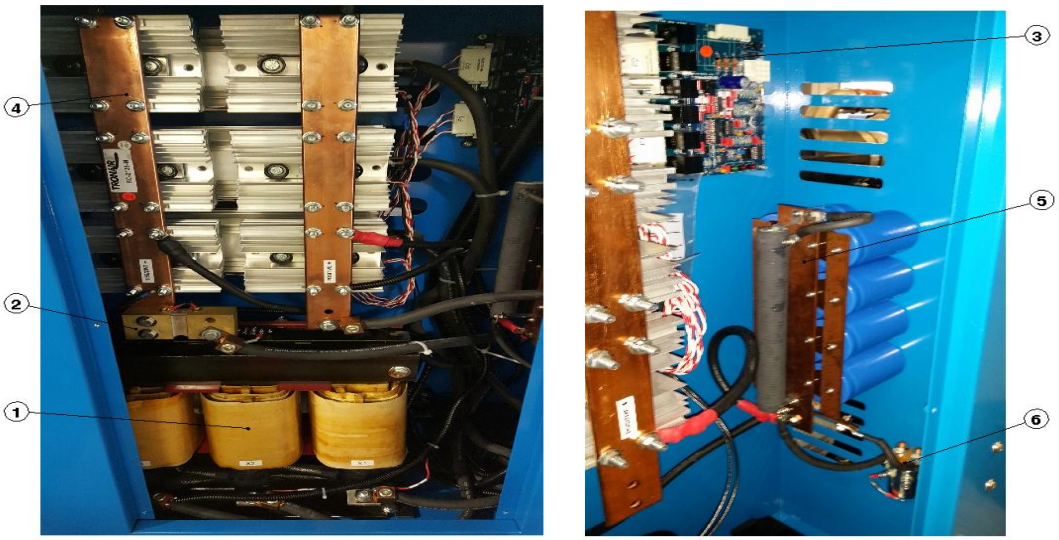
Item	Part Number	Description	Qty
1	18007	Clamp, 3” Muffler	3
2	Z-8812-01	Weldment, Exhaust Tube	1
3	18046-21.00	Tube, Exhaust	1
4	H-2883	Muffler	1
5	18057	Muffler Mounting Band	2

9.0 Maintenance/illustrated parts list continued on following page

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS *(continued)*

9.7 ELECTRICAL ASSEMBLIES

9.7.1 SCR Assembly/DC Capacitor Assembly/DC System Power Transformer

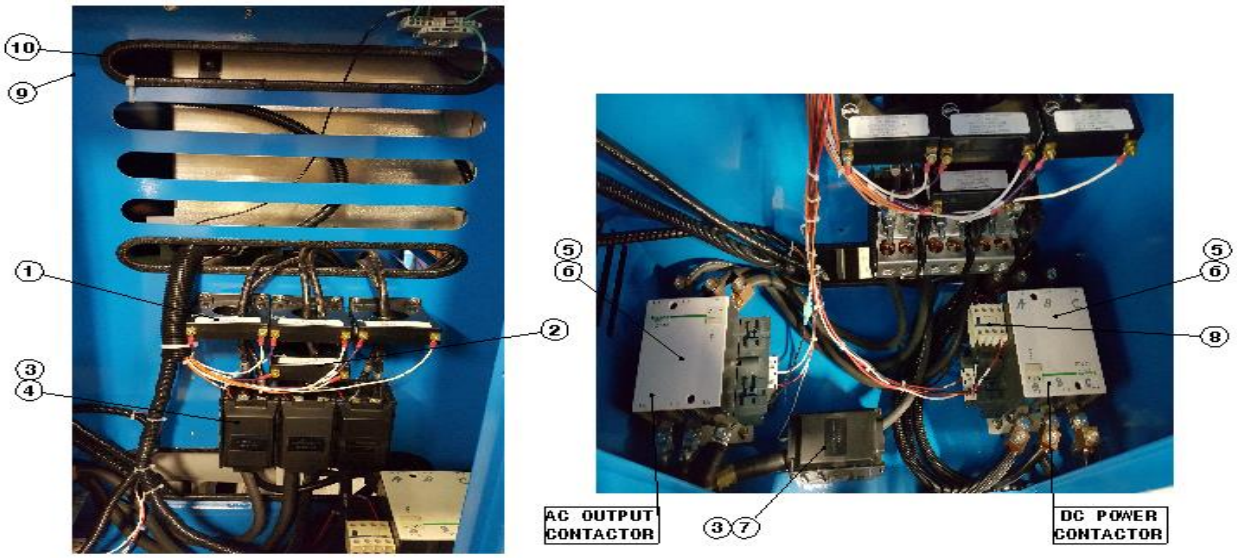


DC OUTPUT SYSTEM

Item	Part Number	Description	Qty
1	EC-2830	Transformer, 400Hz 25KVA	1
2	13002	Shunt, 2500 Amp	1
3	EC-2829	SCR Firing Board (400 Hertz)	1
4	EC-2128-M	SCR Assembly	1
5	Z-6900	Capacitors Assembly	1
6	EC-2177	Relay, High Amp	1
Not Shown	G-1503-1050N	Flatwasher, ¼ SS	4
Not Shown	G-1112-106010	Bolt, HH, SS, 5/16 - 18 x 1 LG	4
Not Shown	G-1503-1060N	Flatwasher, 5/16 SS	16
Not Shown	G-1500-1060	Nut, 5/16 – 18 SST	4
Not Shown	G-1112-107024	Bolt, HH, SS, 3/8 - 16 x 2 ½ LG	2
Not Shown	G-1502-1070R	Lockwasher, ¼ Regular	4
Not Shown	G-1503-1070N	Flatwasher, 3/8 Narrow SS	4
Not Shown	G-1112-107020	Bolt, HH, SS, 3/8 – 16 x 2 LG	1
Not Shown	G-1501-1070	Nut, 3/8 – 16 SS	1
Not Shown	EC-1027	Relay, 400 AMP	1
Not Shown	EC-1175-24-A	Strain Relief	2
Not Shown	G-1112-107012	Bolt, HH, SS, 3/8 – 16 x 1 ¼ LG	1
Not Shown	EC-1176-05	Nut	2
Not Shown	EC-1175-14-A	Strain Relief	1
Not Shown	EC-1176-03	Nut	1
Not Shown	4002-06	Diode, Power 1N5404	1
Not Shown	G-1501-1050	ESN, ¼ - 20	8
Not Shown	H-1082-02	Trim, Edge	30 in
Not Shown	G-1439-1035-S	Nutsert, #10-32	2
Not Shown	G-1112-105010	Bolt, HH, SS, ¼ - 20 x 1 LG	6
Not Shown	EC-1934	Cable, Aircraft DC Output	1

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS *(continued)*

9.7.2 AC Current Transformers/AC Power Distribution Blocks/AC & DC Output Contactors



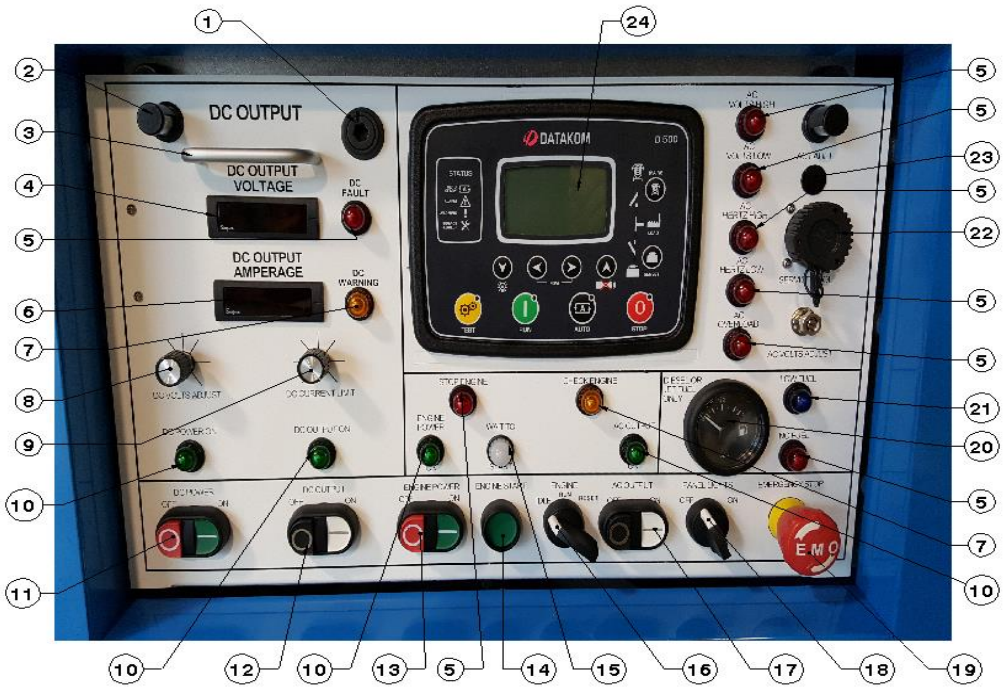
AC Output System

Item	Part Number	Description	Qty
1	EC-2867	Transformer, Current 3-Phase	1
2	EC-2871	Transformer, Current 1-Phase	1
3	EC-2487	Cover, Single Pole	4
4	EC-2486	Terminal, Power 3-Phase	1
5	13009	AC & DC Contactors	2
6	EC-2870	Coil, Contactor 400Hz	2
7	EC-2887	Terminal, Power 1-Phase	1
8	13026	Aux Switch	1
9	S-2805-01	Box, AC Assembly	1
10	H-1082-02	Trim Edge	40In.
Not Shown	17075	Cable, Aircraft W/o Head Sense	1
Not Shown	17083	Connector, 2-1/2 inch	1
Not Shown	17084	Locknut, 2-1/2 inch	1
Not Shown	EC-2700	Switch, Battery Disconnect	1

9.7 Electrical assemblies continued on following page.

9.7 ELECTRICAL ASSEMBLIES *(continued)*

9.7.3 Instrument Panel Drawer (Outside)



Item	Part Number	Description	Qty
1	H-2884	Latch, Door	1
2	EC-2693	Lamp, Panel	2
3	14074	Handle, Drawer	1
4	EC-2318	DC Volt Meter	1
5	EC-2008-03	Lamp, Assembly LED (Red)	8
6	EC-2319	DC Amp Meter	1
7	EC-2008	Lamp, Assembly LED (Amber)	2
8	12031	Knob, DC	1
	EC-2244	Harness, P10	1
9	12031	Knob, DC	1
	EC-2144-07	Potentiometer, 10K Sealed	1
10	EC-2008-02	Lamp, Assembly LED (Green)	4
11	14130	Switch, Power ON/OFF	1
	14142	Flange, Latch	1
	14143	Block, Contact (Green N/O)	1
	14144	Block, Contact (Red N/C)	1
12	14131	Switch, ON/OFF	1
	14142	Flange, Latch	1
	14143	Block, Contact (Green N/O)	2
13	14130	Switch, Power ON/OFF	1
	14142	Flange, Latch	1
	14143	Block, Contact (Green N/O)	1
	14144	Block, Contact (Red N/C)	1

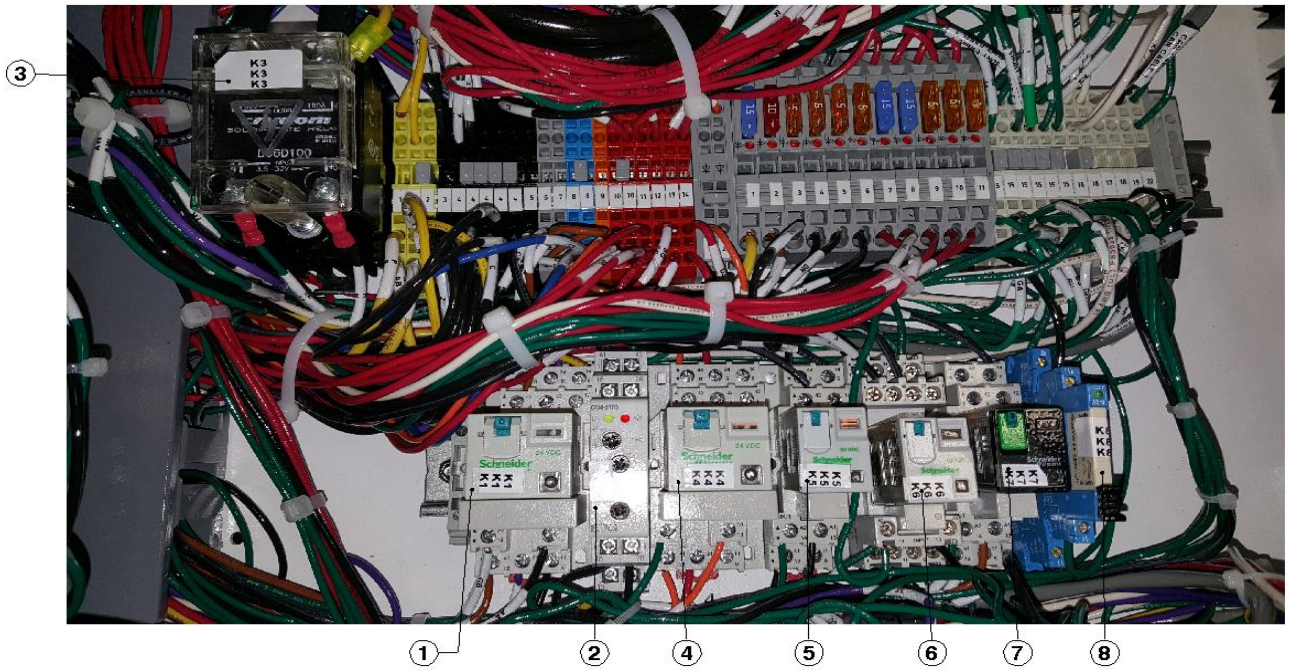
9.7.3 Instrument Panel Drawer (Outside) *(continued)*

Item	Part Number	Description	Qty
14	14141	Switch, Push	1
	14142	Flange, Latch	1
	14143	Block, Contact (Green N/O)	1
15	EC-2292	Lamp, Assembly LED (White)	1
16	Z-8889	Assembly, Switch Idle/Run	1
17	14131	Switch, ON/OFF	
	14142	Flange, Latch	
	14143	Block, Contact (Green N/O)	1
	14144	Block, Contact (Red N/C)	1
18	14133	Switch, 2 Position	1
	14142	Flange, Latch	1
	14143	Block, Contact (Green N/O)	1
19	14133	Switch, Emergency Stop	1
	14142	Flange Latch	1
	14143	Block, Contact (Green)	1
	14144	Block, Contact (Red)	2
20	EC-2294	Bezel, Fuel Gauge	1
	EC-2296	Gauge, Fuel VDO 3-180 OHM	1
21	EC-2008-01	Lamp, Assembly LED (Blue)	1
22	EC-2314	Receptacle, 9-Pin (Service Tool)	1
	EC-2317	Cover, 9-Pin (Service Tool)	1
23	EC-2088	Lamp, Assembly LED 120VAC (Green)	1
24	EC-2860	Alternator/Engine Display and Diagnostic Controller (Datakom D-500)	1

9.7 Electrical assemblies continued on following page.

9.7 ELECTRICAL ASSEMBLIES *(continued)*

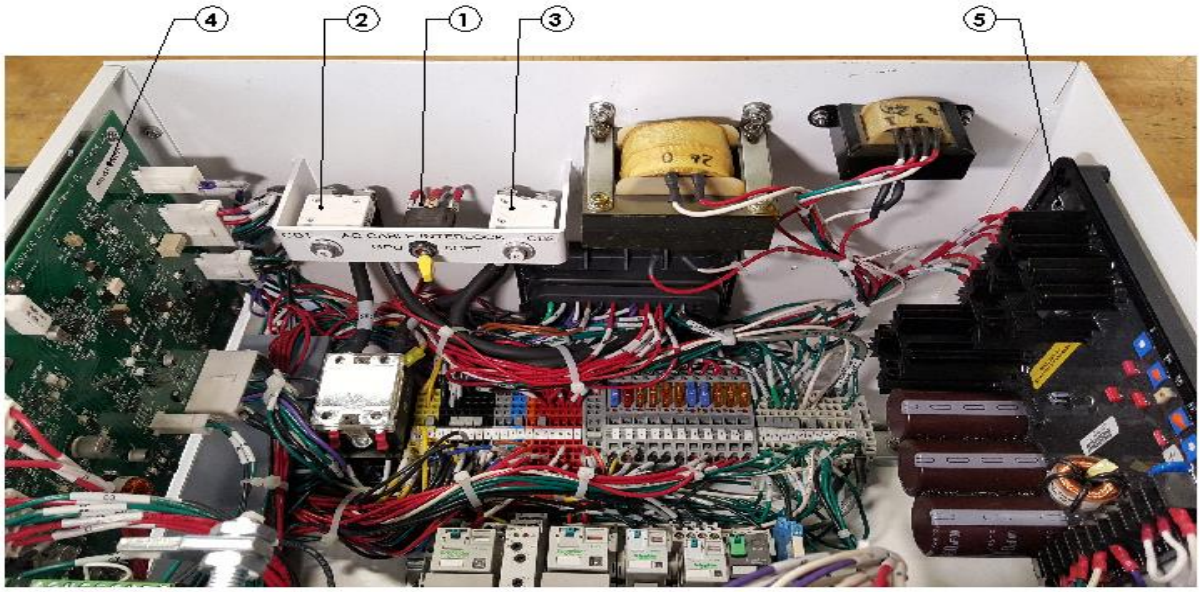
9.7.4 Instrument Panel Drawer (Inside)



RELAYS

Item	Part Number	Description	Qty
1	13074	Socket, Relay (TPDT)	1
	EC-2075	Diode, Plug-In Socket (TPDT)	1
	13064	Relay, Compact 24VDC (TPDT)	1
2	EC-2419	Relay, Time Delay Off 24VDC	1
3	EC-2566	Relay, Solid State (100 Amps)	1
4	13074	Socket, Relay (TPDT)	1
	EC-2075	Diode, Plug-In Socket (TPDT)	1
	13064	Relay, Compact 24VDC (TPDT)	1
5	13073	Socket, Relay (DPDT)	1
	EC-2060	Diode, Plug-In Socket (DPDT)	1
	13063	Relay, Compact 24VDC (DPDT)	1
6	EC-2076	Socket, Relay (4PDT)	1
	EC-2075	Diode, Plug-In Socket (TPDT)	1
	EC-2224	Relay, Compact 24VDC (TPDT)	1
7	13073	Socket, Relay (DPDT)	1
	EC-2060	Diode, Plug-In Socket (DPDT)	1
	13063	Relay, Compact 24VDC (DPDT)	1
8	EC-2902	Relay, Miniature 24vdc (SPDT)	1

9.7.4 Instrument Panel Drawer (Inside) (continued)



AVR and DC INTERFACE BOARD

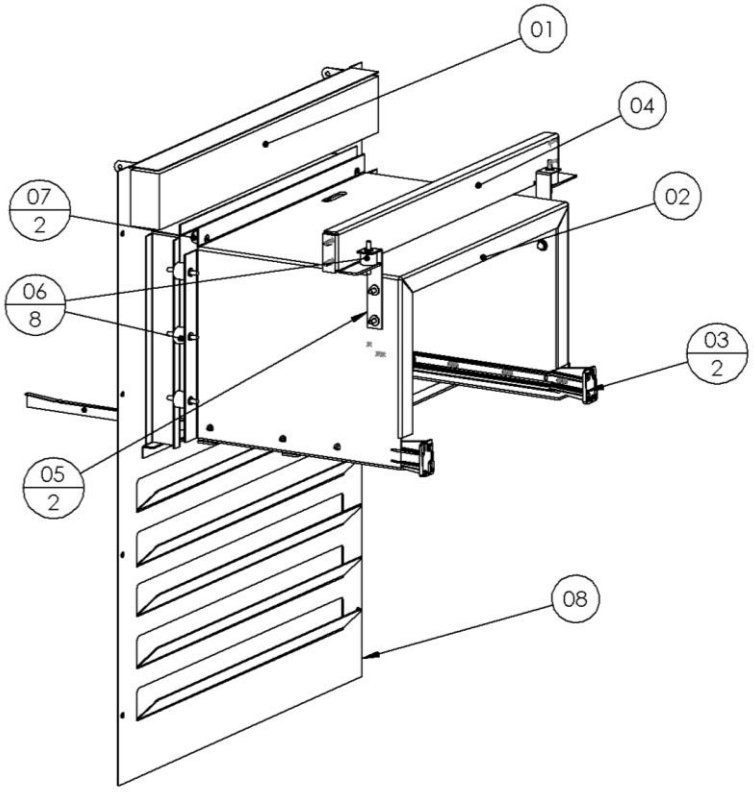
Item	Part Number	Description	Qty
1	EC-2791	Switch, Flat Toggle 2 Position	1
2	12073	Circuit Breaker, 70 Amp	1
3	12073	Circuit Breaker, 70 Amp	1
4	EC-2241	PC Board, Interface	1
5	EC-2858	Regulator, Voltage Automatic (AVR)	1

9.0 Maintenance/illustrated parts list continued on following page.

9.0 MAINTENANCE/ILLUSTRATED PARTS LISTS *(continued)*

9.8 SHEET METAL COMPONENTS

9.8.1 Instrument Panel Mounting

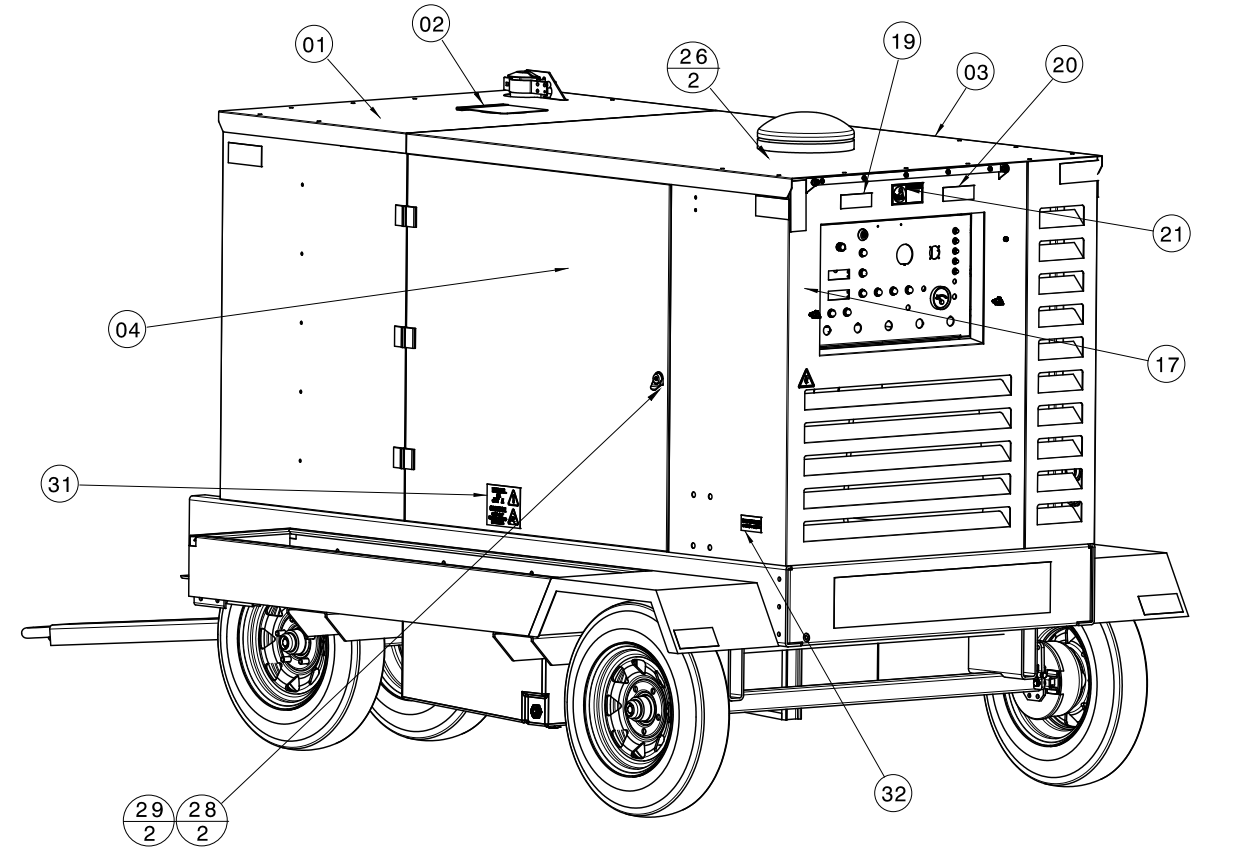


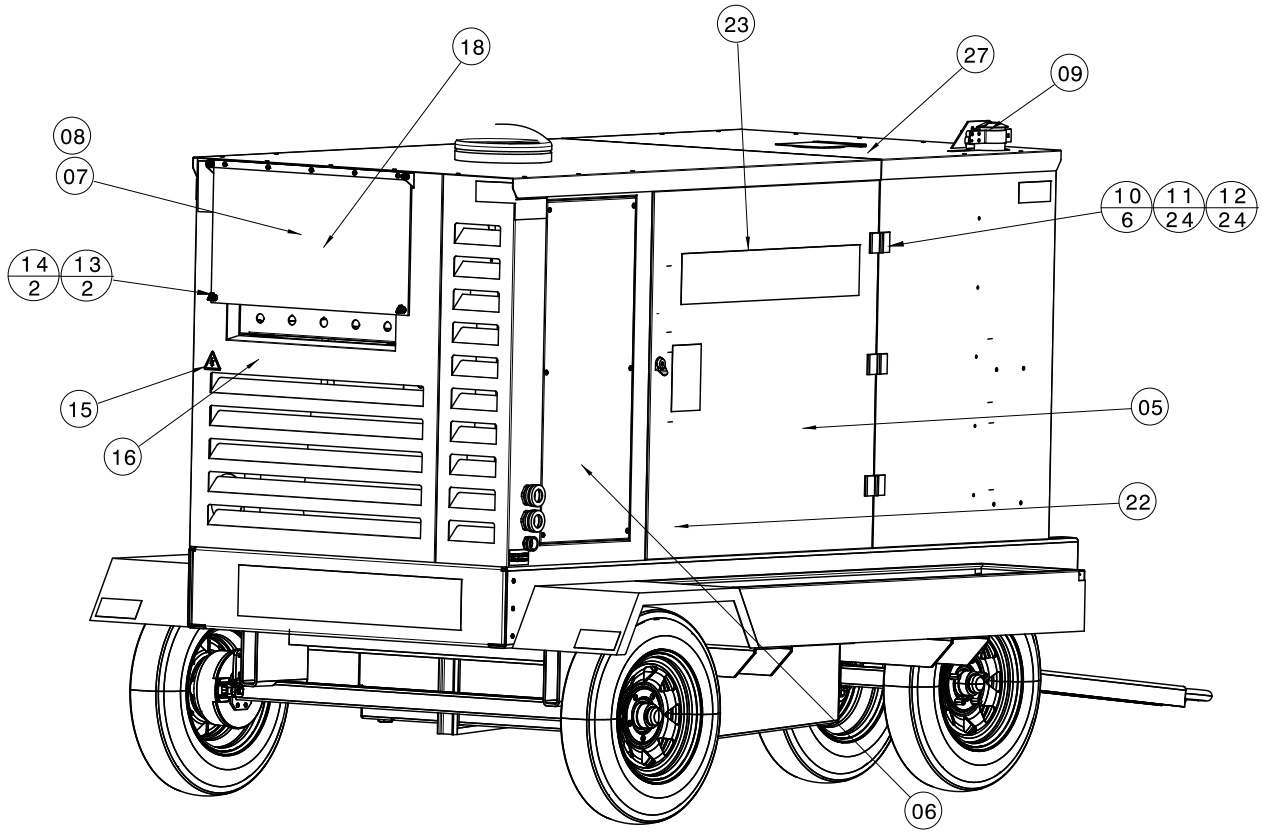
Item	Part Number	Description	Qty
1	K-5053-I	Kit, Soundproofing	1
2	S-2484	Box, Control Cover	1
3	H-3396	Drawer, Slide	2
4	S-2868-01	Support, Drawer, Non 28VDC Units	1
4	S-2759-01	Support, Drawer, 28VDC Units	1
5	S-2055-01	Angle, Drawer	2
6	09042	Vibration Mount	8
7	H-1547-08	Bumper, Rubber	2
8	S-2760-01	Instrument Louver	1

This page left blank intentionally.

9.8 SHEET METAL COMPONENTS *(continued)*

9.8.2 Outer Sheet Metal





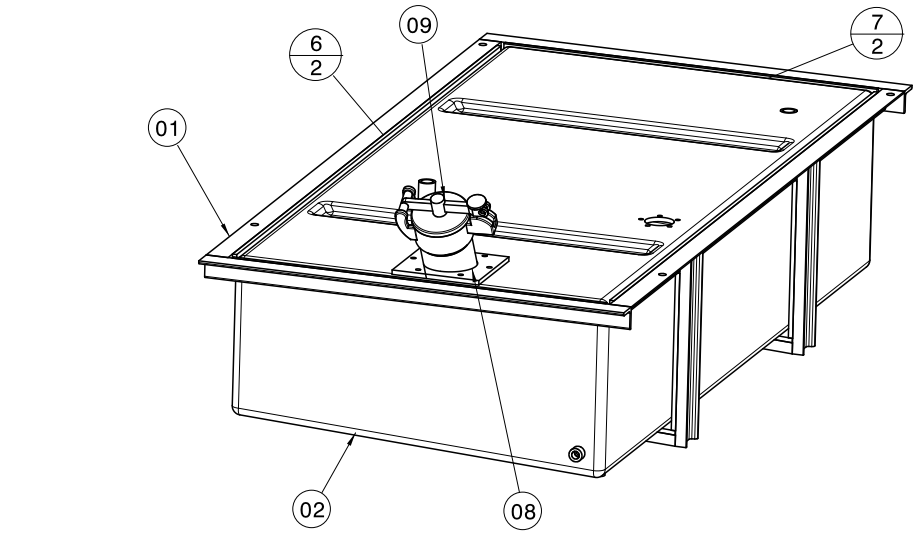
9.8.2 Outer Sheet Metal *(continued)*

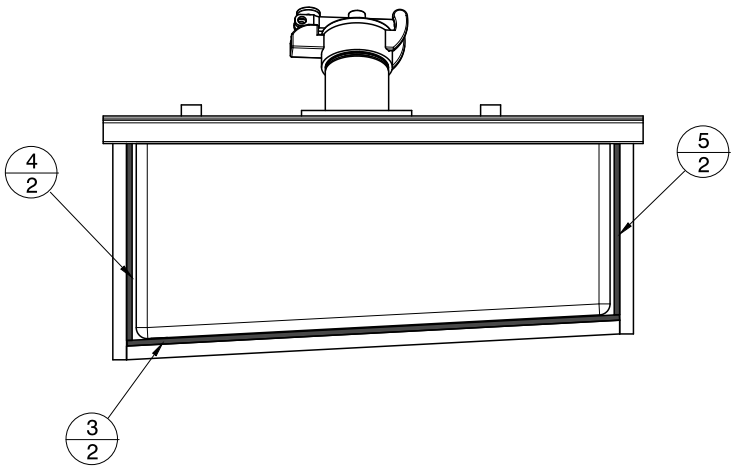
Item	Part Number	Description	Qty
1	Call Tronair	Top, Panel Front	1
2	Z-6168-01	Lid, Radiator Access	1
3	Call Tronair	Top, Panel Rear	1
4	S-2496-01	Door, Engine Long	1
6	S-2477-01	Door, Rectifier	1
7	S-2072-01	Hinge, Bottom	1
8	J-4940	Cover	1
9	18044	Muffler Rain Cap	1
10	H-2827	Hinge	6
11	G-1515-M60	Flatwasher, M6	24
12	G-1470-M6-1.0	ESN, M6-1.0	24
13	Call Tronair	Magnet	2
14	Call Tronair	Nut	2
15	V-1050	Label, Electric Shock	2
16	V-2118	Label, Serial Number CE	1
17	V-2377	Label, 28 V DC Operating Instructions	1
18	V-2096	Label, Danger (Harmonized)	1
19	V-2099	Label, Warning (Harmonized)	1
20	V-2097	Label, Warning (Harmonized)	1
21	V-1986	Label, Read Manual	1
22	V-2108	Label, Battery Switch	1
23	V-1340-04	Label, Tronair	3
24	V-2083	Label, 28.5 DC	2
25	12029	Bumpon	2
27	V-2109	Label, Fill Rate	1
28	H-2884	Door, Latch	2
29	H-2915	Pull, Tab	2
30	Call Tronair	Sheetmetal Package	1
31	V-2111	Label, Diesel or Jet A	1
32	V-2113	Label, Max Tire Pressure	1
Not Shown	H-2806	Reflector, Yellow (Cut 5” Long)	40 in
Not Shown	Call Tronair	Light, Stack Green (optional)	1
Not Shown	Call Tronair	Light, Corner, Amber (optional)	2
Not Shown	Call Tronair	Light, Stack Blue (optional)	1
Not Shown	Call Tronair	Light, Corner, Red (optional)	2

9.8 Sheet metal components continued on following page.

9.8 SHEET METAL COMPONENTS *(continued)*

9.8.3 Fuel Tank And Frame





Item	Part Number	Description	Qty
1	Z-8903-01	Weldment, Fuel Tank Cage	1
2	H-3877	Fuel Tank, Black	1
3	S-2451-01	Pad, Sound Foam (22-3/8”)	2
4	S-2451-02	Pad, Sound Foam (8-15/16”)	2
5	S-2451-03	Pad, Sound Foam (7 ¾”)	2
6	S-2451-04	Pad, Sound Foam (44”)	2
7	S-2451-05	Pad, Sound Foam (21 ½”)	2
8	Z-7756	Weldment, Fuel Filler	1
9	15253	Cap, Fuel	1
Not Shown	09293	Sensor, No Fuel	1
Not Shown	EC-2297	Sending, Unit Fuel Level	1
Not Shown	G-1100-105010	¼ - 20 x 1 Hex Hd GR 5	6

10.0 TROUBLE SHOOTING

This section outlines the probable cause of a malfunction. The GPU is designed for fast fault detection. Assuming that all daily checks have been undertaken and the GPU is properly serviced, regarding all fluid levels and that the GPU 24 VDC batteries are fully charged, then there should be no reason for the engine not to start. If the engine fails to start after the above inspection then the fault may be isolated to:

- Electrical harness
- The instrument panel and switches
- The engine electronic control module
- The Alternator/Engine Display and Diagnostic Controller

If an inspection shows that the cable harnesses are undamaged and properly connected then the instrument panel drawer assembly may be easily be changed for a spare unit and the GPU returned to immediate service.

The following troubleshooting chart is laid out in this same sequence. Commencing with the front of the unit and working through the machine to the aircraft connector. This systematic fault finding technique will greatly speed up identification of where the fault exists which will then allow remedial action to be taken quickly.

WARNING!

The GPU should not be operated for test purposes other than by fully qualified technical personnel. At all times avoid personal contact with electrical power components. During servicing remove all jewelry which could cause a short circuit in any live circuit. Failure to comply with the above basic rules may result in serious injury or death.

Prolonged exposure to high noise levels may cause hearing loss. Ear protection devices should be used when the machine is running.

Prolonged exposure to fuel products and oils may cause skin irritation, and all exposed parts of the body should be immediately washed following any service work on the GPU.

No loose clothing should be worn in the vicinity of the GPU when it is operating with the access doors open. The GPU has rotating parts which can be a hazard in the vicinity of loose clothing.

The 24 volt batteries under certain circumstances can produce explosive gasses and therefore smoking or open flames should not be permitted in the vicinity of the batteries during servicing.

The GPU should not be operated in an enclosed area unless exhaust discharge is properly vented to the outside. Exhaust gases can be deadly.

UNDER NO CIRCUMSTANCES should personnel USE ETHER to start the engine when performing maintenance or service tasks, the engine is equipped with an automatic intake air grid heating system. Failure to comply with these instructions can cause fires and/or explosions and serious personnel injury.

10.1 USE OF THE TROUBLESHOOTING CHART

Electrical schematic and wiring diagrams are included in the Appendices of this manual and should be referred to in conjunction with the other manuals attached in the Appendices of this manual.

First step in troubleshooting is to list the circumstances of the failure and what happened exactly prior to this occurrence. With experience of the machine it will then become quite easy to determine what has actually happened to which component.

The charts list information under three headings:

- Fault
- Possible Cause
- Solution

10.1 Use of the trouble shooting chart continued on following page.

10.1 USE OF THE TROUBLESHOOTING CHART *(continued)*

10.1.1 24 VDC Power

FAULT	POSSIBLE CAUSE	SOLUTION
No power when "power-on" switch is selected	Main breaker off	Reset CB-1
	Main battery switch off	Check, turn on
	Loose battery terminals	Check, clean and tighten terminals
	Low electrolyte	Check fluid and top-up if required
	System leakage-battery discharged	Check power input via P1 connector to the panel, if current flow ceases with P1 disconnected, check leakage to all systems fed by P1 plug. Isolate failed component and rectify. If all P1 fed components okay then inspect the relays for failure-replace
	Power-ON select switch inoperative	24 VDC should be available at the switch. Test switch for correct operation
	Power on circuit relay off	Check emergency stop switch. Refer to schematic of other possible component failures in the power-on circuit
Power-OFF select switch does not remove power	Power-OFF select switch inoperative	Check switch for correct operation if okay, shutdown delay timing relay in drawer defective

NOTE: Upon engine power off, the GPU will continue to run at idle for approximately one minute before stopping

Power on locks in and power ON lamp (green) is on, but engine starter motor will not turn	Idle/Run switch	Check, rotate switch to Idle position
	No Fuel Lamp and relay ON	Fuel level below No Fuel sensor, refuel GPU
	P1 starter wire disconnected	Reconnect. If starter still does not turn jumper battery + to solenoid, if motor turns, check start switch in panel
	The Alternator/Engine Display and Diagnostic Controller not working	The controller is not in AUTO mode. The controller is not receiving a start signal from the start switch
24 VDC power gradually fades, voltage below 18 VDC	Charging alternator inoperative	Check P1 to alternator cable if okay. Check 100 amp relay in panel. If relay wiring okay. Check alternator output current, if zero replace

10.1.2 Engine

FAULT	POSSIBLE CAUSE	SOLUTION
Engine will not start, 24 VDC power okay, starter turns engine okay	Fuel	Check fuel level. Check fuel filter & replace. Check lift pump by loosening outlet fitting, replace, if faulty
	Electrical Engine ECM	Check the Alternator/Engine Display and Diagnostic Controller for engine faults.
Engine starts and then stops within 10-20 seconds	Low oil pressure or empty oil gallery after oil change	Restart. Check oil pressure, if normal engine will continue to run
	Electrical Engine ECM	Check oil pressure with the Alternator/Engine Display and Diagnostic Controller if no indication, check Cummins Engine Manual
High coolant temperature	Low coolant	**LET ENGINE COOL DOWN,** then check coolant level
	Broken fan belt	Replace
Excessive engine vibration at steady state 2000 rpm	Injector or engine valve out of adjustment or worn	Check engine manual in Appendices

All other engine faults consult engine manual in Appendices

10.1.3 Alternator

FAULT	POSSIBLE CAUSE	SOLUTION
High frequency vibration or sound, metal particles in base of alternator	Ingress or digress	With battery disconnected, remove any foreign objects
	Bearing overheat	Check bearing housing, if hot, allow GPU to cool, inspect and replace bearing, according to manual
Any one phase not producing rated voltage or current (phase balance)	Broken or frayed connections	Check alternator output cables and connections to contactors
	Electrical	Test diodes in the non-driven end of the alternator. Consult manual in Appendices

10.1.4 Exhaust System

FAULT	POSSIBLE CAUSE	SOLUTION
Cooling air outlet louver blackened with soot	Leakage within the exhaust plenum chamber	Check all joints, adjust tubes and secure clamps. Any tubes that have corroded should be replaced
Blackened components around exhaust on the engine side of the radiator	Leakage, failure or loose tubes	Ensure all tubes are fully inserted into the mating "bell" ends and re-clamp. Replace corroded or broken tubes

10.1.5 28 VDC DC POWER SYSTEM

FAULT	POSSIBLE CAUSE	SOLUTION
No volts or amps shown on operators panel when in RUN.	Sensing wires disconnected from 50 MV shunt on SCR	Check wires are connected on P1 harness
	Automatic Voltage Regulator not working (AVR AC system).	Check voltage across the AVR F1 and F2 terminals. If no voltage, flash the alternator field. If no voltage output after flashing the field, replace the AVR.
No power output, but AC system working	SCR heat sink, overheat	Turn off and let SCR cool down and re-test. Check continuity of thermostat switch on rectifier
	DC Interface Board not working	Replace Board
	DC Firing Board not working	Replace Board
No power at aircraft plug (assuming all control electronics are operating correctly)	Disconnected/broken power cables	Check continuity of positive and negative cables from GPU to plug
	Volt sensing lines disconnected	Check sensing and interlock continuity between GPU socket and return to plus and minus power points at the end of cable
	Contactor inoperative	Disconnect contactor coil wire. Operate from external 24 VDC 30 amp source. Replace if faulty

10.1 Use of the troubleshooting chart continued on following page.

10.1 USE OF THE TROUBLESHOOTING CHART (continued)

10.1.6 28 VDC CONTROL SYSTEM

FAULT	POSSIBLE CAUSE	SOLUTION
AC system output is correct. DC Output Contactor does not pull in	Contactor inoperative	Check 24 VDC power to K8, if fault persists check pilot relay K4, this should latch in, if faulty replace
	ON switch inoperative	Check signal on BJ with meter between this pin and ground, if no signal when DC “ON” button is pressed, check switch and wiring
	Pilot relay inoperative	Look for LED on K4 relay in control drawer, if none check coil wires
Power will not stay on	DC interlock faulty	Check interlock at cable head and interlock switch for continuity
Over volt light 'on' contactor drops out	DC cable voltage sensing wire broken	The VCC is set to provide 22-32 VDC at GPU based on cable head sensing of 28VDC. Check voltage sensing wires in cable
Overload light 'on' contactor drops out	Exceedance of rating	Consult with Tronair
28 VDC 'no load' available on remote sensing, zero volts indicated, low volts warning lamp on	Wiring fault	If meter indicates 28 VDC check remote sense wiring to cable
	Voltmeter	Check operation and replace if failed
28 VDC 'no load' available on remote sensing load is increased but ammeter shows zero amps	Shunt	Check shunt and wiring, measure MV output with clip leads attached prior to running. 2500 amps = 50 MV if okay check ammeter replace if failed

10.1.7 Instrument Panel

FAULT	POSSIBLE CAUSE	SOLUTION
Contact breaker keeps popping out, AFTER correction of all discernible faults	Weakened CB	Replace
Erratic Engine Idle	Faulty idle circuit in ECM	Contact Tronair
Transient engine performance not to specification	Faulty engine ECM	Contact Tronair

10.1.8 GENERAL

FAULT	POSSIBLE CAUSE	SOLUTION
All action taken per this chart for any specific fault - still not rectified	DC VCC failure	Replace complete. If fault is cleared return failed VCC to Tronair for analysis
Electronic module okay but specific fault still not rectified	Indeterminate	Replace instrument panel complete, if fault clears, then troubleshoot the panel on the bench, returning GPU to service. If fault persists check P2 and J5 harness and operators panel

10.1.9 CIRCUIT BREAKER

FAULT	POSSIBLE CAUSE	SOLUTION
CB-1 POPS	Short circuit in battery voltage wires from K2 relay	Replace relay, find short circuit
CB-2 POPS	Control Circuit Short (12 VDC)	Check control circuit and remedy fault
CB-3, -4, -5	Excitation transformer short	Change excitation transformer

11.0 PROVISION OF SPARES

11.1 SOURCE OF SPARE PARTS

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

12.0 IN SERVICE SUPPORT

Contact Tronair, Inc. for technical services and information. See Section ***1.3 – Manufacturer***.

13.0 GUARANTEES/LIMITATION OF LIABILITY

Tronair products are warranted to be free of manufacturing or material defects for a period of one year after shipment to the original customer. This is solely limited to the repair or replacement of defective components. This warranty does not cover the following items:

a) Parts required for normal maintenance
b) Parts covered by a component manufacturers warranty
c) Replacement parts have a 90-day warranty from date of shipment

If you have a problem that may require service, contact Tronair immediately. Do not attempt to repair or disassemble a product without first contacting Tronair, any action may affect warranty coverage. When you contact Tronair be prepared to provide the following information:

a) Product Model Number
b) Product Serial Number
c) Description of the problem

If warranty coverage is approved, either replacement parts will be sent or the product will have to be returned to Tronair for repairs. If the product is to be returned, a Return Material Authorization (RMA) number will be issued for reference purposes on any shipping documents. Failure to obtain a RMA in advance of returning an item will result in a service fee. A decision on the extent of warranty coverage on returned products is reserved pending inspection at Tronair. Any shipments to Tronair must be shipped freight prepaid. Freight costs on shipments to customers will be paid by Tronair on any warranty claims only. Any unauthorized modification of the Tronair products or use of the Tronair products in violation of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately void any warranty, express or implied.

The obligations of Tronair expressly stated herein are in lieu of all other warranties or conditions expressed or implied. **Any unauthorized modification of the Tronair products or use of the Tronair products in violations of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately *void any warranty, express or implied* and Tronair *disclaims any and all liability for injury (WITHOUT LIMITATION and including DEATH), loss or damage arising from or relating to such misuse*.**

14.0 APPENDICIES

APPENDIX I Electrical Schematics
APPENDIX II Marathon Alternator Manual
APPENDIX III Datakom Advanced Genset Controller User Manual
APPENDIX IV Declaration of Conformity

Additional Documents:
Cummins QSB4.5 Engine Manual
Datakom D-500 Advanced Genset Controller

TRONAIR®

APPENDIX I

400 Hertz/28.5 VDC Electrical Schematics

1190400C28T3 INS-2308
1190400CT3 INS-2306
1190400C1T3 INS-2307
1190400C128T3 INS-2280

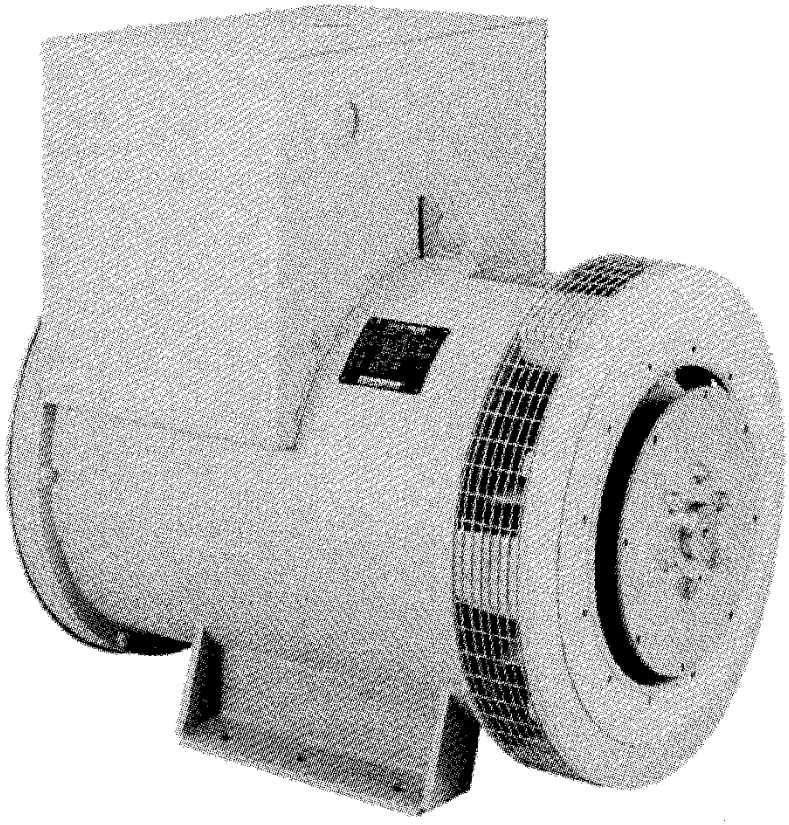
TRONAIR®

APPENDIX Ii

Alternator
Operation and Maintenance Manual

MAGNAPLUS® GENERATOR

280–430 Frame
Installation, Operation, and Maintenance Manual



MARATHON® ELECTRIC

A Subsidiary of Regal-Beloit Corporation

Marathon Electric Mfg. Corp.
A Subsidiary of Regal-Beloit Corp.
P.O. Box 8003
Wausau, WI 54402-8003
Phone: (715) 675 3359
Fax: (715) 675 8026
www.marathonelectric.com

CONTENTS

SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures contained herein, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your MagnaPLUS generator. Each section of this manual has caution and warning messages. These messages are for your safety, and the safety of the equipment involved. If any of these cautions or warnings are not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and lock out all controls to prevent an unexpected start-up of the generator set driver. Proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving your MagnaPLUS generator are pointed out in the installation and maintenance sections. Incorrect lifting or moving can result in personal injury or damage to the unit.

Prior to start-up of the unit ensure that all generator leads are properly connected to the generator link board located inside the connection box. Always assume that there will be voltage present at the generator terminals whenever the generator's shaft is rotating, and proceed accordingly. Residual voltage is present at the generator terminals and at the automatic voltage regulator panel connections even with the regulator fuse removed. Caution must be exercised, or serious injury or death can result.

This manual is not intended to be a substitute for properly trained personnel. Installation and repairs should only be attempted by qualified, trained people. The cautions and warnings point out known conditions and situations that are potentially hazardous. Each installation may well create its own set of hazards

When in doubt, ask. Questions are much easier to handle than mistakes caused by a misunderstanding of the information presented in this manual.

RECEIVING AND STORAGE

RECEIVING AND STORAGE

Upon receipt of the generator, it is recommended that it be carefully examined for possible shipping damage. The generator was given to the freight carrier in good condition; thus, the carrier is responsible for the product from the factory dock to the destination. Any damage should be noted on the freight bill before accepting the shipment. Any claims for damage must be promptly filed with the delivering carrier.

UNPACKING AND HANDLING

Carefully read all instruction tags shipped with the unit. When lifting, attach an overhead crane to the lifting lug(s) on the generator frame. Apply lifting forces in a vertical direction. When transporting single bearing generators, the generator's rotor must be adequately supported to prevent damage.

WARNING

THE LIFTING LUG(S) ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT A COMPLETE GENERATOR AND DRIVER ASSEMBLY BY MEANS OF LIFTING LUG(S) ON THE GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

STORAGE

In the event that the generator is not immediately installed on its prime mover, it is recommended that the unit be stored indoors in a clean, dry area which is not subject to rapid changes in temperature and humidity. If the generator is stored for a long period of time, the generator should be tested, cleaned and dried as required before being put into service. See the maintenance section of this manual for further information. If the unit has been stored in an area where it has been subject to vibration, it is recommended that the bearing(s) be inspected and replaced as necessary.

PRINCIPLES OF OPERATION

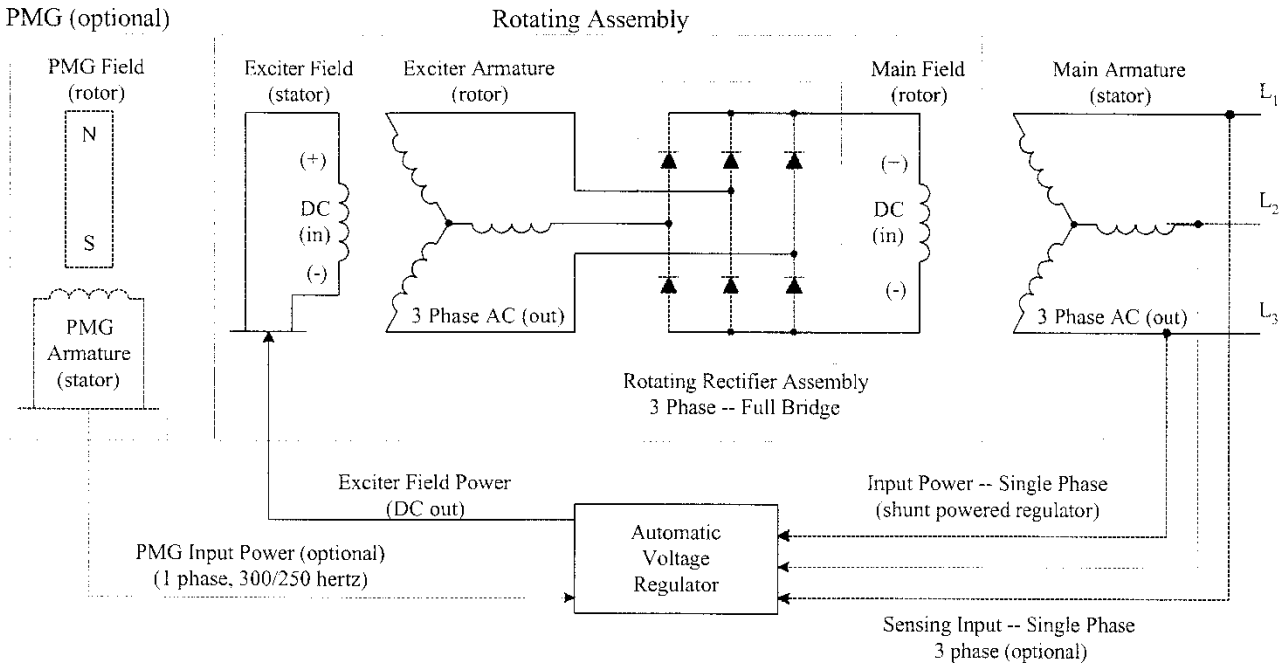


FIGURE 1 -- MagnaPLUS Circuit Diagram

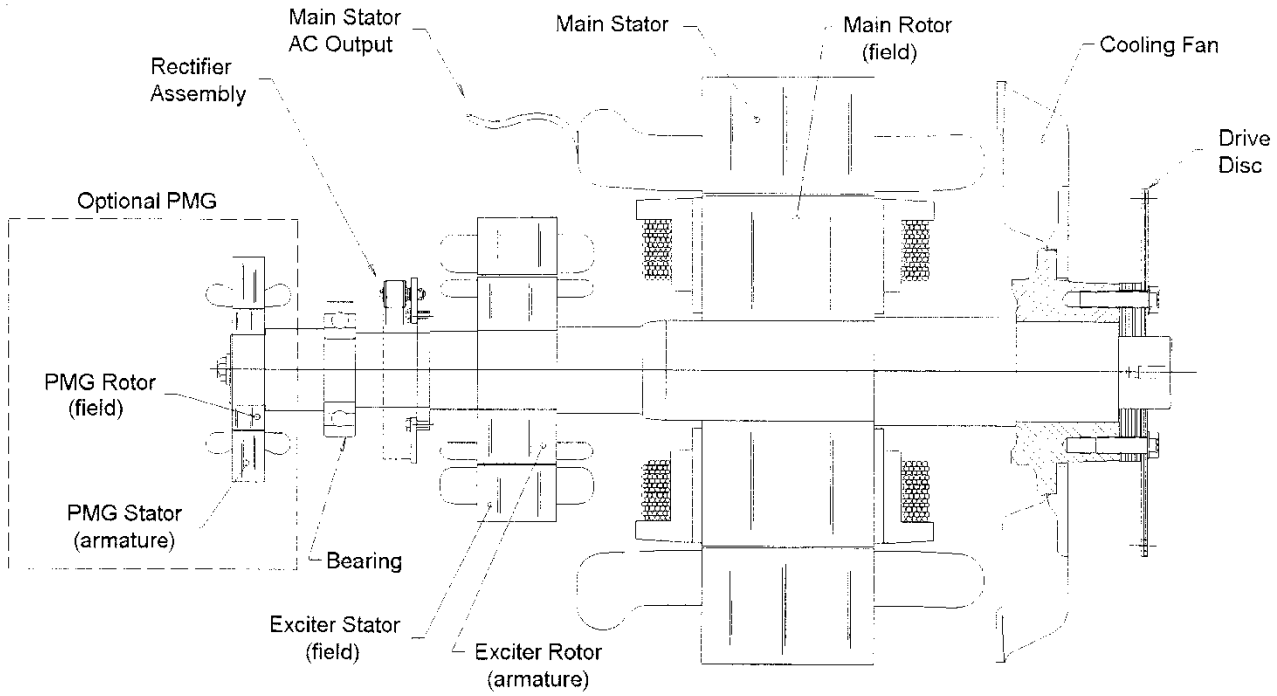


FIGURE 2 -- Typical MagnaPLUS Layout Diagram

MARATHON ELECTRIC
A Subsidiary of Regal-Beloit Corporation

PRINCIPLE OF OPERATION

MagnaPLUS generators are a brushless, self excited, externally voltage regulated, synchronous AC generator. The generator is made up of six major components: main stator (armature), main rotor (field), exciter stator (field), exciter rotor (armature), rectifier assembly, and voltage regulator. In understanding the above terminology, note the following: stators are stationary, rotors rotate, a field is an electrical input, and an armature is an electrical output. These system components are electrically interconnected as shown in figure 1 and physically located as shown in figure 2.

The generator's exciter consists of a stationary field and a rotating armature. The stationary field (exciter stator) is designed to be the primary source of the generator's residual magnetism. This residual magnetism allows the exciter rotor (armature) to produce AC voltage even when the exciter stator (field) is not powered. This AC voltage is rectified to DC by the rotating rectifier assembly and fed directly to the main rotor (field). As the generator shaft continues to rotate, the main rotor (field) induces a voltage into the generator's main stator (armature). At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator. After the generator has established the initial residual voltage, the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

Voltage Regulation

In the standard configuration (shunt excited), the automatic voltage regulator receives both its input power and voltage sensing from the generator's output terminals (See Figure 1). With the optional PMG configuration, the regulator receives input power from the PMG. The regulator automatically monitors the generator's output voltage against an internal reference set point and provides the necessary DC output voltage to the exciter field required to maintain constant generator terminal voltage. The generator's terminal voltage is changed by adjusting the regulator's reference set point. Consult the regulator manual for specific adjustment and operating instructions.

MOTOR STARTING

When a motor is started, a large surge of current is drawn by the motor. This starting current is equivalent to the motors locked rotor or stall current and is 5 to 10 times normal full load current. When the generator supplies this in-rush of starting current, the generator voltage dips temporarily. If the motor is too large for the generator, the generator's voltage dips greater than 30 percent. This may result in the motor starter de-energizing or the motor stalling. MagnaPlus generators generally supply .3 to .4 horsepower per generator KW in motor starting capability. For specific data contact Marathon Electric.

PARALLEL OPERATION

All MagnaPlus generators are built with 2/3 pitch main stator windings and full amortisseur (damper) windings. These features make the MagnaPlus generators suitable for parallel operation when equipped with the proper voltage regulators and voltage regulator accessories. Consult with the factory for further information relative to parallel operations.

NONLINEAR LOADING

Solid state electronic control devices (variable frequency drives, precision motor controls, battery chargers, etc.) utilize electronic switching circuits (thyristors, SCRs, Diodes, etc.). These switching circuits introduce high frequency harmonics which distort the normal wave form of the generator. This creates additional heat in the generator windings and may cause the generator to over-heat. Problems which can occur are not limited to the generator. Poor wave shape may adversely effect various loads connected to the generator. Consult Marathon Electric for further information relative to nonlinear loads.

INSTALLATION

PREPARATION FOR USE

Although the generator has been carefully inspected and tested in operation prior to shipment from the factory, it is recommended that the generator be thoroughly inspected. Check all bolts for tightness and examine the insulation on lead wires for chafing prior to proceeding with installation. Remove all shipping tapes, bags, skids and rotor support blocking. For two bearing units, rotate the shaft by hand to ensure that it rotates smoothly without binding.

WARNING

DISABLE AND LOCKOUT ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THE GENERATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START, DISCONNECT THE AIR SUPPLY. FOR MOTOR GENERATOR SETS, OPEN THE POWER SUPPLY TO THE DRIVE MOTOR. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE.

NEVER "BAR OVER" THE ENGINE GENERATOR SET USING THE GENERATOR'S FAN. THE FAN IS NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN COULD DAMAGE THE FAN AND RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

GENERATOR MOUNTING

Single Bearing Units.

Single bearing units are provided with an SAE flywheel housing adapter flange and flexible drive discs. Coupling the generator's shaft to the engine flywheel is accomplished with special steel drive discs bolted to the shaft. In addition to the drive discs, there may be a hub spacer, spacer discs, or a combination of hub spacer and spacer discs inserted between the drive discs and the shaft to achieve the proper shaft extension ("G" dimension per SAE J620c). Holes are provided in the periphery of the coupling discs which correspond to tapped holes in the prime mover's flywheel. The outside diameter of the drive discs fit in a rabbet in the flywheel so that concentricity is assured.

Grade 8 place bolts and hardened washers are recommended to mount the drive discs to the flywheel. DO NOT USE SPLIT TYPE LOCK WASHERS. Split lock washers when biting into the drive disc cause stress risers which may result in the disc fracturing.

The SAE flywheel housing adapter ring and the engine flywheel housing are designed to match each other with no further alignment necessary. Use grade 5 or greater mounting bolts. MagnaPLUS generator frames are constructed with two or three bolt holes per foot. The feet should be shimmed where necessary to obtain solid contact with the sub-base. With the frame securely bolted to the engine flywheel housing, there is no side thrust or pull on the generator frame, thus no real need to secure the feet with more than one bolt per foot.

GENERATOR MOUNTING

Two Bearing Generators -- Direct Drive

Two bearing generators are provided with a keyed shaft extension. For direct drive generators, the assembler furnishes a flexible coupling which is installed between the driver and the generator's shaft. Aligning the generator and its driver as accurately as possible will reduce vibration, increase bearing life, and ensure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Secure the feet of the generator with grade 5 or greater bolts through the holes provided in the mounting feet. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

GENERATOR MOUNTING

Two Bearing Units -- Belt Driven

Two bearing MagnaPLUS generators can be belt driven provided belts are sized and applied correctly. Please refer to your supplier of belts and sheaves for correct sizing and tensioning specifications. A bearing life calculation should be performed. Marathon Electric recommends a minimum B-10 life of 40,000 hours. If cog type belts are used, a vibration may be introduced which could lead to premature failure of the bearings.

END PLAY TESTING

Refer to the engine manual for recommended end play specifications and measurement procedures. If end play is not to specification, it is an indication that the generator shaft is not moving freely in the assembly, and normal life of the thrust bearing could be impaired. Probable causes of this problem are:

1. Improper seating of drive discs in the flywheel resulting in misalignment.
2. Improper mating of generator frame to engine flywheel housing resulting in misalignment.
3. Improper "G" dimension per SAE J620c on either the engine or generator.

TORSIONAL VIBRATION

Torsional vibrations are generated in all rotating shaft systems. In some cases, the amplitude of these vibrations at critical speeds may cause damage to either the generator, its driver, or both. It is therefore necessary to examine the torsional vibration effect on the entire rotating system. IT IS THE RESPONSIBILITY OF THE GENERATOR SET ASSEMBLER TO ASSURE THE TORSIONAL COMPATIBILITY OF THE GENERATOR AND ITS DRIVER. Drawings showing pertinent dimensions and weights of the rotating assembly will be supplied by Marathon Electric upon request.

MARATHON ELECTRIC
A Subsidiary of Regal-Beloit Corporation

ENVIRONMENTAL CONSIDERATIONS

The MagnaPLUS generator is designed for heavy duty industrial applications; however, dirt, moisture, heat and vibration are enemies of rotating electrical machinery. Excessive exposure to the elements may shorten generator life. The temperature of the cooling air entering the intake openings of the generator should not exceed the ambient temperature shown on the generator's nameplate. Generators intended for outdoor application should be protected with housings having adequate ventilation. Although the standard insulation systems are moisture and humidity resistant, space heaters are recommended for extreme conditions. If the generator is to be installed in an area where blowing sand and dust are present, the enclosure should be fitted with filters. Filters reduce erosion on the generator's insulation by blocking high velocity abrasive particles generated by the flow of cooling air through the generator. Consult the factory for appropriate filters and generator deratings required.

WIRING CONNECTIONS

Wiring of the generator and accessories should be done in accordance with good electrical practices. Follow government, industry and association standards.

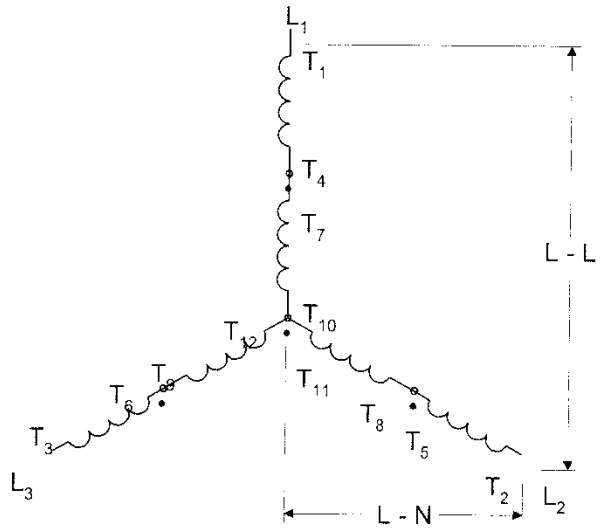
The generator conduit box construction allows cable entry from multiple sides. A hole saw or other appropriate tool may be used to provide for conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit. To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator conduit box.

All MagnaPLUS generators are equipped with link boards (terminal strips) for both internal and external connections. All connections made to the studs of the link board should be made with high quality ring terminals. Ring terminal sizes are: 6 mm (280 Series Frames) and 10 mm (360 and 430 Series Frames). Torque link board connections to the following specifications: 280 frame -- 5.4 NM (4 Ft Lb); 360 & 430 frame -- 27 NM (20 Ft Lb).

Refer to the connection diagram supplied with the generator and / or the proper diagrams shown in this manual. Install all inter-component and external wiring in accordance with national and local electrical codes. The neutral in the following connection diagrams shown below may be either grounded (earthed) or left above ground potential (floating). See national and local codes and / or the system distribution wiring schematic diagram for the proper connection of the neutral.

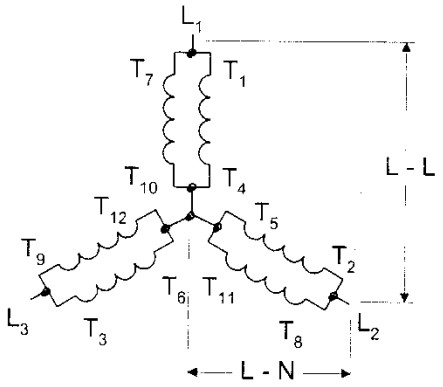
The following connection diagrams are shown for twelve lead generators. Ten lead generators have the same terminal designations except for leads T10, T11, and T12. These three leads are internally connected inside the generator and brought out as a single lead (T0). Ten lead generators can only be connected in a wye configuration

HIGH (SERIES) WYE CONNECTION



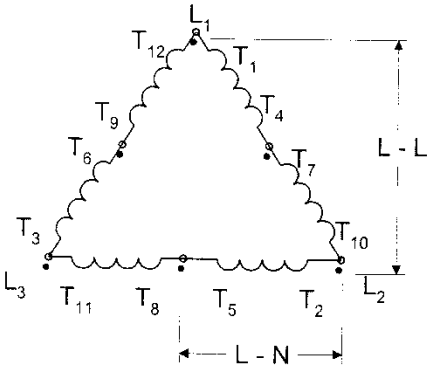
VOLTAGE (HIGH WYE)		
Hz	L-L	L-N
60	480	277
	460	266
	440	254
	416	240
	380	219
50	416	240
	400	231
	380	219

LOW (PARALLEL) WYE CONNECTION



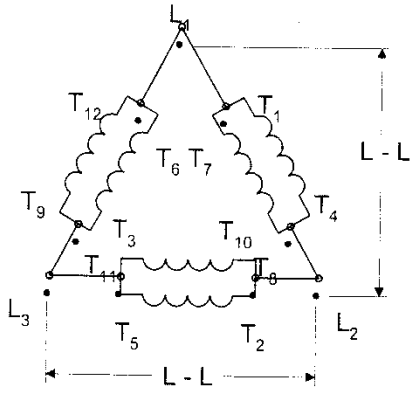
VOLTAGE (LOW WYE)		
Hz	L-L	L-N
60	240	139
	230	133
	220	127
	208	120
	190	110
50	208	120
	200	115
	190	110

HIGH (SERIES) DELTA CONNECTION



VOLTAGE (HIGH DELTA)		
Hz	L-L	L-N
60	277	139
	240	120
50	240	120
	220	110
	200	100

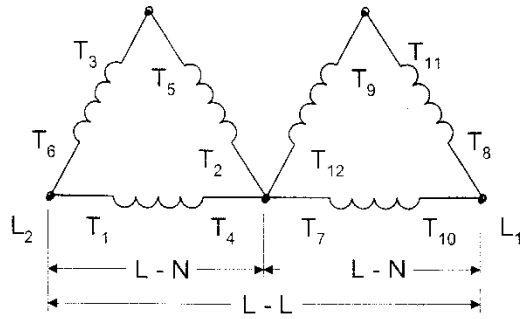
LOW (PARALLEL) DELTA CONNECTION



VOLTAGE (LOW DELTA)		
Hz	L-L	L-N
60	120	NA
	110	NA
50	110	NA
	100	NA

MARATHON ELECTRIC
A Subsidiary of Regal-Beloit Corporation

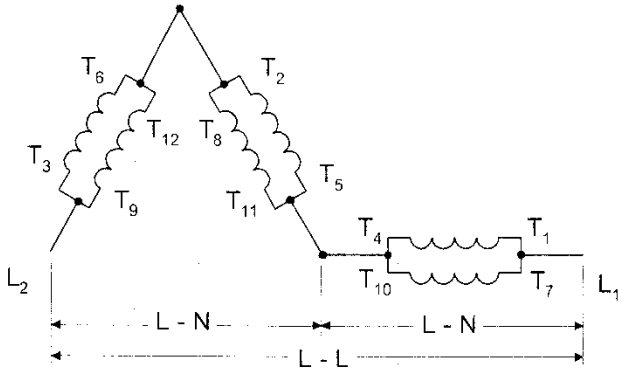
DOUBLE DELTA -- SINGLE PHASE CONNECTION



VOLTAGE (DOUBLE DELTA)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

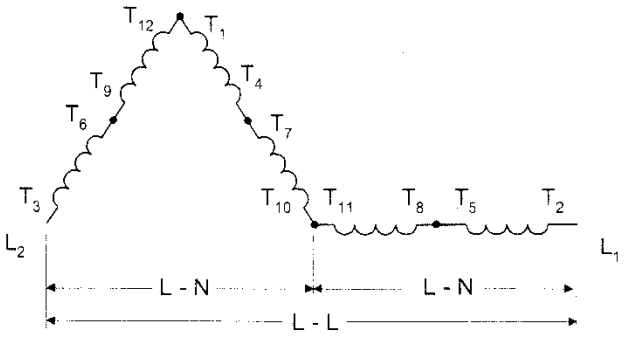
LOW ZIG ZAG -- SINGLE PHASE (PARALLEL) CONNECTION



VOLTAGE (LOW ZIGZAG)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110
	200	100

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

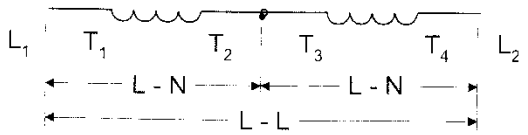
HIGH ZIG ZAG -- SINGLE PHASE (SERIES) CONNECTION



VOLTAGE (HIGH ZIGZAG)		
Hz	L-L	L-N
60	480	240
	460	220
50	415	208
	380	190

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

DEDICATED SINGLE PHASE CONNECTION
HIGH VOLTAGE - SERIES CONNECTED



VOLTAGE (DEDICATED)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110
	200	100

OPERATION

PRE-START INSPECTION

Before starting the generator for the first time, the following inspection checks are recommended:

1. A visual inspection should be made for any loose parts, bad connections, or foreign materials.
2. Bar the set over by hand for at least 2 revolutions to be sure that there is no interference and that the set turns freely. If the set does not turn freely, check for clearance in the generator and exciter air gap.
3. Check all wiring against the proper connection diagrams, and ensure that all connections and terminations are tight and properly insulated.

WARNING

MAGNAPLUS GENERATORS MAY HAVE VOLTAGE PRESENT AT THE LEAD TERMINALS WHEN THE SHAFT IS ROTATING. DO NOT PERMIT OPERATION OF THE GENERATOR UNTIL ALL LEADS HAVE BEEN CONNECTED AND INSULATED. FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE

4. Verify that all equipment is properly grounded (earthed).
5. Clear the surrounding area of any materials that could be drawn into the generator.
6. Check all fasteners for tightness.
7. Check all access plates, covers, screens and guards. If they have been removed for assembly or inspection, reinstall and check for security.
8. Review all prime mover prestart-up instructions, and ensure that all recommended steps and procedures have been followed.
9. Remove any masking materials affixed during painting. Inspect the generator, prime mover, and any accessory equipment to ensure that nameplates, and all safety warning / caution signs and decals provided with the equipment are in place and clearly visible.

   Note: It is strongly recommended that the authority having jurisdiction over the installation site be consulted to determine if any additional warning or caution notices, or additional safety devices are required by local codes / standards. Any such required notices or devices should be installed prior to initial startup.

START-UP

The following procedure should be followed when starting the generator set for the first time.

1. The generator output must be disconnected from the load. Be sure that the main circuit breaker or fused disconnect is in the open position.
2. Open the input power to the automatic voltage regulator. Remove the fuse or disconnect and insulate one of the regulator input power leads. (See separate regulator manual)
3. Verify that all prime mover start-up procedures have been followed.
4. If the unit is provided with space heaters, ensure that they are de-energized. In some installations, a set of auxiliary contacts on the main circuit breaker or transfer switch will automatically open the space heater circuit when the generator is connected to the load.
5. Start the prime mover, and adjust it for proper speed. See generator nameplate.

6. The purpose of this initial test with the regulator out of the circuit is to detect any wiring mistakes without exposing the unit to undue risk. Check all line to line and line to neutral voltages for balanced voltage. If voltages are balanced, shut down the set and reconnect the regulator. If voltages are unbalanced, shut down the equipment and check for improper wiring. If the problem persists, consult the factory.

   With the regulator de-energized, the residual voltage should be 10 - 25% of rated value. It is recommended that this residual voltage and driver RPM be recorded for use as a future troubleshooting benchmark.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

7. Start the set and adjust the terminal voltage to the desired value by means of the regulator voltage adjustment. If the regulator is equipped with a stability adjustment, follow the instructions in the regulator manual to adjust the stability. Again, check all line to line and line to neutral voltages for balance. It is recommended practice to record the no load excitation (DC voltage to the exciter stator), generator terminal voltage, and driver speed as a benchmark for future troubleshooting.

8. Close the main circuit breaker to the load.

9. Monitor the generator output current to verify that it is at or below nameplate value.

10. Check generator speed (frequency) under load. Adjust as necessary. (Refer to prime mover or governor manuals)

SHUTDOWN PROCEDURE

There are no specific instructions for shutting down the generator; however, several good practices should be observed to prolong equipment life.

1. It is advisable to disconnect all loads (open main circuit breaker or disconnect) prior to shutdown. This is especially important if loads can be damaged by low voltage or low frequency conditions during generator "coast down".

2. Isolate all conditions that could apply voltage to the generator terminals while the generator is at rest. Failure to comply could result in personnel injury or equipment damage.

3. If the unit is equipped with space heaters, verify that the heater circuit is energized.

MAINTENANCE

The following maintenance procedures should be followed to ensure long equipment life and satisfactory performance. Maintenance intervals will depend upon operating conditions.

1. Routinely check intake and exhaust air screens to ensure that they are clean and free of debris. Clogged intake air screens will reduce cooling air flow and result in higher operating temperatures. This will reduce generator life and may result in generator damage.

2. All MagnaPLUS generators are equipped with double shielded ball bearings lubricated for the life of the bearing. Every 1,000 hours check the bearing(s) for smooth, quiet operation. For continuous duty generators, recommended practice is to replace the bearing during major overhauls of the engine.

3. Periodically inspect the unit for any buildup of contamination (dirt, oil, etc.) on the windings. If the wound components have become coated with heavy concentrations of oil and grime, the unit should be disassembled and thoroughly cleaned. This operation is not one that can be accomplished effectively on site, but rather one that should be conducted by an authorized service center equipped with the appropriate apparatus and solvents necessary to properly clean and dry the generator.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

4. Every 2,000 operating hours or in conjunction with scheduled engine maintenance, check the DC no load excitation voltage per item #7 in the startup procedure. Compare this voltage with the value recorded during initial startup. If this value of no load excitation voltage is markedly higher than the bench mark reading, it is an indication of problems in either the exciter, main field, or the rotating rectifier assembly. Ensure that RPM is the same as initial test.

5. Monitor and record insulation resistance with a 500 volt mega-ohm meter. The minimum acceptable reading is 2 mega-ohms. If the reading drops below the minimum, the generator should be cleaned and dried at an authorized service shop. Consult Marathon Electric for more information.

DRYING WINDINGS

Generators in service may inadvertently have their windings exposed to splashing or sprayed water. Units that have been in transit or storage for long periods of time may be subjected to extreme temperature and moisture changes causing excessive condensation. Regardless of the source of moisture, wet windings should be thoroughly dried out before operating the unit. If this precaution is not taken, serious damage to the generator can result. The following procedures may be utilized in drying the generator's windings. The method selected will be influenced by winding wetness and situation limitations.

Space Heaters

An electric heater may have been supplied with the generator. When energized from a power source other than the generator, the heater will gradually dry the generator. This process can be accelerated by enclosing the unit with a covering and inserting additional heating units. A hole should be left at the top of the covering to permit the escape of moisture. Care should be taken not to overheat various accessory equipment mounted with the generator.

Forced Air

Another method to dry the generator is to run the set with no excitation (see startup procedure item #2). The natural flow of ambient air through the generator will tend to dry the windings. This method can be accelerated by adding a source of heat at the air intake to the generator. Heat at point of entry should not exceed 80 C (180 F).

TESTING

Visual Inspection

Remove covers and look for any obvious problems: burnt windings, loose connections, broken wires, frayed insulation, cracked brackets, missing hardware, etc. Check for foreign objects which may have been drawn into the generator. Verify that the generator's air gaps (main rotor and exciter) are free from obstructions. If possible, rotate the generator manually to ensure free rotation. Never "bar over" the engine generator set using the generator fan.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

CONSTANT EXCITATION TEST (12V BATTERY TEST)

The generator "no load" voltage is dependent on exciter input voltage and generator speed. With the generator operating at rated speed and 12 volts dc applied to the exciter field, the generators terminal voltage will be near rated value.

1. Shutdown the generator set and connect a voltmeter on the generator terminals.

2. Disconnect the regulator's F+ (F1) and F- (F2) leads and connect them to a 12V battery. Caution should be taken to ensure that the battery is not exposed to any potential arcing.

3. With no load on the generator (main breaker open) run the generator at rated speed. Measure the generator's terminal voltage and compare this value with values recorded during installation.

If voltage readings are normal, the main generator and excitation are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes, surge suppressor, and windings.

Continuity / Resistance Test

The generator has four components which can be checked using an ohm meter: exciter stator, exciter rotor, main stator and main rotor. Each of these components are comprised of various windings which form a complete electrical path of relatively low resistance. Using an ohm meter measure the loop resistance of each component. Compare these measured values with the values listed in the specification section of this manual. Note that very small resistance values require precision equipment to make accurate measurements; however, a standard ohm meter will provide a good indication of winding continuity.

Insulation Test

Insulation resistance is a measure of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or be degraded by contaminants: dust, dirt, oil, grease, and especially moisture. Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shutdown

Insulation resistance is measured with a megger (mega-ohm meter). A megger measures insulation resistance by placing 500 volts between the winding and the frame of the generator. Caution must be taken to remove all electronic devices (regulators, diodes, surge protectors, capacitors, protective relays, etc.) from the winding circuit before checking the insulation. Winding insulation can be checked on the main stator, main rotor, exciter stator, and exciter rotor. Minimum resistance is 2 mega-ohms. If the winding resistance is low it must be dried (see maintenance section) or repaired.

DIODE TESTING

If the generator is close coupled to an engine, it may be necessary to "bar over" the engine in order to gain access to a given area of the rectifier assembly. **NEVER** use the generator's fan as a fulcrum to accomplish this. Use the engine manufacturer's recommended practice to manually turn over the engine. To prevent possible injury to personnel, and damage to the equipment, ensure that the engine cannot start during this procedure.

Remove the two main rotor leads and the three exciter rotor leads from the rectifier assembly (figure 4). The rectifier assembly is now electrically isolated from the generator. The diodes remain mounted and the diode leads remain connected to the terminal posts. Using an ohmmeter or a battery light continuity tester, place one test probe on the diode lead terminal post. In succession, touch the other test probe to the lead screw hole in each heat sink. Reverse the probes and repeat the procedure. You have now tested the three diodes connected to this terminal post in both the forward and reverse direction. Repeat the procedure using the other diode terminal post.

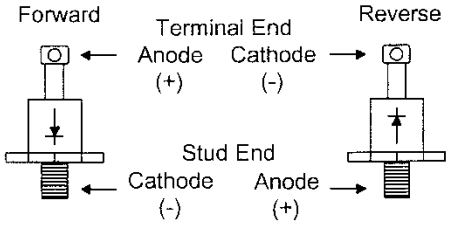


FIGURE 3: DIODE POLARITY

When the positive test probe is connected to the diode's anode and the negative test probe is connected to the diode's cathode (forward biased), the diode will switch on and conduct electricity (figure 3). This is observed by a low resistance reading when using an ohm meter or the lighting of the bulb when using a battery light continuity tester. Reversing the test leads (reverse biased) will result in the diode switching off and no electricity will be conducted. The results of these tests should indicate one of three conditions:

1. **Good diode:** Will have a much greater resistance in one direction than the other. Typical reverse biased resistance will be 30,000 ohms or greater, while forward biased resistance will be less than 10 ohms. The battery-light tester will have the light "on" in one direction and "off" in the other.

2. **Shorted condition:** Ohmmeter reading will be zero, or very low in both directions. The continuity tester will have the light "on" in both directions.

3. **Open condition:** Ohmmeter will have a maximum (infinity) reading in both directions. Continuity tester light will be off in both directions.

Diode failure after a 25 hour "run-in" period is generally traceable to external causes such as a lightning strike, reverse current, line voltage spikes, etc. All 6 diodes are essentially in the same circuit. When a diode is stressed to failure, there is no easy method to determine remaining life in the other diodes. To avoid possible continued failures, it is recommended that the entire rectifier assembly be replaced rather than replacing individual diodes.

SERVICE

GENERAL

The service procedures given in this section are those which can reasonably be conducted on-site with a minimum number of special tools and equipment. All service procedures should be conducted by qualified maintenance personnel. Replacement parts may be ordered through an authorized service center or directly from the factory.

FIELD FLASHING

Restoring Residual Magnetism
(not applicable on PMG equipped generators)

To restore residual magnetism to the generator, connect a 12 volt battery to the exciter field while the generator using the following procedure:

1. **Shutdown the generator set.** Remove the exciter field leads F+ and F- from the regulator.

CAUTION:

Failure to remove the exciter field leads from the automatic voltage regulator during flashing procedures may destroy the regulator.

2. Connect the F+ and F- leads to the battery's corresponding positive and negative terminals. This should be done using an appropriate length of lead wire to separate the battery from the point of connection (batteries may explode when exposed to an electric arc). After 3 to 5 seconds, remove the F- lead. An inductive arc should result. If no arc is drawn, repeat the procedure.

3. Reconnect the F+ and F- leads to the regulator. Restart the generator and verify that terminal voltage is developed. If terminal voltage does not develop, repeat the field flashing procedure and / or consult the trouble shooting section.

BEARING REMOVAL

Prior to performing this operation, it is suggested that the alternator's shaft be rotated until two of the main rotor poles are in a vertical position. Once the bearing bracket is backed out, the rotor will drop on the main stator core. Having the rotor in this position will limit the amount of rotor drop to that of the air gap. Visually inspect the bearing bore for damage or wear. If worn or damaged, replace prior to reassemble.

Opposite Drive End Bearing Bracket Removal.
Prior to proceeding with bracket removal, disconnect exciter field leads F+ and F- from the automatic voltage regulator and ensure that they are free to move when the bearing bracket is removed. Remove the bearing bracket retaining bolts. Using a pair of screw drivers, wedge the bracket off the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame and will drop until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore and o-ring (if equipped) for damage or wear. If worn or damaged, repair or replace prior to reassembly.

Drive End Bearing Bracket Removal, Two Bearing Units.
Remove any drive arrangement from the generator shaft extension. Remove the bearing lock ring retaining screws. There is no o-ring in the drive end bearing bracket. The shaft extension must be supported before proceeding further. A hoist and sling, jack, or some other means of support with a capacity of 2 tons should be used.

Remove the bearing bracket retaining cap screws. Using a flat bladed screw driver or chisel, pry the bracket back from the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame. Lower the shaft extension until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore for damage or wear. If worn or damaged, sleeve or replace prior to reassembly.

Reassembly note: Before the bearing bracket is seated against the frame, a threaded rod may be used to help align the inner bearing cap with the bearing bracket.

BEARING REPLACEMENT

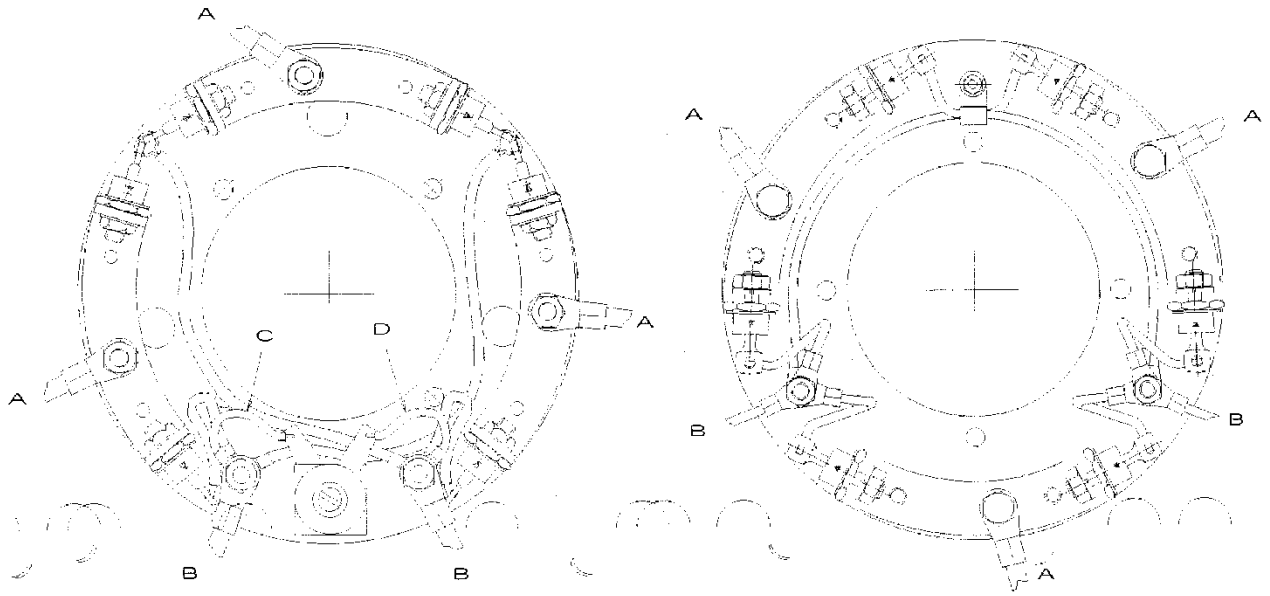
Using a bearing puller, remove the existing bearing. It is strongly recommended that the bearing be replaced any time the it is removed from the shaft. **ALWAYS** install the same type and size bearing that was supplied as original equipment. Order by part number from the parts list, and include the unit serial number and part number when ordering. Heat the bearing to a maximum of 100°C (212°F) in an oven. Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. The bearing should slide on the shaft and be seated without excessive force. Should the bearing bind on the shaft prior to being seated against the shoulder, a piece of tubing slightly larger than the press fit area can be used to drive the bearing to its final position. Using light taps with a soft mallet, apply pressure to the inner race only.

RECTIFIER ASSEMBLY REMOVAL

The rectifier assembly cannot be removed until the opposite drive end bearing bracket and bearing have been removed (see bearing removal procedure). Remove the three exciter rotor leads from the heat sinks and the two main rotor leads from the main rotor posts (see Figures 4). Remove the screws securing the rectifier assembly and pull the assembly free from the shaft.

DIODE REPLACEMENT

Prior to installing a replacement diode on the heat sink, apply a thin film of conductive heat sink compound around the base of the diode (do not coat the threads). When installing a diode on the heat sink, care should be taken not to over torque the retaining nut which could cause damage to the device. Torque to 28 pound-inches. If not damaged, the existing diode lead wire may be unsoldered from the failed diode, and resoldered on the replacement.



430 FRAME **280 / 360 FRAME**

A - Exciter Rotor Lead, B - Main Rotor Lead, C - Red (+) Suppressor Lead, D - Black (-) Suppressor Lead

FIGURE 4: ROTATING RECTIFIER ASSEMBLY

RETURNED GOODS

Contact Marathon Electric Manufacturing Corporation for authorization before returning any product. We can not be responsible for any items returned without authorization.

CAUTION

Single bearing generators must have their rotor assembly properly secured to prevent damage during transit to the factory, or to an authorized service center.

TROUBLESHOOTING

This section is intended to suggest a systematic approach to locating and correcting generator malfunctions. The section is arranged according to the symptoms of the problem. The steps have been arranged in an attempt to do the easy checks first and prevent further damage when troubleshooting a disabled machine.

The first step of troubleshooting is to gather as much information as is possible from operating personnel and individuals present during the failure. Typical information includes: how long the unit had been operating; what loads were on line; weather conditions; protective equipment that did or did not function. In addition, information as to the operating condition of the generator's prime mover is vital. Has the prime mover been maintaining constant speed? If not, have there been extended periods of under speed operation? Has the prime mover experienced an over-speed condition? If yes, what was the maximum speed, and how long did the unit operate at that elevated speed?

The generator speed should be maintained at rated nameplate value during all operating tests. The frequency of the generator depends upon rotational speed. Most regulators used with MagnaPLUS generators have built in under frequency protection such that if the speed is reduced more than 5%, the voltage will drop off rather rapidly with further reductions in speed.

WARNING

HIGH VOLTAGES MAY BE PRESENT AT THE GENERATOR'S TERMINALS WHEN THE UNIT IS RUNNING. SOME ACCESSORY EQUIPMENT SUCH AS SPACE HEATERS MAY BE ENERGIZED FROM AN OUTSIDE POWER SOURCE WHEN THE UNIT IS AT REST. TOOLS, EQUIPMENT, CLOTHING AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS. SPECIAL PRECAUTIONS MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE REMOVED OR DISABLED TO GAIN ACCESS AND PERFORM TESTS. BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

GENERATOR PRODUCES NO VOLTAGE

CAUSE	CHECK AND REMEDY
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for loose connections, open circuits, grounds, and short circuits.
Loss of residual	Flash the field. Refer to field flashing in the service section. If the generator is equipped with a PMG, field flashing is not necessary -- check regulator fuse and input power from the PMG.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator protection operating	Adjust regulator. Consult regulator manual.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE, NO LOAD

CAUSE	CHECK AND REMEDY
Underspeed operation	Check speed using a tachometer or frequency meter.
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for grounds, open circuits and short circuits.
Loss of regulator power	Check regulator fuse and input power. Input power is produced by the generator's residual voltage or from an optional PMG.
Regulator adjustment	Adjust regulator settings. Consult regulator manual.
Regulator incorrectly connected	Review the generator connection diagram or reference the regulator manual.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE WHEN LOAD APPLIED

CAUSE	CHECK AND REMEDY
Excessive load	Reduce load. The load on each leg should be evenly balanced, and rated current should not be exceeded on any leg.
Large motor starting or low load power factor	Motor starting currents are too large for the generator. When starting multiple motors, sequence the motors and start the largest motors first. Reduce lagging power factor load.
Driver speed droop or belt slip	Check driver. If belt driven, check belt tension. Check under frequency setting on regulator. Under frequency voltage roll-off may be activated.
Reactive droop	If the generator is equipped for parallel operation, some droop is normal as reactive load increases. When operating as a single unit, the parallel CT can be shorted to eliminate this effect. Refer to Regulator manual.
Line drop	If voltage is proper at generator terminals but low at load terminals, increase external wire size.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.

GENERATOR PRODUCES FLUCTUATING VOLTAGE

CAUSE	CHECK AND REMEDY
Fluctuating engine speed	Check engine and governor systems for malfunctions. Check load for fluctuation.
Regulator stability	Adjust Regulator stability. Refer to Regulator manual.
Regulator external rheostat	Replace defective or worn rheostat. Use shielded cable to minimize electrical noise.
Defective rectifier assembly	Check assembly for loose connections. Test the diodes as specified in the test section.
Loose terminal or load connections	Improve connections both mechanically and electrically.
Defective regulator	Replace regulator.

GENERATOR PRODUCES HIGH VOLTAGE

CAUSE	CHECK AND REMEDY
Faulty metering	Check voltage with separate meter at generator terminals.
Incorrect connections	Verify generator connections. Refer to drawings supplied with the generator or connection diagrams in this manual.
Regulator adjustments	Adjust regulator. Consult regulator manual.
Leading power factor	Check the power factor of the load. If power factor is leading, change load configuration. Excessive leading power factor (capacitors) can cause voltage to climb out of control.
Incorrect regulator connection	Verify regulator voltage sensing is connected correctly. Consult regulator manual.
Defective regulator	Replace regulator.

GENERATOR BUILDS VOLTAGE FROM STARTUP, THEN GOES TO LOW (RESIDUAL) VOLTAGE

CAUSE	CHECK AND REMEDY
Regulator protective circuit operating	Check indicators on regulator. Correct problems and adjust regulator as is required. Refer to regulator manual.

GENERATOR IS OVERHEATING

CAUSE	CHECK AND REMEDY
Generator is overloaded	Reduce load. Check with ammeter and compare with nameplate rating.
Clogged ventilating screens	Clean air passages.
High room temperature or altitude	Improve ventilation or reduce load.
Insufficient circulation of cooling air	Generator location and enclosure design must provide adequate air flow and minimize recirculation of hot air.
Unbalanced load	The load on each leg should be as evenly balanced as possible and should not exceed rated current on any one leg.

GENERATOR PRODUCES MECHANICAL NOISE

CAUSE	CHECK AND REMEDY
Defective bearing	Replace bearing.
Loose or misaligned coupling	Tighten, realign, or replace coupling.
Belt slap or loose guards	Check belt tensioning. Check belt guard fasteners.

EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR SET

CAUSE	CHECK AND REMEDY
Distorted voltage waveform	Analyze load. Excessive SCR (thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Marathon Electric..
Improper generator voltage or frequency	Check name plates of devices comprising the load. Compare required voltage and frequency with that of the generator. Adjust driver speed and/or generator voltage as necessary to match generator output to load requirements.

CAUTION: Compare required voltage, frequency, and KVA with generator nameplate to ensure adequate generator capacity. If in doubt, consult Marathon Electric for information regarding generator capacity.

MARATHON ELECTRIC
A Subsidiary of Regal-Beloit Corporation

SPECIFICATIONS

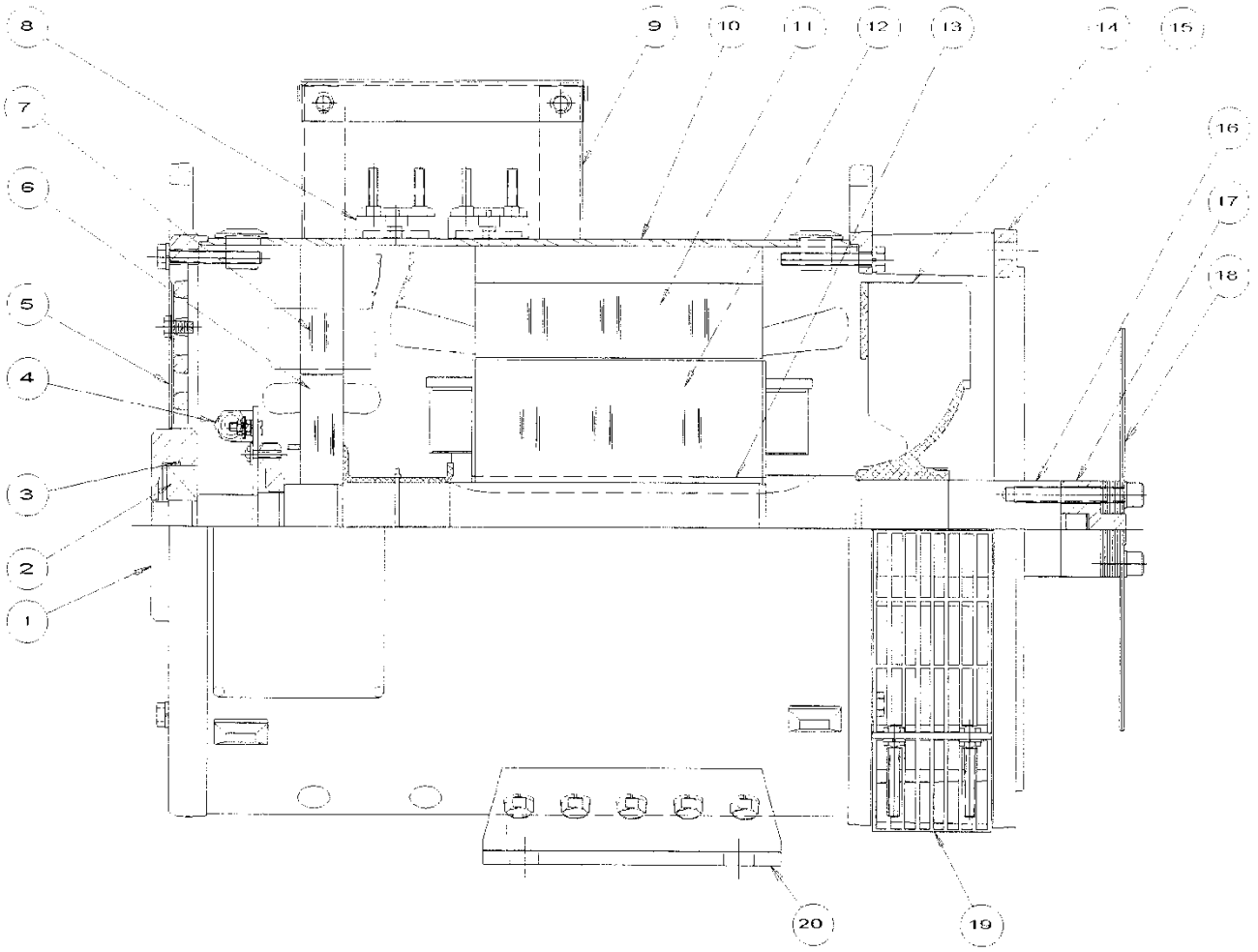
MODEL / FRAME SIZE	EXCITER RESISTANCE	
	STATOR	ROTOR
281, 282, 283, 284	23.0	.120
361, 362, 363 -- three phase	23.5	.120
361, 362, 363 -- dedicated single phase	23.0	.135
431, 432, 433 -- three phase	20.33	.076
431, 432 -- dedicated single phase	18.0	.105

MODEL	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS 480 V / 60 HZ	NO LOAD TERMINAL VOLTAGE WITH 12 VDC FIXED EXCITATION	
	STATOR*	ROTOR		HIGH WYE / 60 HZ	HIGH WYE / 50 HZ
281PSL1500	4.20	.400	11.0	485	400
281PSL1501	4.15	.400	11.0	490	404
281PSL1502	3.20	.439	9.0	528	435
282PSL1503	2.00	.470	10.4	500	415
282PSL1504	1.51	.512	11.3	490	400
282PSL1505	1.00	.575	10.1	515	415
283PSL1506	.681	.654	11.0	495	400
283PSL1507	.480	.758	12.0	480	390
284PSL1508	.346	.875	12.0	480	375
361PSL1600	.381	.750	11.8	485	400
361PSL1601	.264	.810	12.5	475	385
361PSL1602	.181	.990	14.1	460	370
362PSL1604	.138	1.05	12.2	480	380
362PSL1606	.0980	1.20	10.8	500	405
363PSL1607	.0692	1.37	12.2	475	380
431PSL6202	.0214	.8114	15.1	440	360
431PSL6204	.0477	.6373	13.6	455	385
431PSL6206	.0371	.6793	13.82	455	370
431PSL6208	.0133	.715	12.20	475	390
432PSL6210	.0214	.8114	15.1	440	360
432PSL6212	.0226	.8656	14.1	445	385
433PSL6216	.01215	1.0672	16.2	425	345
433PSL6220	.01214	.9743	15.6	430	350

* Stator resistance measured line to line in a high wye connection.

DEDICATED SINGLE PHASE	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS / 60 HZ
	STATOR	ROTOR	
281PSL1511	1.420	.381	8.3
281PSL1512	1.106	.395	8.1
281PSL1513	.632	.430	8.7
282PSL1514	.436	.450	9.2
282PSL1515	.240	.520	9.7
283PSL1516	.160	.620	13.3
284PSL1517	.0918	.760	12.2
284PSL1518	.0610	.857	16.6
361PSL1611	.0695	.750	17.5
361PSL1612	.0434	.857	16.1
361PSL1613	.0369	.926	13.6
362PSL1615	.0191	1.20	17.0
363PSL1617	.0119	1.35	23.0
431PSL1811	.0248	.516	9.9
431PSL1813	.0129	.615	13.8
432PSL1814	.00931	.643	15.1
432PSL1815	.00723	.852	11.2

PARTS LIST – SINGLE BEARING
Typical Generator Cross Section

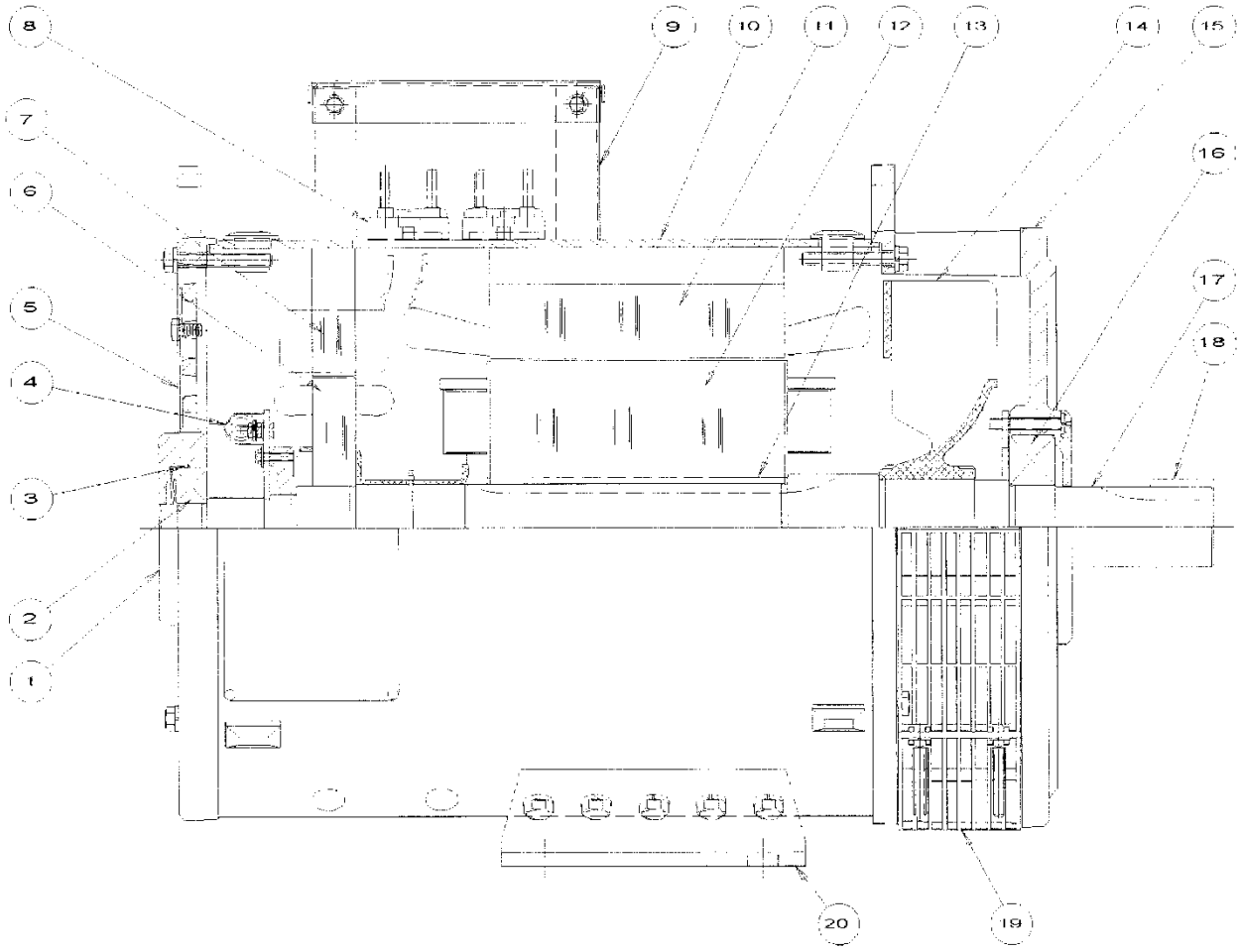


Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	Mounting Adapter (SAE)
6	Exciter Rotor	16	Shaft
7	Exciter Stator	17	Drive Hub
8	Link Board (terminal block)	18	Drive Disk (SAE)
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

MARATHON ELECTRIC
A Subsidiary of Regal-Beloit Corporation

PARTS LIST – DUAL BEARING
Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing (nondrive end)	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	End Bracket (drive end)
6	Exciter Rotor	16	Bearing (drive end)
7	Exciter Stator	17	Shaft
8	Link Board (terminal block)	18	Key
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

APPENDIX III

Datakom
Advanced Genset Controller User Manual

APPENDIX IV

Declaration of Conformity

Declaration of Conformity

The design, development and manufacture is in accordance with European Community guidelines

Ground Power Unit
(Electric Motor Driven)

Relevant draft complied with by the machinery:
prEN 1915-1:1995

Relevant standards complied with by the machinery:
prEN 982:1996
prEN 60204-1:1997
HFPA/JIC T2.24.1-1990
ISO 4021:1997
ARP 1247B
NFPA 70/NEC 1999

Identification of person empowered to sign on behalf of the Manufacturer:

Patrick Finch

Quality Assurance Representative

Tronair, Inc.
1 Air Cargo Pkwy East
Swanton, OH 43558

Phone: (419) 866-6301 | 800-426-6301
Web: www.tronair.com
Email: sales@tronair.com