



Installation Manual

Our energy working for you.™



**Power
Generation**

Generator Set with Engine 6BTA5.9G2

with PowerCommand® 1301 Control

C135 D6

C150 D5

FOREWORD

The purpose of this manual is to provide the Installation Engineer with sound, general information for the installation of the generator set. Refer to the Generator Set Operator Manual (0908-0115) for additional information which must also be read before operating the set.

This manual provides installation instructions for the generator set models listed on the front cover. This includes the following information:

Mounting Recommendations - for fastening generator set to base and space requirements for normal operation and service.

Mechanical and Electrical Connections - covers most aspects of the generator set installation.

Prestart - checklist of items or procedures needed to prepare generator set for operation.

Installation Checklist - reference checks upon completion of installation.

This manual **DOES NOT** provide application information for selecting a generator set or designing the complete installation. If it is necessary to design the various integrated systems (fuel, exhaust, cooling, etc.), additional information is required. Review standard installation practices. For engineering data specific to the generator set, refer to the *Specification and Data Sheets*.

This manual is for guidance and assistance with recommendations for correct and safe procedures. Cummins Power Generation Limited cannot accept any liability whatsoever for problems arising as a result of following recommendations in this manual.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Power Generation Limited policy of continuous development and improvement, information may change at any time without notice. The Installers should therefore ensure that before commencing any work, they have the latest information available.

Generator Set Owners are respectfully advised that it is their responsibility to employ competent persons to carry out any installation work in the interests of good practice and safety. Consult your Authorised Distributor for further information or assistance if required. It is essential that the utmost care is taken with the application, installation and operation of any diesel engine due to their potentially dangerous nature. Careful reference should also be made to other Cummins Power Generation Limited literature, in particular the Health and Safety Manual 0908-0110.

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Engine Specific Publications – Installation / Operator Level

The relevant engine specific manual must be read in conjunction with this manual for the safe installation and operation of this generator set. One of the following Engine Manuals – Operator Level - will be supplied with the documentation package for your generator set.

Where appropriate the corresponding Instruction Manual(s) will also be supplied with any accessory that you order.

Title	Publication No
Lead Acid Battery	0908-0101
Radiator Information	0908-0107
Health and Safety (Diesel Generator Sets)	0908-0110
Generator Set Operator Manual	0908-0115
Engine Operator Manual	A030F380
Service Manual (Controller)	0928-0508

If further, more detailed information is required, Engine Operation and Maintenance Manuals and Service Manuals are available. Contact your authorised distributor.

Engine Manual	4021389
Alternator Manual	UCH-027 (0900-9901)

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SECTION 1 – BASIC INFORMATION AND SAFETY

1 Safety

1.1 Warning, Caution and Note Styles Used In This Manual

The following safety styles found throughout this manual indicate potentially hazardous conditions for the operator, service personnel or the equipment.



WARNING: WARNS OF A HAZARD THAT MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.



Caution: Warns of a hazard or an unsafe practice that can result in product or property damage.



Note: A short piece of text giving information that augments the current text.

1.2 General Information

This manual should form part of the documentation package supplied by Cummins Power Generation Limited with specific generator sets. In the event that this manual has been supplied in isolation please refer to other Cummins Power Generation Limited literature, in particular the Health and Safety Manual (0908-0110).



Caution: It is in the Operator's interest to read and understand all Health and Safety information together with all Warnings and Cautions contained within the documentation relevant to the generator set, its operation and daily maintenance.

1.3 Generator Plant Safety Code

Before operating the generator set, read the manuals and become familiar with them and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.



WARNING: IMPROPER OPERATION AND MAINTENANCE CAN LEAD TO SEVERE PERSONAL INJURY OR LOSS OF LIFE AND PROPERTY BY FIRE, ELECTROCUTION, MECHANICAL BREAKDOWN OR EXHAUST GAS ASPHYXIATION. READ AND FOLLOW ALL SAFETY PRECAUTIONS, WARNINGS AND CAUTIONS THROUGHOUT THIS MANUAL AND THE HEALTH AND SAFETY MANUAL 0908-0110.



WARNING: LIFTING AND REPOSITIONING ON THE GENERATOR SET MUST ONLY BE CARRIED OUT USING SUITABLE LIFTING EQUIPMENT, SHACKLES AND SPREADER BARS IN ACCORDANCE WITH LOCAL GUIDELINES AND LEGISLATION BY SUITABLY TRAINED AND EXPERIENCED PERSONNEL. INCORRECT LIFTING CAN RESULT IN SEVERE PERSONAL INJURY, DEATH AND/OR EQUIPMENT DAMAGE. FOR MORE INFORMATION CONTACT YOUR AUTHORISED DISTRIBUTOR.

1.3.1 Positioning of Generator Set

The area for positioning the set should be adequate and level and the area immediately around the set must be free of any flammable material.

1.3.2 AC Supply and Isolation

It is the sole responsibility of the customer to provide the AC power supply and the means to isolate the AC input to the terminal box. Refer to the wiring diagram supplied with the generator set.



Note: *A separate disconnecting device is required by BS EN 12601:2001.*



Note: *The AC supply must have the correct over current and earth fault protection according to local electrical codes and regulations.*

The disconnecting device is not provided as part of the generator set, and Cummins Power Generation Limited accepts no responsibility for providing the means of isolation.

1.3.3 Spillage

Any spillage that occurs during fuelling or during oil top-up or oil change must be cleaned up before starting the generator set.



Note: *Where spillage containment is not part of Cummins supply, it is the responsibility of the installer to provide the necessary containment to prevent contamination of the environment, especially water courses/sources.*

1.3.4 Fluid Containment

If fluid containment is incorporated into the bedframe, any liquid present should be drained out and disposed of in line with local health and safety regulations. (See Health and Safety manual 0908-0110). Failure to perform this action may result in spillage of liquids which could contaminate the surrounding area.

Any other fluid containment area must also be checked and emptied, as above.

1.3.5 Exhaust Precautions



WARNING: EXHAUST PIPES AND CHARGE AIR PIPES ARE VERY HOT AND THEY CAN CAUSE SEVERE PERSONAL INJURY OR DEATH FROM DIRECT CONTACT OR FROM FIRE HAZARD.



WARNING: HOT EXHAUST GAS CAN CAUSE BURNS RESULTING IN SEVERE PERSONAL INJURY.

The exhaust outlet may be sited at the top of the set, or at the bottom, make sure that the exhaust outlet is not obstructed. Personnel using this equipment must be made aware of the exhaust position.



WARNING : CONTAMINATED INSULATION IS A FIRE RISK WHICH CAN RESULT IN SEVERE PERSONAL INJURY.

The exhaust pipes may have some insulating covers fitted. If these covers become contaminated by fuel or oil they must be replaced before the generator set is run.

To minimise the risk of fire ensure the following steps are observed:

- Ensure that the engine is allowed to cool thoroughly before topping up the oil or draining the fuel filters.
- Clean the exhaust pipe thoroughly.

1.4 Earthing Rod Connection

Although this generator set may be supplied with an earthing rod it will not be suitable for all local conditions.



Note:

The end user is responsible for ensuring that an earthing arrangement that is compliant with local conditions is established and tested before the equipment is used.

1.5 Decommissioning and Disassembly



Note:

Decommissioning and disassembly of the generator set at the end of its working life must comply with local guidelines and legislation for disposal/recycling of components and contaminated fluids. This procedure must only be carried out by suitably trained and qualified service personnel. For more information contact your authorised distributor.



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SECTION 2 - INTRODUCTION

2 Generator Set Identification

Each generator set is provided with a Generator Set Rating Plate similar to those shown in Figure 1 and Figure 2 This provides information unique to the generator set.




 Power Generation Manston Park, Columbus Avenue, Ramsgate, Kent, England, CT12 5BF				
Model Number Specification letter	C55 D5			
Serial Number	C07K990020			
Manufacturing Number	990020			
Year of Manufacture	2007			
Declared Rating	Standby		Prime	
Rated power @ 27°C Ambient kVA	55.0	-	50.0	-
kW	44.0	-	40.0	-
@ 40°C Ambient kVA	53.0	-	48.1	-
kW	42.4	-	38.5	-
@ 45°C Ambient kVA	51.4	-	46.8	-
kW	41.1	-	37.4	-
@ 50°C Ambient kVA	49.9	-	45.0	-
kW	39.9	-	36.0	-
Voltage	400	-	400	-
Frequency	50Hz	60Hz	50Hz	60Hz
Power factor	0.8	0.8	0.8	0.8
Generating set Max Mass - wet kg	1,176	1,176	1,176	1,176
Controller	1301	1301	1301	1301
Altitude before derate ASL m	150	150	150	150
Performance class ISO8528-1	G2	G2	G2	G2
Declared rating Enclosed Noise	Standby		Prime	
Sound Pressure Level @ 1m dB(A)	78	68	77	68
Average @ 7m dB(A)	68	68	67	68
Average @ 15m dB(A)	63	68	62	68
 LWA 97 dB <small>LWA, 50Hz @ 75% Prime as per 2000/14/EG Directive</small>				
				

Figure 1 Typical Enclosed Generator Set Rating Plate



 Power Generation Manston Park, Columbus Avenue, Ramsgate, Kent, England, CT12 5BF				
Model Number Specification letter		C55 D5		
Serial Number		C07K990020		
Manufacturing Number		990020		
Year of Manufacture		2007		
Declared Rating	Standby		Prime	
Rated power @ 27°C Ambient kVA	55.0	-	50.0	-
kW	44.0	-	40.0	-
@ 40°C Ambient kVA	53.0	-	48.1	-
kW	42.4	-	38.5	-
@ 45°C Ambient kVA	51.4	-	46.8	-
kW	41.1	-	37.4	-
@ 50°C Ambient kVA	49.9	-	45.0	-
kW	39.9	-	36.0	-
Voltage	400	-	400	-
Frequency	50Hz	60Hz	50Hz	60Hz
Power factor	0.8	0.8	0.8	0.8
Generating set Max Mass - wet kg	1,176	1,176	1,176	1,176
Controller	1301	1301	1301	1301
Altitude before derate ASL m	150	150	150	150
Performance class ISO8528-1	G2	G2	G2	G2
				

Figure 2 Typical Open Generator Set Rating Plate

2.1 After Sales Services

We offer a full range of after sales services as follows:

- Maintenance
- Warranty
- Spares
- Overseas Support
- Additional Literature.

2.1.1 Maintenance



WARNING: INCORRECT SERVICE OR PARTS REPLACEMENT CAN RESULT IN SEVERE PERSONAL INJURY, DEATH, AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE TRAINED AND EXPERIENCED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

For customers who wish to have their generator sets expertly serviced at regular intervals your local distributor offers a complete maintenance contract package. This covers all items subject to routine maintenance and includes a detailed report on the condition of the generator set. In addition, this can be linked to a 24-hour call-out arrangement, providing assistance 365 days a year if necessary. Specialist engineers are available to maintain optimum performance levels from customer's generator sets, and it is recommended that maintenance tasks are only undertaken by trained and experienced engineers provided by your authorised distributor.

2.1.2 Warranty

All generator sets have a twelve months warranty from the commissioning date as standard. Extended warranty coverage is also available. In the event of a breakdown prompt assistance can normally be given by factory trained service engineers with facilities to undertake all minor and many major repairs to equipment on site.

For further warranty details contact your authorised distributor.



Note: *Any damage caused to the generator set as a direct result of running in the Battle Short mode will not be covered by the Warranty.*



Note: *Damage to any component caused by freezing, will be rejected if the incorrect mix of anti-freeze has been used. Please contact your authorised Cummins distributor.*

2.1.3 Spares

An extensive Spare Parts Department is available for any emergency breakdown and for the engineer who carries out his own routine maintenance. Please contact your authorised Cummins distributor.

Please quote Plant Nos., Serial Nos., and Part Nos. when ordering spares.

2.1.4 Overseas Support

Agents and representatives in almost 100 countries throughout the world offer installation and after sales service for the equipment provided. We can provide the name and address of the agent for your specific location.

For details on any of the above services contact your authorised distributor.

2.1.5 Additional Literature

Should you require further, more detailed information regarding the engine or alternator please contact your authorised distributor.

Please quote Plant Nos., and Serial Nos.

- Engine Manual 4021389
- Alternator Manual UCH-027 (0900-9901)

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SECTION 3 – SYSTEM OVERVIEW

3 System Overview

3.1 Generator Components – Typical Generator Set

The main components of a typical Generator Set are shown below, and referred to within this section. Refer to the specific manual for additional, generator set information, together with the drawings supplied with the set.

Various options are listed although they may not be available for all models.

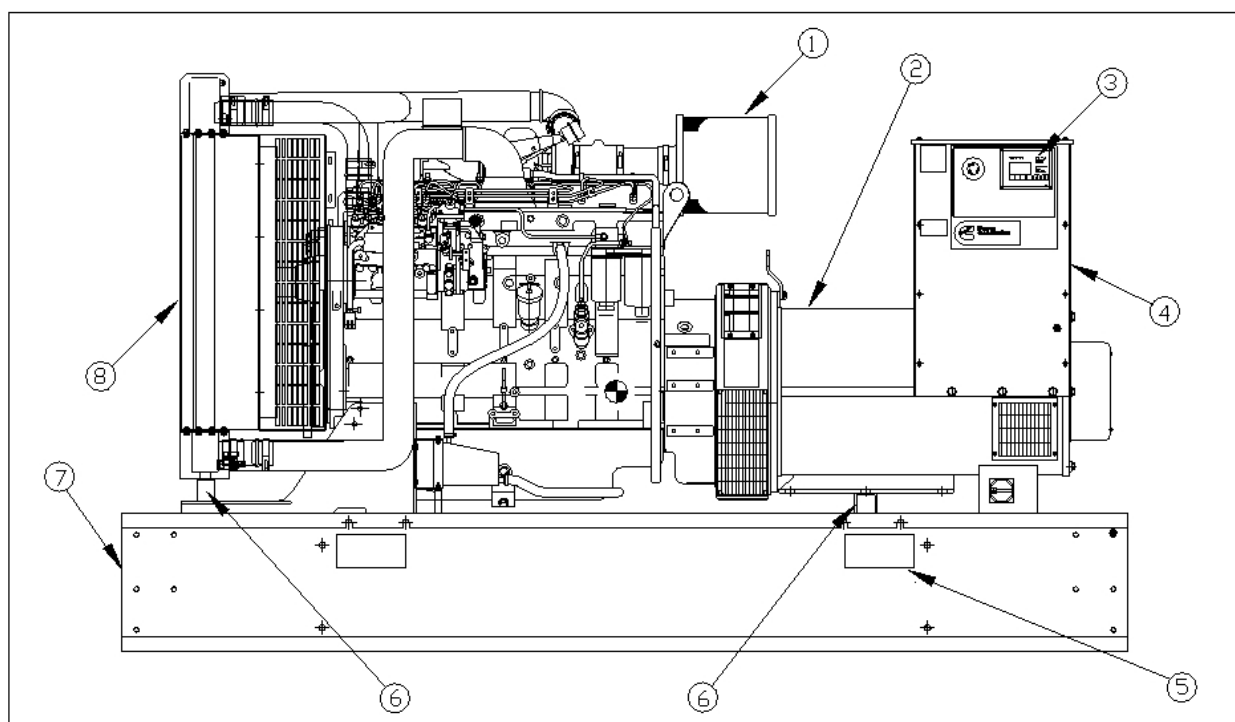


Figure 3 Typical Generator Set

KEY

1.	Air Cleaner	5.	Forklift Points
2.	Alternator	6.	Resilient Mountings
3.	Control Panel	7.	Bed Frame
4.	Control Housing	8.	Radiator

3.2 Generator Rating

For details of your generator set rating refer to the Generator Set Rating Plate. Refer to the operating manual for operation at temperatures or altitudes above those stated on the Rating Plate.

3.3 Engine

For engine specific information please refer to the relevant Engine Operator Manual (A030F380) supplied with the generator set document package.

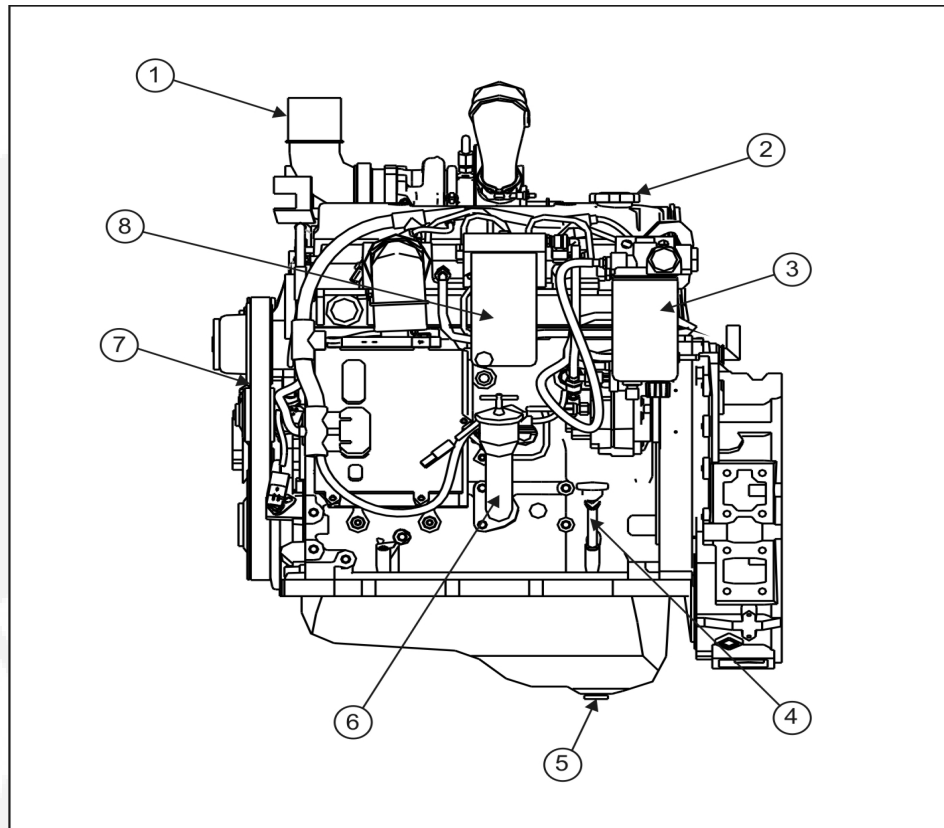


Figure 4 Typical External Engine Components

KEY			
1.	Exhaust	5.	Sump Drain
2.	Oil Filler Cap	6.	Secondary Oil Fill
3.	Water Separator	7.	Fan Belt
4.	Dipstick	8.	Fuel Filter

3.3.1 Fuel Changeover System (Where Fitted)

A 3-way fuel valve system is provided to enable the generator set to be fuelled directly from an external tank.

Where the system comprises two valves it is essential that both valves are in the same position to prevent the following:

- Fuel spillage from the generator set tank vent when fuel is drawn from the external tank and spill returned to the generator set tank.
- Fuel shortage when fuel is drawn from the generator set tank and spill returned to the external tank.



WARNING: DO NOT ATTEMPT TO OPERATE THE GENERATOR SET WITH THE VALVES SET TO EXTERNAL TANK SUPPLY AND WITH THE BLANKING PLUGS FITTED AS THIS WILL CAUSE DAMAGE TO THE ENGINE'S FUEL SYSTEM.



Note: Consult your authorised distributor to establish the maximum head of fuel allowable at the generator set fuel pump.

3.3.2 Mains Powered Battery Charger – Set Mounted (Option)

Optional single phase, mains powered battery charger, which is panel mounted, is available to maintain the battery in a charged condition when the generator set is not running.



Note: It is the sole responsibility of the Customer to provide the power supply and the means to isolate the supply to the charger. Cummins Power Generation Limited accepts no responsibility for providing the means of isolation.



Note: The AC supply must have the correct over current and earth fault protection according to local electrical codes and regulations.

3.3.3 Battery Isolator (Where Fitted)

A battery isolator is provided which isolates the negative feed from the battery to the engine. This can be used to isolate the battery to prevent battery drain through prolonged periods of generator set inactivity or where static battery charging is not available.



WARNING: THE BATTERY ISOLATOR SWITCH MUST NOT BE OPERATED WHILST THE GENERATOR SET IS RUNNING, AND MUST NOT BE USED TO STOP THE GENERATOR SET.

3.3.4 Sensors

Various generator set parameters are measured by sensors, and the resulting signals are applied to the PowerCommand display.

Engine-mounted sensors are able to monitor the following systems:

- Lube Oil Pressure
- Cooling System Temp
- Miscellaneous Areas.

3.3.5 Alarm Module (Option)

The Alarm Module provides audible warning. A rocker switch provides the means to switch the alarm facility on or off, see Figure 5.



Note: If this module has been switched off after giving an audible warning it will not be automatically re-set from the Control Panel after correcting the fault. **Ensure that the manual rocker switch reflects the On or Off mode that is required.**

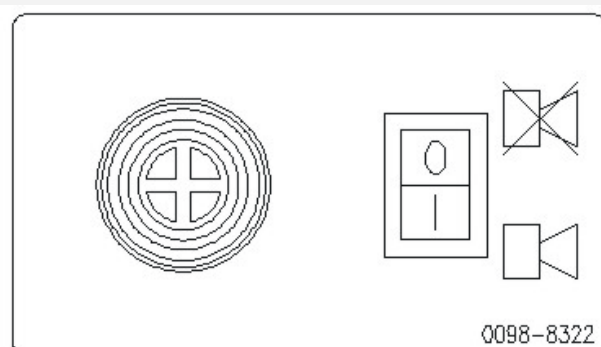


Figure 5 Alarm Module Front Panel

3.4 Heaters



Caution: *Heater(s) must not be energised if the coolant system has been drained.*

3.4.1 Heater Supply and Isolation

A heater supply is required for the operation of the engine and alternator heaters (if fitted), see [Sections 8.7 and 8.8](#).



Note: *This disconnecting device is not provided as part of the generator set.*



Note: *It is the sole responsibility of the customer to provide the power supply and the means to isolate the AC input to the terminal box. Cummins Power Generation Limited accepts no responsibility for providing the means of isolation.*

SECTION 4 – INSTALLATION OVERVIEW

4 Installation Overview

These installation recommendations apply to typical installations with standard model generator sets. Whenever possible, these recommendations also cover factory designed options or modifications. However, because of the many variables in any installation, it is not possible to provide specific recommendations for every situation. If there are any questions not answered by this manual, contact your nearest Cummins Power Generation distributor for assistance.

4.1 Application and Installation

A power system must be carefully planned and correctly installed for proper operation. This involves two essential elements.

- **Application** (as it applies to generator set installations) refers to the design of the complete power system that usually includes power distribution equipment, transfer switches, ventilation equipment, mounting pads, and cooling, exhaust, and fuel systems. Each component must be correctly designed so the complete system will function as intended. Application and design is an engineering function generally done by specifying engineers or other trained specialists. Specifying engineers or other trained specialists are responsible for the design of the complete power system and for selecting the materials and products required.
- **Installation** refers to the actual set-up and assembly of the power system. The installers set up and connect the various components of the system as specified in the system design plan. The complexity of the system normally requires the special skills of qualified electricians, plumbers, sheet-metal workers, etc. to complete the various segments of the installation. This is necessary so all components are assembled using standard methods and practices.

4.2 Safety Considerations

The generator set has been carefully designed to provide safe and efficient service when properly installed, maintained, and operated. However, the overall safety and reliability of the complete system is dependent on many factors outside the control of the generator set manufacturer. To avoid possible safety hazards, make all mechanical and electrical connections to the generator set exactly as specified in this manual. All systems external to the generator (fuel, exhaust, electrical, etc.) must comply with all applicable codes. Make certain all required inspections and tests have been completed and all code requirements have been satisfied before certifying the installation is complete and ready for service.

4.3 Standby Heating Devices

Cummins Power Generation recommends installing diesel standby generator sets (life safety systems) equipped with engine jacket water coolant heaters in locations where the minimum ambient temperature is below 40°F (4°C). Cummins Power Generation also requires that the engine be heated as necessary to maintain the water jacket temperature determined by the manufacturer for cold start and load acceptance for the type of system. Although most Cummins Power Generation generator sets will start in temperatures down to -25°F (-32°C) when equipped with engine jacket water coolant heaters, it might take more than 10 seconds to warm the engine before a load can be applied when ambient temperatures are below 40°F (4°C).

On generator sets equipped with a graphic display, the **Low Coolant Temperature** message, in conjunction with illumination of the Warning LED, is provided to meet the current requirements. The engine cold sensing logic initiates a warning when the engine jacket water coolant temperature falls below 70°F (21°C). In applications where the ambient temperature falls below 40°F (4°C), a cold engine may be indicated even though the coolant heaters are connected and operating correctly. Under these conditions, although the generator set may start, it may not be

able to accept load within 10 seconds. When this condition occurs, check the coolant heaters for proper operation. If the coolant heaters are operating properly, other precautions may be necessary to warm the engine before applying a load.

4.4 Product Modifications

Agency certified products purchased from Cummins Power Generation comply only with those specific requirements and as noted on company product specification sheets. Subsequent modifications must meet commonly accepted engineering practices and/or local and national codes and standards. Product modifications must be submitted to the local authority having jurisdiction for approval.

Table 1 - Specifications

MODELS	C135 D6 C150 D5	
Engine Cummins Diesel Series	6BTA5.9G2	
Generator kW Rating	See generator set nameplate for rating information.	
Engine Fuel Connection Inlet/Outlet Thread Size	Refer to Generator Outline Drawing	
Fuel Flow Max Fuel Inlet Restriction Max. Fuel Return Restriction	4in. Hg. (102 mmHg) 8in. Hg. (204 mmHg)	
Exhaust	1500 RPM	1800 RPM
Outlet Size Max. Allowable Back Pressure Exhaust Flow at Rated Load Exhaust Temperature	4 in. NPD 3 in. 76 mmHg 569 cfm (268L/s) 1023° F (551° C)	4 in. NPD 3 in. 76 mmHg 735 cfm (347L/s) 963° F (517° C)
Electrical System Starting Voltage Battery Group Number CCA (minimum) Cold Soak @ 0° F (-18° C)	12 or 24 Volts DC 1 or 2 x 12 Volt 31 12V = 800A 24V = 400A	
Cooling System Capacity with Standard Radiator	9.1L (2 gal)	
Lubricating System Oil Capacity with Filters	16.4L (4.3 gal)	

Table 2 - Fuel Consumption (Standby/Fuel Load)

RPM	1500	1800
L/hr (gph)	22 (4.8)	26 (5.7)

These figures are subject to change according to engine speed and settings.

SECTION 5 - INSTALLING THE GENERATOR SET

5 Installation Instructions

Generator set installations must be engineered so the generator set will function properly under the expected load conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing any components. The complete installation must comply with all local and state building codes, fire regulations, and other applicable regulations.

Requirements to be considered prior to installation are:

- Level mounting surface
- Adequate cooling air
- Adequate fresh induction air
- Discharge of generator set air.
- Non-combustible mounting surface
- Discharge of exhaust gases
- Electrical connections
- Accessibility for operation and servicing
- Noise levels
- Vibration isolation.



Caution: *Depending on your location and intended use, ensure that international, national or local laws and regulations regarding Air Quality Emissions have been observed and complied with. Be sure to consult local pollution control or air quality authorities before completing your construction plans.*

5.1 Location

Generator set location is decided mainly by related systems such as ventilation, wiring, fuel, and exhaust. The set should be located as near as possible to the main power service entrance. Exhaust must not be able to enter or accumulate around inhabited areas.

Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions. An optional housing is available for outside operation.



WARNING: INCORRECT INSTALLATION, SERVICE OR PARTS REPLACEMENT CAN RESULT IN SEVERE PERSONAL INJURY, DEATH, AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE TRAINED AND EXPERIENCED TO PERFORM ELECTRICAL AND MECHANICAL COMPONENT INSTALLATION.

5.2 Mounting

Generator sets are mounted on a steel skid that provides proper support. The engine-generator assembly is isolated from the skid frame by rubber mounts that provide adequate vibration isolation for normal installations. Where required by building codes or special isolation needs, generator sets may be mounted on rubber pads or mechanical spring isolators.



WARNING: THE USE OF UNAPPROVED ISOLATORS MAY RESULT IN HARMFUL RESONANCES AND MAY VOID THE GENERATOR SET WARRANTY.

Mount the generator set on a substantial and level base such as a concrete pad. A non-combustible material must be used for the pad.

Use 16mm ($\frac{5}{8}$ inch) anchored mounting bolts to secure the generator bedframe to the base. Secure the generator bedframe to the skid using flat washer and hexagonal nut for each bolt (see

Figure 6). The 38mm x 152mm (1½ x 6 inch) pipe inserted over the mounting bolts allows minor adjustment of the bolts to align them to the holes in the bedframe.

The fixing centres for the mounting bolts can be found on the generator set *Outline Drawing* referenced in the *Data Sheet*.

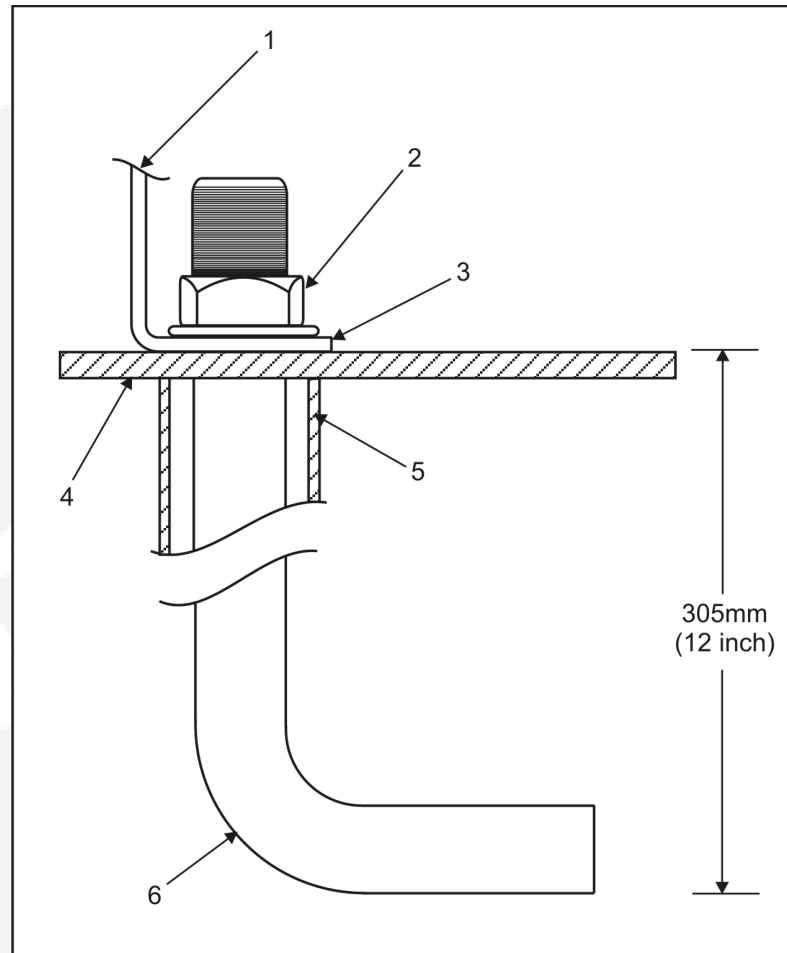


Figure 6 Bolt Diagram

KEY			
1.	Generator Bedframe Flange	4.	Mounting Base on Concrete
2.	Hexagonal Nut	5.	38mm x 152mm Pipe (1½ inch x 6inch)
3.	Flat or Bevel Washer	6.	Mounting Bolt Set in Concrete

5.3 Access to Set

Generally, at least 1 meter (3.3 feet) of clearance should be provided on all sides of the generator set for maintenance and service access. (Increase clearance by width of door if optional housing is used.) A raised foundation or slab of 152 mm (6 inches) or more above floor level will make servicing easier. Lighting should be adequate for operation, maintenance and service operations and should be connected on the load side of the transfer switch so that it is available at all times.

5.4 Moving the Generator Set



WARNING: TRANSPORTATION AND HANDLING OF GENERATOR SETS MUST ONLY BE UNDERTAKEN BY SUITABLY TRAINED AND EXPERIENCED PERSONNEL.

It is essential that there are sufficient trained and experienced personnel in attendance to ensure the lifting and transportation of the generator set is undertaken in a safe and appropriate manner and in accordance to local guidelines and legislation.



WARNING: DO NOT LIFT THE GENERATOR SET BY ATTACHING TO THE ENGINE OR ALTERNATOR LIFTING POINTS. IMPROPER HANDLING OF THE GENERATOR SET MAY CAUSE SERIOUS DAMAGE TO THE GENERATOR SET AND ITS COMPONENTS AND CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH.

Before lifting the generator set, lifting points, angle of slings, mass, access to intended site and the distance of movement should all be taken into account when organising a suitable crane/hoist. Consult the generator set information supplied with your generator set for details of dimensions and mass.

- Ensure that the crane operating area is able to support the mass of the crane and the generator set.



WARNING: DO NOT USE THE GENERATOR SET AS A MEANS OF ACCESS WHEN ATTACHING LIFTING SHACKLES, CHAINS ETC. USE AS ACCESS MAY DAMAGE THE GENERATOR SET AND/OR CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH.



WARNING: ON AN ENCLOSED GENERATOR SET, THE CANOPY DOORS MUST BE LOCKED BEFORE RE-POSITIONING AND MUST REMAIN LOCKED DURING TRANSPORTATION AND SITING.

- Attach the lifting device to the lifting points only, using suitable shackles, chains and spreader bars.
- Slowly tighten the slings. Inspect the lifting attachments before commencing a full lift to ensure they are attached correctly.
- Hoist the generator set slowly using the indicated lifting points only.



WARNING: NEVER STAND UNDERNEATH A LIFTED GENERATOR SET. CONTACT WITH A LIFTED GENERATOR SET CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH.

- Guide the generator set with ropes at a safe distance, to prevent uncontrolled rotation when positioning the generator set.
- Move the generator set to the desired location and place in position, bringing the set down slowly.
- Loosen the slings, unhook and remove the shackles.

5.4.1 Positioning a Generator Set Using a Forklift Truck



WARNING: TRANSPORTATION AND HANDLING OF GENERATOR SETS BY FORKLIFT TRUCKS MUST ONLY BE UNDERTAKEN BY SUITABLY TRAINED AND EXPERIENCED PERSONNEL WHO ARE FAMILIAR WITH THE TRANSPORT OF THESE ITEMS.

If using a forklift truck to transport/position the generator set, the dimensions, mass and route must be taken into account when selecting an appropriate lifting truck.



WARNING: DO NOT ATTEMPT TO LIFT A GENERATOR SET WITH AN UNDERSIZED FORKLIFT TRUCK. IMPROPER HANDLING OF THE GENERATOR SET MAY CAUSE SERIOUS DAMAGE TO THE GENERATOR SET AND ITS COMPONENTS AND CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH.

It is essential that there are sufficient trained and experienced personnel in attendance to ensure the lifting and transportation of the generator set is undertaken in a safe and appropriate manner and in accordance to local guidelines and legislation.



WARNING: ON AN ENCLOSED GENERATOR SET, THE CANOPY DOORS MUST BE LOCKED BEFORE RE-POSITIONING AND MUST REMAIN LOCKED DURING TRANSPORTATION AND SITING.

- Position the arms of the forklift under the frame or pallet, making sure the mainframe is resting on the arms.
- Lift and handle the equipment slowly.
- Set down the generator set in its final position slowly.

5.5 Transportation



WARNING: TRANSPORTATION AND HANDLING OF GENERATOR SETS MUST ONLY BE UNDERTAKEN BY SUITABLY TRAINED AND EXPERIENCED PERSONNEL WHO ARE FAMILIAR WITH THE TRANSPORT OF THESE ITEMS.



WARNING: DO NOT LIFT THE GENERATOR SET BY ATTACHING TO THE ENGINE OR ALTERNATOR LIFTING POINTS. IMPROPER HANDLING OF THE GENERATOR SET MAY CAUSE SERIOUS DAMAGE TO THE GENERATOR SET AND ITS COMPONENTS AND CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH.



WARNING: ON AN ENCLOSED GENERATOR SET, THE CANOPY DOORS MUST BE LOCKED BEFORE RE-POSITIONING AND MUST REMAIN LOCKED DURING TRANSPORTATION AND SITING.

- Ensure the generator set is prepared for transport. If necessary drain fluids and ensure that acid or fumes do not leak from the battery (where applicable).
- If the generator set is transported over long distances, protect it against environmental influences by sealing it in a plastic cover or similar.
- For lifting procedures see [5.4 Moving the Generator Set](#)
- Ensure the generator set is secured to the vehicle with suitable securing straps. Wooden chocks and pallets alongside the securing straps can prevent movement during transportation.
- If required, attach impact indicators to the generator set. Upon delivery check these impact indicators and contact the transport company immediately if an impact has been detected. Impacts can cause serious damage to the generator set and its components.
- Ensure that the generator set cannot turn over during transportation.
- Do not overload the transport vehicle. Under no circumstances should the generator be started while inside a truck.
- Lifting eyes where fitted are to be checked at regular intervals to ensure they are damage free and tight.

SECTION 6 - MECHANICAL CONNECTIONS

6 Mechanical Connections

This model is fitted with an integral fuel tank with sufficient capacity to run the generator set for approximately 8 hours, depending on engine load and settings. If the generator set is to be supplied by an external fuel supply the following instructions must be followed.

The generator set mechanical system installation includes connecting the fuel, exhaust, ventilation and cooling systems. Before starting any type of fuel installation, all pertinent state and local codes must be complied with and the installation must be inspected before the unit is put in service.

6.1 Fuel System

Cummins engines normally use a diesel fuel specified to ASTM No. 2 or BS EN 590:2000, Automotive fuels. They will, however, operate on alternate diesel fuels within the specifications shown in the Generator Set Operator Manual (0908-0115).

In all fuel system installations, cleanliness is of the utmost importance. Make every effort to prevent entrance of moisture, dirt or contaminants of any kind into the fuel system. Clean all fuel system components before installing.



Note: *A fuel filter/strainer/water separator of 100-120 mesh or equivalent (approximately 150 microns nominal) must be fitted between either the main tank and day tank or between the main tank and the engine.*

Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Buried fuel lines must be protected from corrosion.



Caution: *Never use galvanized or copper fuel lines, fittings or fuel tanks. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The molecular structure of the copper or galvanized lines or tanks reacts with the acid and contaminates the fuel.*

An electric solenoid valve in the supply line is recommended for all installations and required for indoor automatic or remote starting installations. Connect the solenoid wires to the generator set "Switched B+" circuit to open the valve during generator set operation.

Separate fuel return lines to the day tank or supply tank must be provided for each generator set in a multiple-set installation to prevent the return lines of idle sets from being pressurized. Fuel return lines must not contain a shutoff device. Engine damage will occur if the engine is run with the return fuel lines blocked or restricted.



Caution: *Never install shutoff device in fuel return line(s). If fuel return line(s) is blocked or exceeds fuel restriction limit, engine damage will occur.*

6.2 Fuel Return Restrictions (or Pressure) Limit

Fuel return drain restriction (consisting of friction head and static head) between the engine injector return line connection and the fuel tank must not exceed the limit stated in the model-specific generator set *Specification Sheet*.

6.3 Fuel Lines Routing

A flexible fuel hose(s) or section of flexible fuel hose(s) must be used between the engine's fuel system and fuel supply and return line(s) to protect the fuel system from damage caused by vibration, expansion and contraction. Flexible lines for connecting between the engine and the stationary fuel lines are supplied as standard equipment.



WARNING: FUEL LEAKS CREATE FIRE AND EXPLOSION HAZARDS WHICH CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. ALWAYS USE FLEXIBLE TUBING BETWEEN ENGINE AND FUEL SUPPLY TO AVOID LINE FAILURE AND LEAKS DUE TO VIBRATION. THE FUEL SYSTEM MUST MEET ALL APPLICATION CODES.

INSTALLATION OF THE FUEL HOSE MUST BE DONE ACCORDING TO ALL APPLICATION CODES AND STANDARDS, AND INSTALLATION RECOMMENDATIONS PROVIDED BY THE MANUFACTURER. THE SUPPLIED FLEXIBLE HOSE IS APPROVED BY THE HOSE MANUFACTURER FOR USE WITH THE GENERATOR SET FUEL TYPE AND PRODUCT APPLICATION.

SUPPORT FUEL LINES TO RESTRAIN MOVEMENT AND PREVENT CHAFING ON CONTACT WITH SHARP EDGES, ELECTRICAL WIRING AND HOT EXHAUST PARTS.



WARNING: SPARKS AND HOT SURFACES CAN IGNITE FUEL, LEADING TO SEVERE PERSONAL INJURY OR DEATH. DO NOT ROUTE FUEL LINES NEAR ELECTRICAL WIRING OR HOT EXHAUST PARTS.

FUEL LINES MUST BE ROUTED AND SECURED TO MAINTAIN A 12.7 mm ($\frac{1}{2}$ inch) MINIMUM CLEARANCE FROM ELECTRICAL WIRING AND A 51 mm (2 inch) MINIMUM CLEARANCE FROM HOT EXHAUST PARTS.

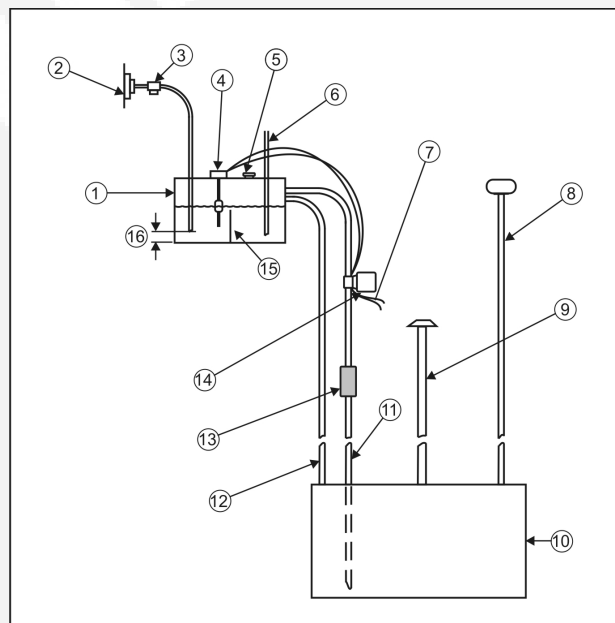


Figure 7 Typical Fuel Supply Installation

KEY

1.	Day Tank	9.	Fill Pipe
2.	Engine Fuel Pump	10.	Main Fuel Tank
3.	Shut Off Valve	11.	Supply Line
4.	Float Switch	12.	Larger Overflow Line 120 Mesh Fuel Strainer
5.	Vented Fill Cap	13.	120 Mesh Fuel Strainer
6.	Injector Fuel Return Line	14.	Fuel Transfer Pump electric motor driven
7.	Connect to AC output	15.	Baffle
8.	Vent Pipe	16.	25.4mm (1inch) clearance

6.4 Engine Fuel Connections

Identification tags are attached to the fuel supply line and fuel return line connections. All models require a fuel return line from the injectors to the tank.

6.5 Supply Tank

Locate the fuel tank as close as possible to the generator set and within the restriction limitations of the fuel pump.

Install a fuel tank that has sufficient capacity to supply the generator set operating continuously at full rated load for the planned period of operation or power outage. Refer to Table 2 for fuel consumption data.

If the fuel inlet restriction exceeds the defined limit due to the distance/customer-supplied plumbing between the generator set and the main fuel tank, a transfer tank (sometimes referred to as a day tank) and auxiliary pump will also be required. If an overhead main fuel tank is installed, a transfer tank and float valve will be required to prevent fuel head pressures from being placed on the fuel system components.



Note: *For critical start applications, where generator sets are paralleled or must satisfy emergency start-time requirements, it is recommended that a fuel tank or reservoir be located such that the lowest possible fuel level is not less than 6 inches (150 mm) above the fuel pump inlet. This will prevent air from accumulating in the fuel line while the generator set is in standby, eliminating the period during startup when it has to be purged.*

6.6 Fuel Inlet Pressure/Restriction Limit

Engine performance and fuel system durability will be compromised if the fuel inlet pressure or restriction limits are not adhered to. Fuel inlet pressure or restriction must not exceed the limits stated in the model-specific generator set *Specification Sheet*.

6.7 Day Tank (If Used)

Fuel day tanks are used when fuel inlet restriction limits can not be met, or the supply tank is overhead and presents problems of high fuel head pressure for the fuel inlet and return lines.

6.8 Supply Tank Lower Than Engine

With this installation, the day tank is installed near the generator set, below the fuel injection system and within the fuel inlet restriction limit. Install a fuel transfer pump, to pump fuel from the supply tank to the day tank. A float switch in the day tank controls operation of the auxiliary fuel pump.



Note: *The supply tank top must be below the day tank top to prevent siphoning from the fuel supply to the day tank.*

Provide a return line from the engine injection system return connection to the day tank. Plumb the return line to the bottom of day tank as shown in Figure 7. Provide a day tank overflow line to the supply tank in case the float switch fails to shut off the fuel transfer pump.



WARNING: **SPILLED FUEL PRESENTS THE HAZARD OF FIRE OR EXPLOSION WHICH CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. PROVIDE AN OVERFLOW LINE TO THE SUPPLY TANK FROM THE DAY TANK.**

6.9 Supply Tank Higher Than Engine

With this installation, the day tank is installed near the generator set, below the fuel injection system and within the fuel inlet restriction limit. Include an automatic fuel shutoff valve in the fuel line between the fuel supply tank and the day tank to stop fuel flow when the generator set is off.

Provide a return line from the engine injection system return connection to the day tank. Plumb the return line to the bottom of day tank as shown in Figure 7.



WARNING: SPILLED FUEL CAN CREATE ENVIRONMENTAL HAZARDS. CHECK LOCAL REQUIREMENTS FOR CONTAINMENT AND PREVENTION OF DRAINING TO SEWER AND GROUND WATER.

6.10 Exhaust System

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlets away from any air inlets to avoid gases re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation and light loads. Regularly inspect the exhaust system both visually and audibly to see that the entire system remains fume tight and safe for operation.



WARNING: INHALATION OF EXHAUST GASSES CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. USE EXTREME CARE DURING INSTALLATION TO PROVIDE A TIGHT EXHAUST SYSTEM. TERMINATE EXHAUST PIPES AWAY FROM ENCLOSED OR SHELTERED AREAS, WINDOWS, DOORS AND VENTS.

For indoor installation, the exhaust system should use sealed joint type fittings where possible to provide a tight exhaust system. Use of slip type fittings (secured with a muffler clamp) may allow leakage of exhaust gases into the building if not fitted correctly fitted. Check there are **NO** exhaust leaks.



WARNING: INHALATION OF EXHAUST GASSES CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. USE EXTREME CARE DURING INSTALLATION TO PROVIDE A TIGHT EXHAUST SYSTEM.

Use an approved thimble (see Figure 8) where exhaust pipes pass through wall or partitions. Insulated wall/roof thimbles are used where exhaust pipes pass through a combustible roof or wall. This includes structures, such as wood framing or insulated steel decking, etc. Uninsulated wall/roof thimbles are used where exhaust pipes pass through a non-combustible wall or roof, such as concrete. Build according to the code requirements in effect at the installation site.



WARNING: HOT EXHAUST PIPES CAN START A FIRE AND CAUSE SEVERE INJURY OR DEATH IF IMPROPERLY ROUTED THROUGH WALLS. USE AN APPROVED THIMBLE WHERE EXHAUST PIPES PASS THROUGH WALL OR PARTITIONS.



WARNING: INHALATION OF EXHAUST GASES CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. DO NOT USE EXHAUST HEAT TO WARM A ROOM, COMPARTMENT OR STORAGE AREA.

Rain caps are available for the discharge end of vertical exhaust pipes. The rain cap clamps onto the end of the pipe and opens due to exhaust discharge force from the generator set. When the generator set is stopped, the rain cap automatically closes, protecting the exhaust system from rain, snow, etc.

Use a section of flexible exhaust pipe between the engine and remainder of exhaust system. Support the exhaust system to prevent weight from being applied to engine exhaust outlet elbow/turbocharger connection.



Caution: *Weight applied to the engine manifold can result in turbocharger damage. Support the silencer and exhaust piping so no weight or stress is applied to the engine exhaust elbow.*

The exhaust system design should meet local code requirements.



Note: *Liability for injury, death, damage, and warranty expense due to use of unapproved mufflers or modifications to the exhaust system becomes the responsibility of the person installing the unapproved muffler or performing the modification. Contact a Cummins Power Generation distributor for approved exhaust system parts.*

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for muffler and tailpipe. Pitch a horizontal run of exhaust pipe **DOWNWARD** (away from engine) to allow any moisture condensation to drain away from the engine. If an exhaust pipe must be turned upward, install a condensation trap at the point where the rise begins see Figure 9.

Shield or insulate exhaust lines if there is danger of personal contact. Allow at least 305 mm (12 inches) of clearance if the pipes pass close to a combustible wall or partition. Before installing insulation on exhaust system components, check the exhaust system for leaks while operating the generator set under full load and correct all leaks.

If the exhaust line must be pitched upward, construct a condensation trap at the point of rise. Avoid sharp bends and drain the trap periodically.



WARNING: EXHAUST PIPES ARE VERY HOT AND THEY CAN CAUSE SEVERE PERSONAL INJURY OR DEATH FROM DIRECT CONTACT OR FROM FIRE HAZARD. SHIELD OR INSULATE EXHAUST PIPES IF THERE IS DANGER OF PERSONAL CONTACT OR WHEN ROUTED THROUGH WALLS OR NEAR OTHER COMBUSTIBLE MATERIALS.

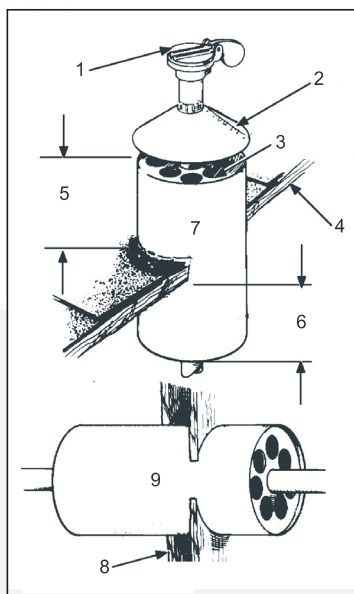


Figure 8 Mounting Exhaust Thimble

KEY

1.	Rain Cap	6.	230mm - 9 inches
2.	Drip Cap	7.	Vertical Alignment
3.	Holes in End of Inner sleeve	8.	Wall or Partition
4.	Roof	9.	Horizontal Alignment
5.	230mm - 9 inches		

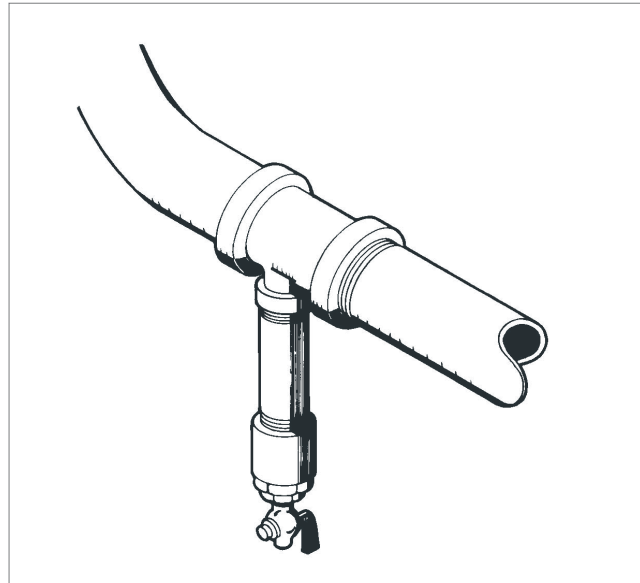


Figure 9 Condensation Trap

6.11 Ventilation and Cooling

Generator sets create considerable heat that must be removed by proper ventilation. Outdoor installations normally rely on natural air circulation but indoor installations need properly sized and positioned vents for required airflow.

6.12 Vents and Ducts

For indoor installations, locate vents so incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement.

Size the vents and ducts so they are large enough to allow the required flow rate of air.



Note: *The "free area" of ducts must be as large as the exposed area of the radiator. Refer to the generator set Specification Sheet for the airflow requirements and allowed airflow restriction.*

Wind will restrict free airflow if it blows directly into the air outlet vent. Locate the outlet vent so the effects of wind are eliminated, or if outlet vent cannot be located as mentioned, install wind barrier, see Figure 10.



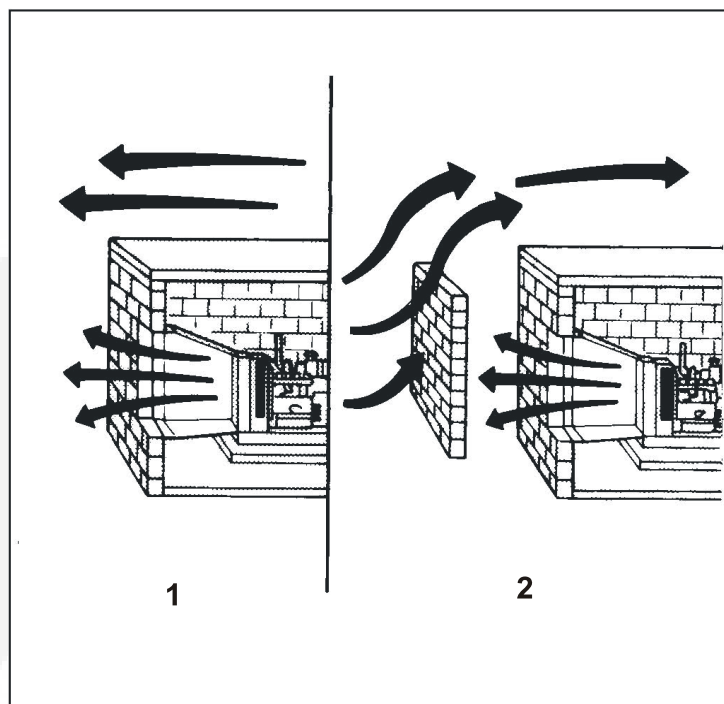


Figure 10 Wind Barrier

KEY

- | | |
|----|------------------------------------------------------------------|
| 1. | Prevailing Wind Away from Air Outlet Vent. |
| 2. | Prevailing Wind Towards Air Outlet Vent, Wind Barrier Installed. |

6.13 Dampers

Dampers or louvers protect the generator set and equipment room from the outside environment. Their operation of opening and closing should be controlled by operation of the generator set.

In cold climates, the radiator exhaust air can be re-circulated to modulate the ambient air temperature in the generator set room. This will help the generator set warm up faster, and help to keep fuel temperatures higher than the cloud point of the fuel. If recirculation dampers are used, they should be designed to “fail closed”, with the main exhaust dampers open, so that the generator set can continue to operate when required. Designers should be aware that the generator set room operating temperature will be very close to the outdoor temperature, and either not route water piping through the generator set room, or protect it from freezing.

6.14 Radiator Set Requirements

Louvers and screens over air inlet and outlet openings restrict air flow and vary widely in performance.

A louver assembly with narrow vanes, for example, tends to be more restrictive than one with wide vanes. The effective open area specified by the louver or screen manufacturer should be used.

Radiator set cooling air is drawn past the control end of the set by a pusher fan that blows air through the radiator. Locate the air inlet to the rear of the set. Make the inlet vent opening 38mm (1½ inches) times larger than the radiator area.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The outlet opening must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow.

A flexible duct connector must be provided at the radiator to prevent exhaust air recirculation around the radiator, to take up generator set movement and vibration, and prevent transmission of

noise. Attach the flexible duct using screws and nuts so the duct can be removed for maintenance purposes.

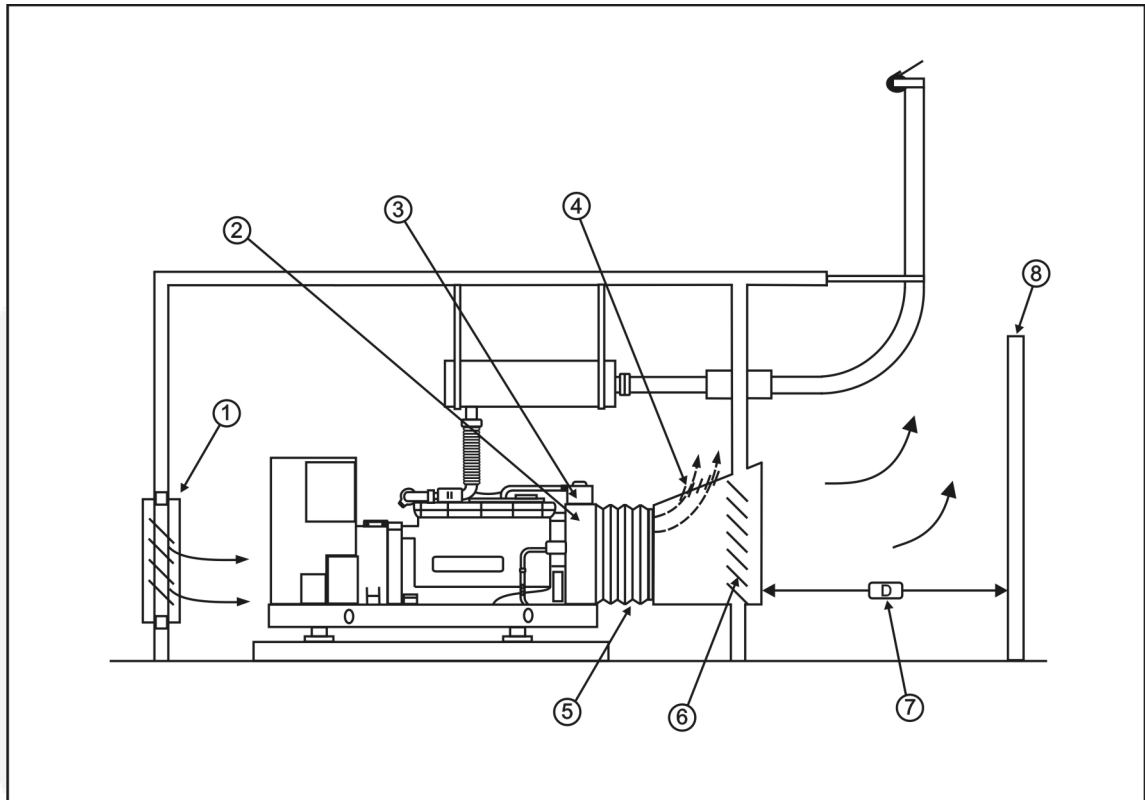


Figure 11 Typical Radiator Set Installation

KEY

1. Cool Air Inlet Damper	5. Flexible Duct Connector
2. Engine Driven Fan	6. Hot Air Outlet Damper
3. Radiator	7. Distance Should Not be Less Than Height of Radiator
4. Thermostat Controlled Re-circulating Damper	8. Wind / Noise Barrier

SECTION 7 – DC CONTROL WIRING

7 Control Wiring

The generator set control box contains connection points for remote control and monitor options.



Caution: *Stranded copper wire must be used for all customer connections to the control panel. Solid copper wire may break due to the generator set vibration.*

Use flexible conduit for all wiring connections to the generator set.



WARNING: **HAZARDOUS VOLTAGE! TOUCHING UNINSULATED HIGH VOLTAGE PARTS INSIDE THE CONTROL BOX CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. ENSURE ALL POWER IS OFF BEFORE PERFORMING CONTROL WIRE INSTALLATION.**



WARNING: **TO PREVENT ACCIDENTAL ELECTROCUTION STAND ON A CLEAN DRY WOODEN PLATFORM OR CLEAN RUBBER INSULATING MAT, MAKE SURE YOUR CLOTHING AND SHOES ARE DRY, REMOVE JEWELLERY AND USE TOOLS WITH INSULATED HANDLES.**

Route the control wiring through the bottom of the control housing, keep DC wiring away from high voltage AC wiring. See Figure 12 which shows the terminal blocks for connection and controller circuit boards.

Use cable ties to keep control wiring away from sharp edges and AC power cables within the control housing.

7.1 TB1 Remote Monitor / Control Connections

Customer monitor/control connections are attached to terminal block TB1 (see *Figure 12*). Optional equipment, such as sensing devices used to monitor generator set operation, remote start/stop switches, etc. are also attached to TB1.

Available options will vary between controller models.

7.2 TB1 Wiring



Caution: *Always run control circuit wiring in separate metal conduit from AC power cables to avoid inducing currents that could cause problems within the control.*

Digital Connections: Connection points, other than relayed outputs and network are considered digital connections to terminal strip TB1. The type/ gauge wire to use for these connections are:

Less than 305 metres, (1000 feet) use 20 gauge stranded copper wire.

305 to 610 metres (1000 to 2000 feet), use 18 gauge stranded copper wire.

Relay Connections: Due to the wide variety of devices that can be attached to the relay outputs of TB1, the electrical contractor must determine the gauge of the stranded copper wire that is used at this installation site.

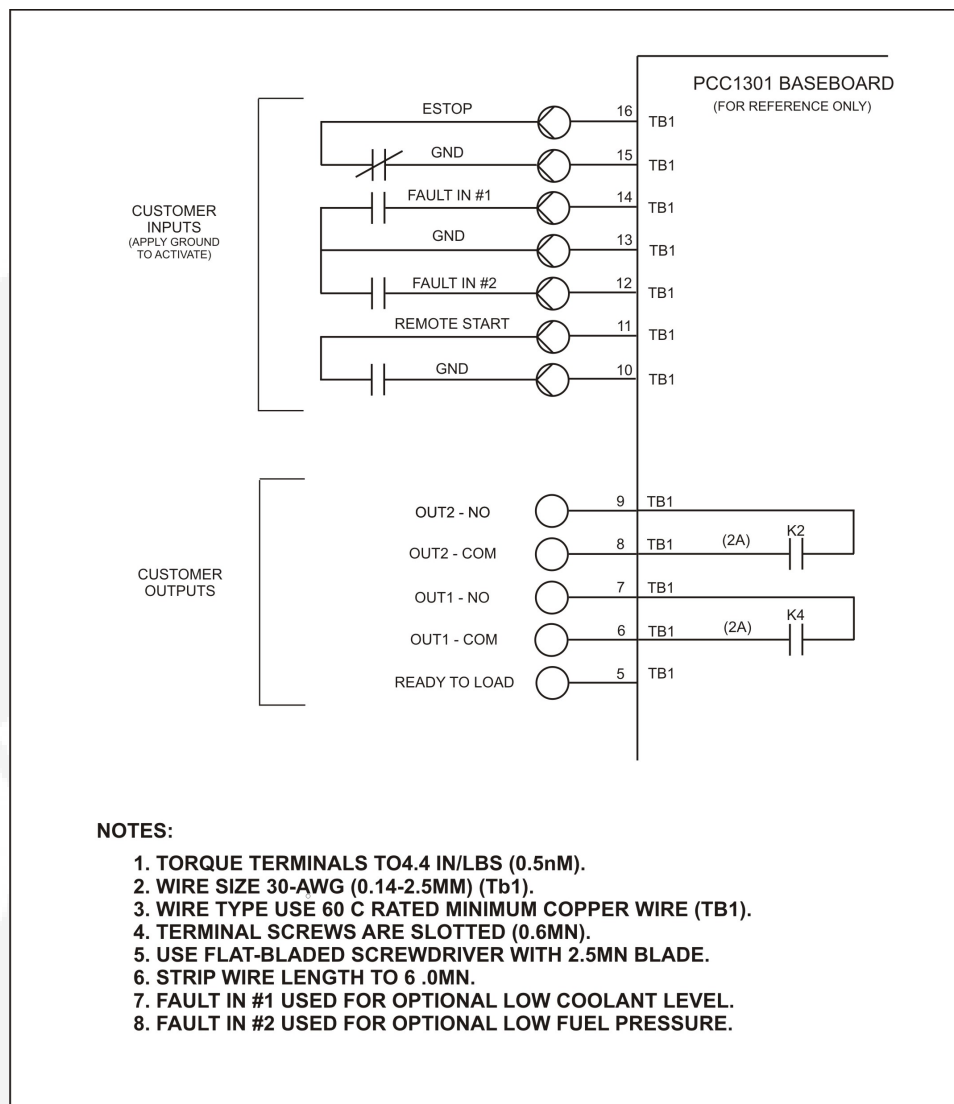


Figure 12 TB1 Customer Connections

7.3 TB1 Customer Inputs

See Figure 12 for typical connections to TB1.

Remote Start: When the control is in Auto/Remote mode, grounding this input initiates the engine cranking and start sequence. This circuit must be opened to permit resetting a shutdown condition with the Reset input. (The remote stop is actually the removal of the remote start signal to the control.)

Remote Emergency Stop: Opening this input causes an immediate shutdown. Emergency stop must be reset at the front panel.

Customer Fault Inputs 1 and 2: Grounding any one of these inputs activates the corresponding warning or shutdown sequence.

External sensing equipment must be connected to the designated digital input.

The nature of the fault is an optional customer selection. Example inputs: Low Coolant Level, Low Fuel Pressure, Ground Fault, etc.

Each of the two fault functions can be programmed as follows:

Status, Warning or Shutdown. Default = Warning.



Note: The InPower Service Tool or access to the Setup Submenus is required to modify the customer fault inputs. Contact an authorized service center for assistance.

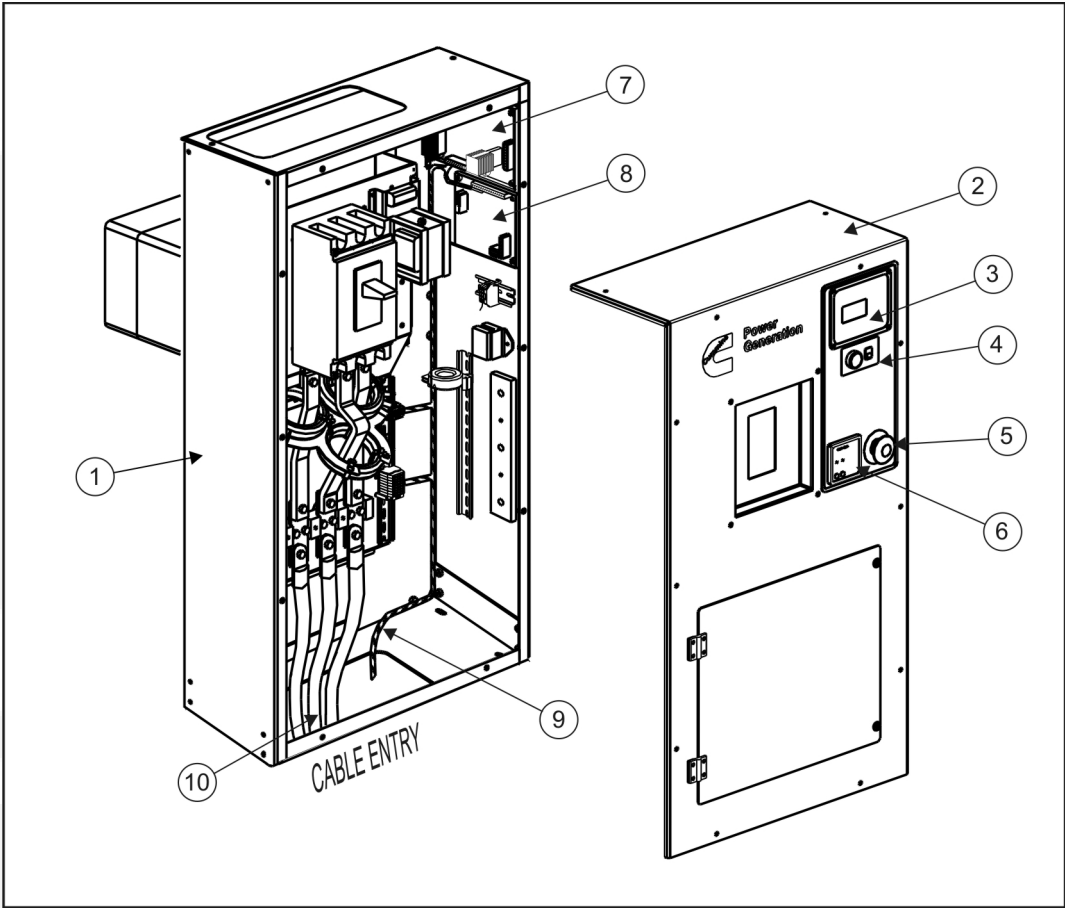


Figure 13 Suggested Customer Wire Routing

KEY			
1.	Control Box Assembly	6.	Earth Fault Relay
2.	Front Cover Control Box	7.	PCC1301 Controller PCB
3.	Control Assembly Display	8.	PCB Assembly - System I/O Device
4.	Audible Alarm	9.	Customer Connections DC
5.	Emergency Stop Actuator	10.	Customer Connections AC (3 phase)

7.4 TB1 Customer Outputs

See Figure 12 for typical connections to TB1.

Customer Outputs 1 and 2: One set of normally open (NO) contacts, rated for 2 Amps at 30 VDC for each of the two output signals. The relays can be used to control small devices and indicator lamps.

The nature of the customer output signal (contacts closed) is an optional customer selection. Example outputs: Generator set running (event), common warning, common shutdown, etc. (Refer to Generator Set Operator Manual 0908-0115 for the warning and shutdown code listing.

7.5 Switched B+

Switched B+ quick connect terminal is located on TB2-12 dinrail situated in the top of the pedestal controller.

The contacts are rated:

-
- Wiring diagram for the 120VAC control circuit of a 1500 HP motor. The diagram shows the connection of a 120VAC source (B+) through a series of interlocking switches (K10, K11) and a thermal relay (TB1) to a terminal block (TB10). The switches K10 and K11 are shown in their closed positions. The thermal relay TB1 is shown in its latched position. The terminal block TB10 is shown with its internal connections. The diagram includes labels for various terminals and components: B+, TO TB10-1, TO TB10-2, TO TB10-3, TO TB10-4, TO TB10-5, TO TB10-6, K10, K11, TB1, and TB10. The diagram also includes a legend for the terminal block TB10 connections.
- Legend for TB10:**
- | Terminal | Connection |
|----------|------------|
| 1 | K10 - 30 |
| 2 | K10 - 87 |
| 3 | K10 - 87A |
| 4 | K11 - 30 |
| 5 | K11 - 87 |
| 6 | K11 - 87A |
| 7 | K10 - COM |
| 8 | K10 - N/O |
| 9 | K10 - N/C |
| 10 | K11 - COM |
| 11 | K11 - N/O |
| 12 | K11 - N/C |

Figure 14 Optional Run Relays (K10, K11)

SECTION 8 - AC ELECTRICAL CONNECTIONS

8 AC Electrical Connections

This section provides the procedure that is used to connect the AC electrical system of the generator set.

Before making any AC electrical connections, make certain the generator set cannot be accidentally started. Place the control panel run switch in the OFF position. Turn off or remove AC power from the battery charger and then remove the negative (–) battery cable from the set starting battery.



WARNING: IGNITION OF EXPLOSIVE BATTERY GASES CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. ARCING AT BATTERY TERMINALS, LIGHT SWITCH OR OTHER EQUIPMENT, FLAME, PILOT LIGHTS AND SPARKS CAN IGNITE BATTERY GAS. DO NOT SMOKE, OR SWITCH TROUBLE LIGHT ON OR OFF NEAR BATTERY. DISCHARGE STATIC ELECTRICITY FROM BODY BEFORE TOUCHING BATTERIES BY FIRST TOUCHING A GROUNDED METAL SURFACE.



WARNING: VENTILATE BATTERY AREA BEFORE WORKING ON OR NEAR BATTERY—WEAR GOGGLES—STOP GENERATOR SET AND DISCONNECT CHARGER BEFORE DISCONNECTING BATTERY CABLES—DISCONNECT NEGATIVE (–) CABLE FIRST AND RECONNECT LAST.



Caution: *Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.*



WARNING: ACCIDENTAL STARTING OF THE GENERATOR SET CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. PREVENT ACCIDENTAL STARTING BY DISCONNECTING THE NEGATIVE (–) CABLE FROM THE BATTERY TERMINAL.



WARNING: EACH OF THE OPERATIONS DESCRIBED IN THIS SECTION SHOULD BE DONE ONLY BY PERSONS TRAINED AND EXPERIENCED IN ELECTRICAL MAINTENANCE. IMPROPER PROCEDURES MAY RESULT IN PROPERTY DAMAGE, BODILY INJURY OR DEATH.

Connecting the generator set AC electrical system involves:

- Installation of transfer switch
- Generator output voltage selection
- Load cable connection
- Standard and optional AC equipment connections (e.g., control box heater, coolant heater, etc.).

Local regulations often require that wiring connections be made by a licensed electrician, and that the installation be inspected and approved before operation. All connections, wire sizes, materials used, etc. must conform to the requirements of electrical codes in effect at the installation site.



WARNING: IMPROPER WIRING CAN CAUSE A FIRE OR ELECTRICAL HAZARD, RESULTING IN SEVERE PERSONAL INJURY OR DEATH AND/OR PROPERTY AND EQUIPMENT DAMAGE.

Before starting the generator set, check to make sure that all electrical connections are secure, and that all wiring is complete. Replace and secure any access panels that have been removed during installation. Check that the load cables from the generator set are properly connected.



WARNING: BACKFEED TO UTILITY SYSTEM CAN CAUSE ELECTROCUTION OR PROPERTY DAMAGE. DO NOT CONNECT TO ANY BUILDING ELECTRICAL SYSTEM EXCEPT THROUGH AN APPROVED DEVICE AND AFTER BUILDING MAIN SWITCH IS OPENED.

8.1 Transfer Switch

If the installation is for standby service, a transfer switch must be used for switching the load from the normal power source to the generator set (see Figure 15). Follow the installation instructions provided with the transfer switch when connecting the load and control wiring.

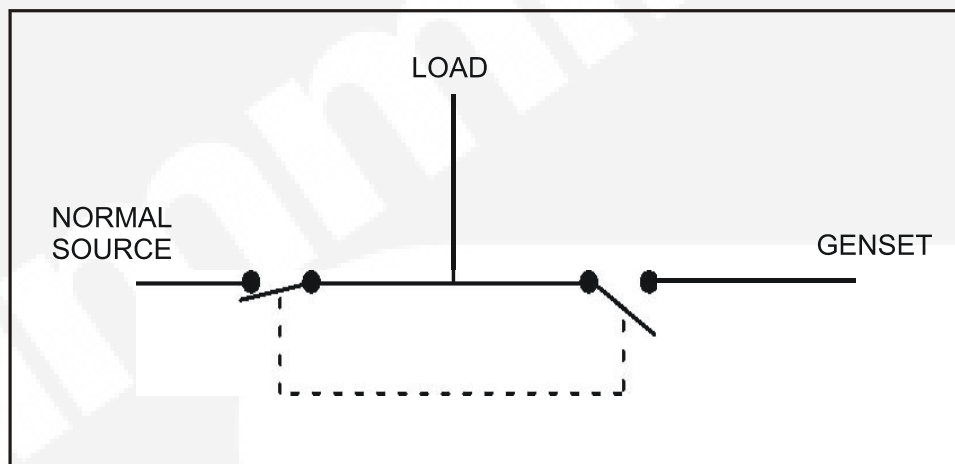


Figure 15 Typical Load Transfer Function

8.2 Generator Voltage Connections

The available generator output voltages and maximum current ratings are specified on the generator set nameplate. Line-to-neutral voltage is always the lower voltage shown and line-to-line voltage is the higher rating.

These generators can be configured to the nameplate voltages as shown on the Reconnection Diagram decal, attached to the backside of the control box cover. Many of the voltages listed will require reconfiguration of the generator output leads on the connection terminal block. This reconfiguration must only be done by service personnel that are trained and experienced to perform electrical installation. The generator set was adjusted to produce a specified voltage during production verification testing prior to shipment. The installer must always check the voltage lead terminal block connections and perform any necessary reconnect to obtain the voltage required.

Some generator sets are capable of producing a wide range of voltages and connection configurations, others have specific limited capabilities. Refer to wiring diagram and generator voltages (from the nameplate) when reviewing the voltage connection information and use the wiring diagram supplied with your generator set when actually performing load connections.



Caution: *Reconfiguring generator sets to higher voltages can exceed the voltage capability of the specific generator windings and damage the generator and also decrease line current, rendering line circuit breakers too large. Consult with your distributor before performing reconnection for a different voltage.*



Caution: *Reconfiguring generator sets to lower voltages can reduce generator set ratings, and also increase line current, rendering line circuit breakers too small. Consult with your distributor before performing reconnection for a different voltage.*

8.3 Load Connections

8.3.1 Flexible conduit and stranded conductors must be used for connections to take up movement of the generator set.

All loads are connected to the generator by bolting stranded load wires to the appropriate terminals on the generator reconnection terminal block or circuit breaker lugs. The terminals are marked U, V, W and N to indicate the line and neutral connections. (Reference: U, V, and W correspond with L1, L2 and L3; and N with L0 respectively).

8.4 Load Balancing

When connecting loads to the generator set, balance the loads so that the current flow from each line terminal (L1, L2 and L3) is about the same. This is especially important if both single phase and three phase loads are connected. Any combination of single phase and three phase loading can be used as long as each line current is about the same, within 10 percent of median value and no line current exceeds the nameplate rating of the generator. Check the current flow from each line after connections by observing the control panel ammeter.

8.5 Current Transformers

The optional current transformers (CT's) are used to display generator set load in kVA and alternator amperage. The CT's must be installed as noted in the following *CT Installation Requirements*.

Refer to the Reconnection Diagram to identify the generator output leads/phase that must be routed through each CT, and also appropriate transformer post selection for control sensing leads. The transformers are labelled CT1, CT2 and CT3 on the re-connection wiring diagram. (The Reconnection Diagram is located on the control box cover.)

8.5.1 CT Installation Requirements:

The CT has a dot on one side. This dot must be facing toward the generator reconnection terminal block (conventional current flowing into the dot). A dot is also used to indicate pin 1 of the CT.

Route the load lead (U, V or W) through the appropriate CT (refer to Reconnection Diagram).

The CT's have dual secondary's (3 pins). The CT secondary wire marked 1 is connected to pin 1 of the CT. CT secondary wire marked 2/3 is connected to pin 3 for low voltage generator sets.

8.6 Grounding

The following is a brief description of system and equipment grounding of permanently installed AC generators within a facility wiring system.



Note: *It is important to follow the requirements of the local electrical code.*

Figure 16 illustrates typical system grounding for a 3-pole and a 4-pole Automatic Transfer Switch (ATS). In the 3-pole ATS, note that the generator neutral is connected to the ATS and is NOT bonded to ground at the generator. In the 4-pole ATS system, a grounding electrode conductor and a bonding jumper are used to connect the generator neutral to ground.

Make sure the generator set is grounded to earth in one location only. On generators without a circuit breaker, ground to the point indicated on the top of the generator. On generator sets with circuit breakers, use the ground lug provided in the circuit breaker box.



WARNING: ELECTRIC CURRENT CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. BONDING AND GROUNDING MUST BE DONE PROPERLY. ALL METALLIC PARTS THAT COULD BECOME ENERGIZED UNDER ABNORMAL CONDITIONS MUST BE PROPERLY GROUNDED.

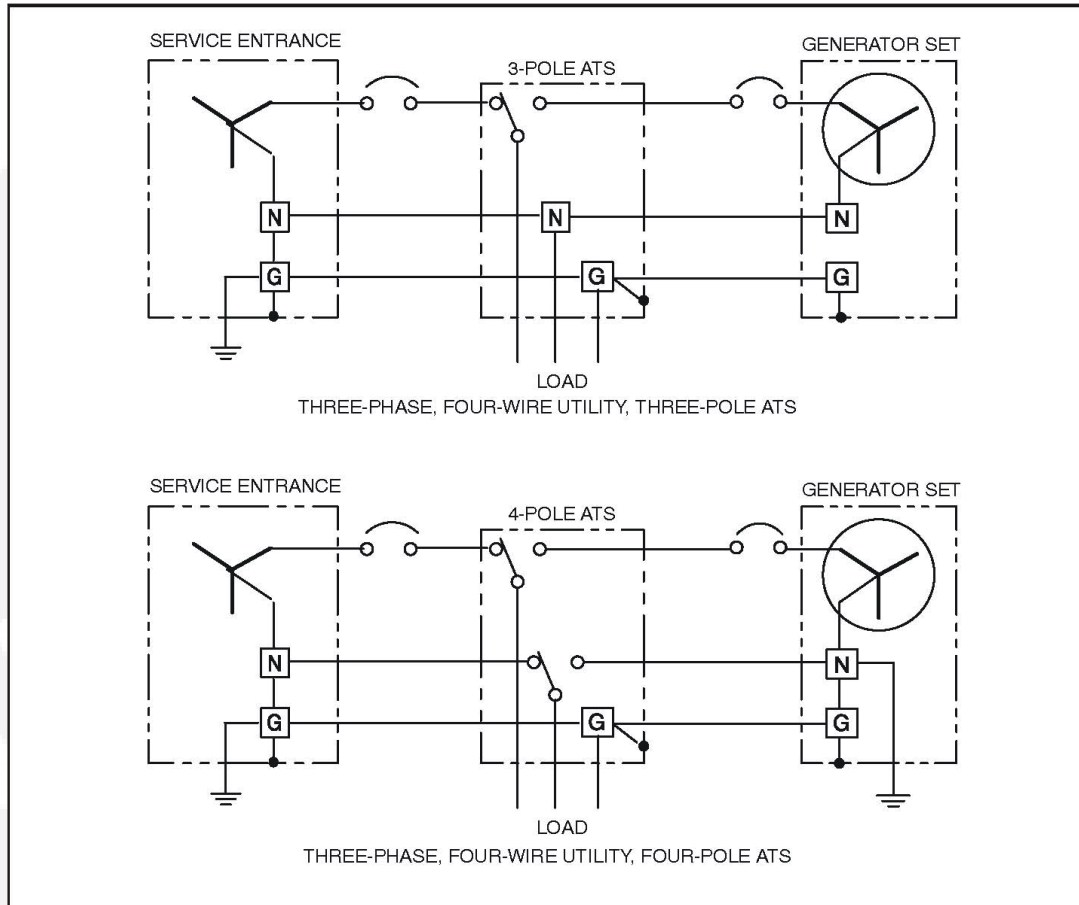


Figure 16 Typical System Grounding One-Line Diagrams

8.7 Coolant Heater (Optional)

A coolant heater keeps engine coolant warm when the engine is shut down. It heats and circulates the coolant within the engine. This reduces startup time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

Caution: The coolant heater must not be operated while the cooling system is empty or damage to the heater will occur.

Figure 17 shows the heater line connection. Connect the heater to a source of power that will be on during the time the engine is not running. Ensure the supply voltage and circuit current is correct for the heater element rating.

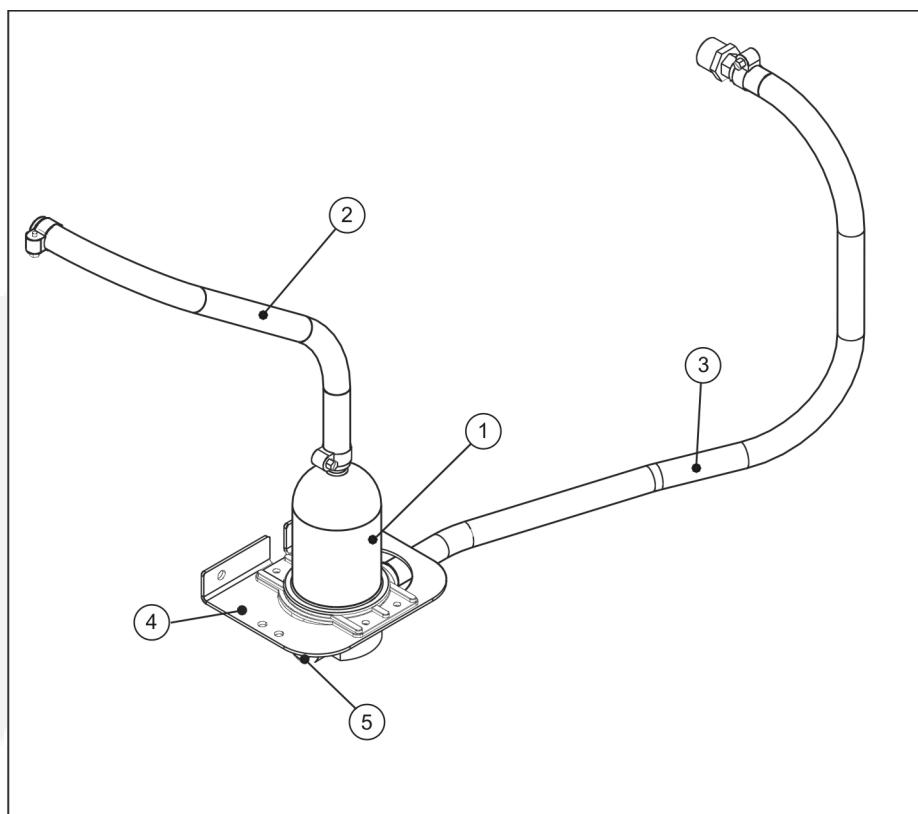


Figure 17 Coolant Heater

KEY

- | | |
|-----------------------------|--------------------------|
| 1. Heater – Engine Coolant | 4. Mounting Bracket |
| 2. Heated Coolant to Engine | 5. Electrical Connection |
| 3. Coolant from Engine | |

8.8 Generator Heater (Optional)

A generator heater(s) is used to help keep the generator free of condensation when the generator set is not running. During cool and humid conditions, condensation can form within a generator, creating flashing and shock hazards.

WARNING: WATER OR MOISTURE INSIDE A GENERATOR INCREASES THE POSSIBILITY OF FLASHING AND ELECTRICAL SHOCK, WHICH CAN CAUSE EQUIPMENT DAMAGE AND SEVERE PERSONAL INJURY OR DEATH. DO NOT USE A GENERATOR WHICH IS NOT DRY INSIDE AND OUT.

Figure 18 shows the installation of two heater elements. Connect the heater(s) terminals to a source of power that will be on during the time the engine is not running. Be sure the supply voltage and circuit amperage is correct for the heater element rating.

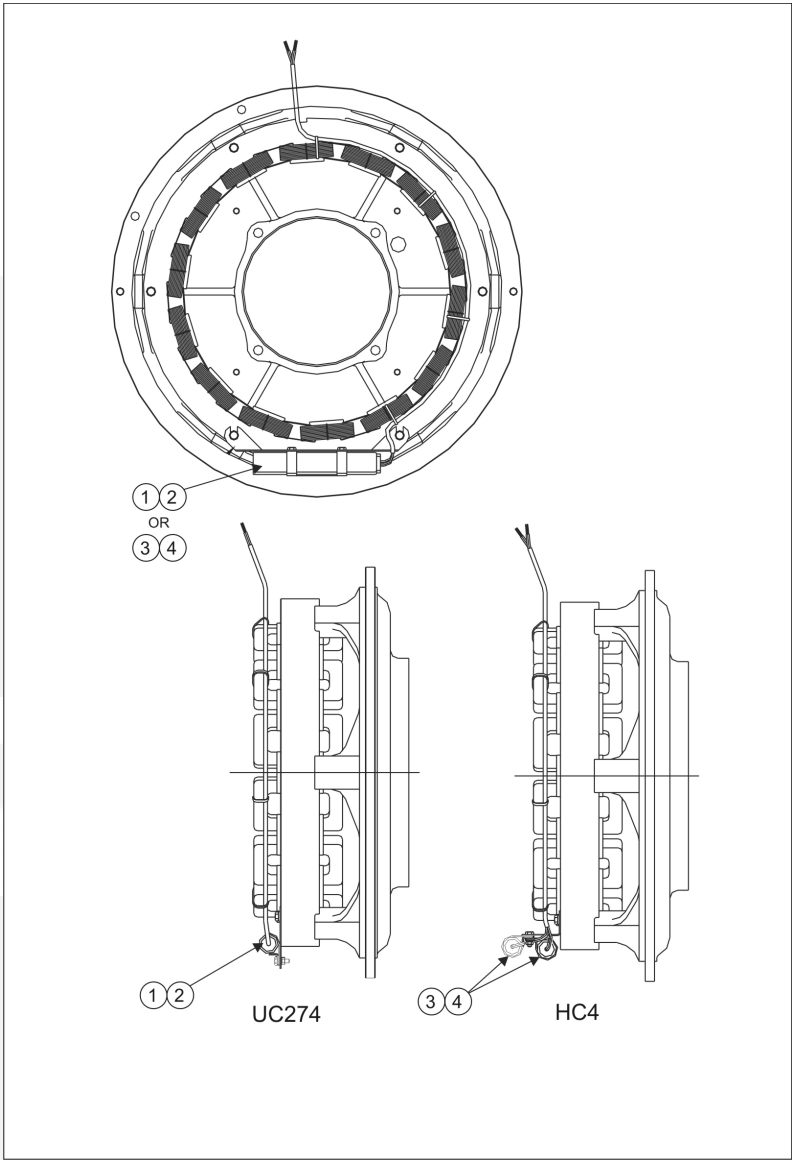


Figure 18 Generator Heater

KEY			
1.	Heater-Alternator-240V (UC274)	3.	Heater Cartridge-Alternator-120V (HC4)
2.	Heater-Alternator-120V (UC274)	4.	Heater Cartridge-Alternator-240V (HC4)

8.9 Fuel Transfer Pump

A fuel transfer pump and control are available as an option when a sub-base or in-skid day tank are provided. The automatic control operates the fuel pump to maintain a reservoir of fuel in the day tank.

WARNING: DIESEL FUEL IS HIGHLY COMBUSTIBLE. IMPROPER INSTALLATION OF THIS KIT CAN LEAD TO SPILLAGE OF LARGE QUANTITIES OF FUEL AND LOSS OF LIFE AND PROPERTY IF THE FUEL IS ACCIDENTALLY IGNITED. INSTALLATION AND SERVICE MUST BE PERFORMED BY TRAINED AND EXPERIENCED PERSONS IN ACCORDANCE WITH THE APPLICABLE CODES.

WARNING: DO NOT SMOKE NEAR FUEL AND KEEP FLAMES, SPARKS, PILOT LIGHTS, ARCING SWITCHES AND EQUIPMENT, AND OTHER SOURCES OF IGNITION WELL AWAY.

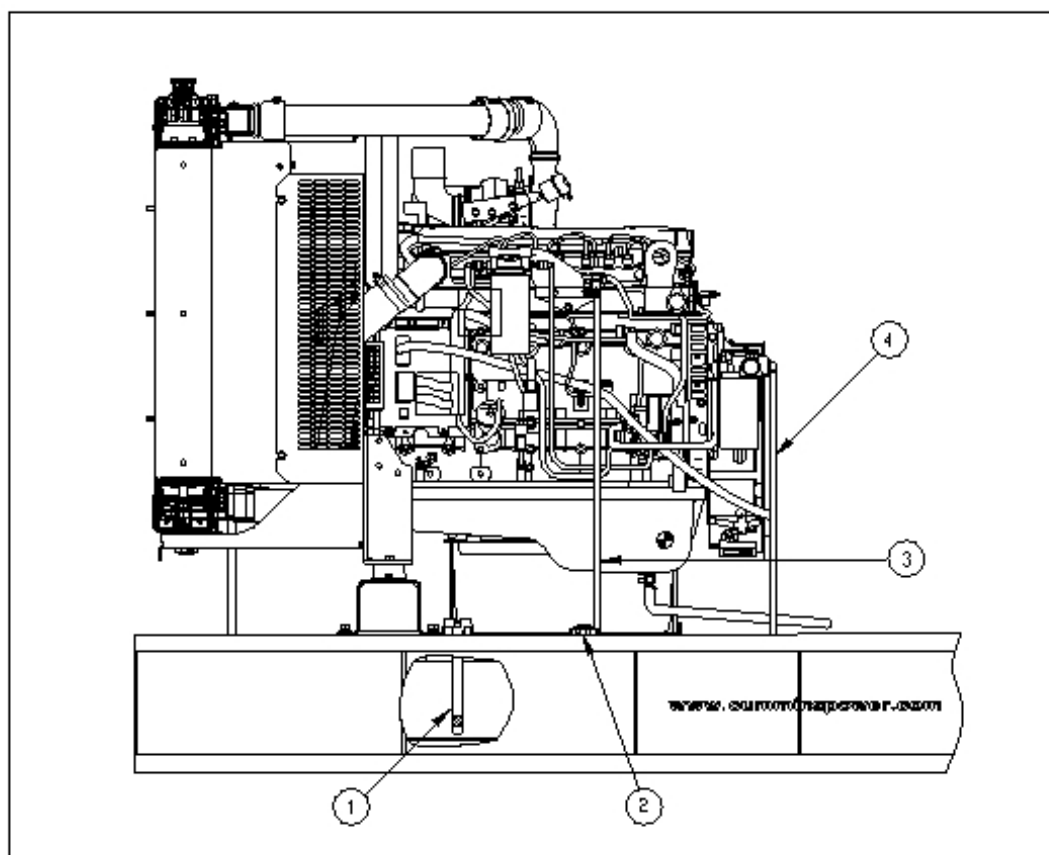


Figure 19 Typical Sub-Base Installation

KEY

1.	Float Switch Assembly	3.	Fuel Supply Line
2.	Fuel Fill Cap	4.	Fuel Flexible Return Line

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SECTION 9 – PRE-START PROCEDURE

9 Pre-Start Preparation

Before attempting the initial start of the generator set, be sure to complete the installation checklist in [Section 10](#).

9.1 Electrical System

Verify all electrical connections are secure and all wiring is complete and inspected. Replace and secure any access panels that may have been removed during installation.

9.2 Battery Connections



WARNING: ACCIDENTAL STARTING OF THE GENERATOR SET CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. MAKE SURE THAT THE PCC IS IN THE OFF MODE BEFORE CONNECTING THE BATTERY CABLES.

Starting the unit requires a 12 volt battery. Connect positive battery cable before connecting negative battery cable to prevent arcing.

Service the batteries as necessary. If an automatic transfer switch is installed without a built-in charge circuit, connect a separate battery charger. Proper selection and maintenance of batteries and battery chargers is essential for system reliability.



WARNING: IGNITION OF EXPLOSIVE BATTERY GASES CAN CAUSE SEVERE PERSONAL INJURY OR DEATH. ALWAYS CONNECT NEGATIVE (–) BATTERY CABLE LAST TO PREVENT ARCING.



WARNING: VENTILATE BATTERY AREA BEFORE WORKING ON OR NEAR BATTERY. ARCING AT BATTERY TERMINALS, LIGHT SWITCH OR OTHER EQUIPMENT, FLAME, PILOT LIGHTS AND SPARKS CAN IGNITE BATTERY GAS. DO NOT SMOKE, OR SWITCH TROUBLE LIGHT ON OR OFF NEAR BATTERY. DISCHARGE STATIC ELECTRICITY FROM BODY BEFORE TOUCHING BATTERIES BY FIRST TOUCHING A GROUNDED METAL SURFACE.

9.3 Starting

Refer to the Generator Set Operator Manual (0908-0115) for important safety precautions and recommended procedures for starting the generator set and verifying proper operation. Start the generator set and verify all engine and generator menus are displaying the correct values.

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SECTION 10 – INSTALLATION CHECKLIST

10 Installation Checklist

TICK	GENERAL ITEMS
	Generator set wattage capacity is sufficient to handle maximum anticipated load.
	At least 3 feet of clearance (or greater for housing door) is provided around the entire generator set for service and ventilation.
	The generator set is located in an area not subject to flooding.
	All operating personnel have read and are familiar with Generator Set Operator Manual 0908-0115 and Health And Safety Manual 0908-0110.
	All operators have been thoroughly briefed on preventative maintenance procedures.
	All operators have read and understand all Important safety Instructions.
	GENERATOR SET SUPPORT
	Floor, roof or earth on which the generator set rests is strong enough and will not allow shifting or movement. Observe local codes on soil bearing capacity due to freezing and thawing.
	Generator set is properly supported and retained to approved base
	Supporting base is large enough and is of non-combustible material, extending 6 inches all around the generator set.
	COOLING AIR FLOW
	Generator set air inlet is faced into direction of strongest, prevailing winds.
	Air inlet openings are unrestricted and at least 1 to 1 1/2 times larger than air outlet area.
	Cooling air outlet is on downwind side of building (if not, wind barrier is constructed).
	Proper ducting material (Sheet metal, canvas) is used between radiator and air outlet.
	DIESEL FUEL SYSTEM
	Fuel tanks meet or exceed all Local, State or National codes.
	Fuel lines are properly installed, supported and protected against damage.
	Approved flexible fuel line is installed between main fuel supply and generator set's fuel system near the generator set, to protect it against damage caused by vibration, expansion and contraction.
	Strainer or fuel screen (100 to 200 mesh) is installed in the fuel supply line to protect the fuel lift pump, day tank transfer pump or float valve seat from fuel tank debris.
	Fuel supply shutoff valves are installed to prevent fuel flow in case of leaks.
	No shutoff valves are installed on engine fuel return line.
	External fuel pumps are connected and operational at all times (generator set started or shut down).
	Fuel tanks are filled with the correct grade / type of fuel.
	Fuel system is properly primed.
	No fuel leaks are found in supply line or engine fuel system.

TICK	CHECKLIST ITEM
	EXHAUST SYSTEM
	Operators are thoroughly briefed on the dangers of carbon monoxide gas.
	Areas around generator set are well ventilated. No possibility of exhaust fumes entering building doors, windows, or intake fans.
	Exhaust gases are piped safely outside and away from building.
	The correct length of approved rigid pipe is connected to the generator set flexible pipe using approved securing methods with no weight resting on engine exhaust components. There are no bends in flex section.
	Condensation drain is provided in lowest section of exhaust piping.
	Exhaust piping is insulated to guard against burns to personnel.
	Exhaust piping passing through walls or ceilings have approved fire-proof materials and are in compliance with all codes.
	Exhaust piping is large enough in diameter to prevent excessive back pressure on engine.
	AC AND DC WIRING
	Wire sizes, insulation, conduits and connection methods all meet applicable codes.
	AC and DC wires are separated in their own conduit to prevent electrical induction.
	All load, line and generator connections are well made and correct.
	Flexible conduit is used between generator and building or surrounding structure.
	GENERATOR SET PRESTART
	Generator set engine is properly serviced with oil and coolant.
	Batteries are properly installed, serviced and charged.
	Battery charger and engine coolant heater are connected and operational.
	All generator set covers and safety shields are installed correctly.
	All fuel and coolant shutoff valves are operational.
	Radiator Fan and other external moving parts including drive belts are unrestricted.

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