Installation Manual

Our energy working for you.™

Power Generation

Generator Set

GQMA
GQMB
GQNA
GQNB
GQPB
GQKA
GQNC
GQPC

English 11-2007 983-0604

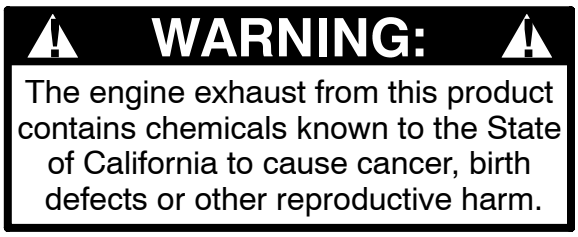
WARNING:
The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

Table of Contents

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS – This manual contains important instructions that should be followed during installation and maintenance of the generator and batteries.

Before operating the generator set (genset), read the Operator's Manual and become familiar with it 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.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠ DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠ CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

FUEL AND FUMES ARE FLAMMABLE

Fire, explosion, and personal injury or death can result from improper practices.

- Natural gas is lighter than air, and will tend to gather under hoods. Propane is heavier than air, and will tend to gather in sumps or low areas. NFPA code requires all persons handling propane to be trained and qualified.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment. Exhaust height should be tall enough to help clear gases, avoid accumulation of snow or in accordance with local mechanical code.
- Be sure the unit is well ventilated.
- Engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts. Loose clothing and jewelry can become caught in moving parts.
- Before starting work on the generator set, disconnect battery charger from its AC source, then disconnect starting batteries, negative (-) cable first. This will prevent accidental starting.
- To prevent accidental air starting, make sure the air supply line is connected until the generator set is ready to start.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment. Do not wear jewelry. Jewelry can short out electrical contacts and cause shock or burning.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag and lock open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

MEDIUM VOLTAGE GENERATOR SETS (601V to 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training is required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Due to the nature of medium voltage electrical equipment, induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.
- Make sure generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breath or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as radiator, turbo charger and exhaust system.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

1. Introduction

ABOUT THIS MANUAL

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.

Installation Checklist – reference checks upon completion of installation.

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

Initial Startup – test complete system to ensure proper installation, satisfactory performance, and safe operation. Refer to Operators Manual for troubleshooting information.

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*. For application information, refer to the *Application Manual for Liquid Cooled Generator Sets* (T030) found in the Cummins Power Generation Power Suite Library available on CD[1].

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.

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

Application

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

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. Figure 1-1 provides a view of a typical genset.

1. Alternatively, go to the WEB site, *http://www.cumminspower.com/library/appengineering/appengineering.jhtml*, to view and print the application manual.

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.

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.

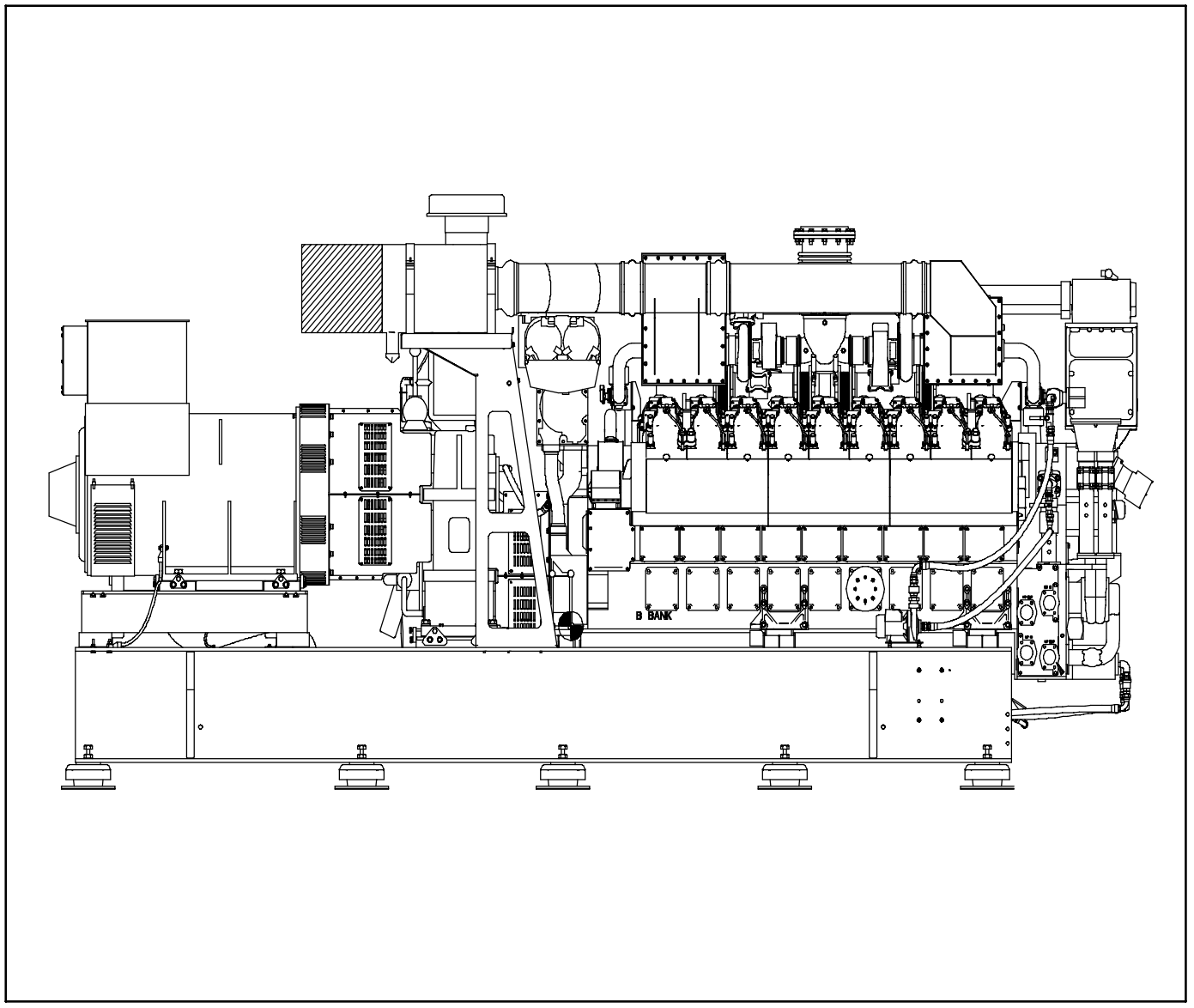

FIGURE 1-1. TYPICAL GENSET - RIGHT HAND VIEW

2. Location and Mounting

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 ordinances, and other applicable regulations.

Requirements to be considered prior to installation:

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

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.

ACCESS TO SET AND LIGHTING

Generally, at least 1 meter (3 feet) of clearance should be provided on all sides of the generator set for maintenance and service access.

Lighting should be adequate for operation, maintenance and service operations and should be connected on the load side of the paralleling switchgear so that it is available at all times.

LIFTING

See the generator set Operators Manual for lifting details.

⚠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.

IMPORTANT

DEPENDING ON LOCATION AND INTENDED USE, FEDERAL, STATE OR LOCAL LAWS AND REGULATIONS MAY REQUIRE THAT YOU OBTAIN AN AIR QUALITY EMISSIONS PERMIT BEFORE BEGINNING INSTALLATION OF THE GENSET. MAKE SURE TO CONSULT LOCAL POLLUTION CONTROL AND AIR QUALITY AUTHORITIES BEFORE COMPLETING CONSTRUCTION PLANS.

MOUNTING

The engine-generator assembly is mounted directly to a skid-base. Vibration isolation between the skid-base and the supporting structure is always required. The use of unapproved isolators may result in harmful resonances and may void the genset warranty.

Locate the vibration isolators (Figure 2-1) as shown on the generator set *Outline Drawing* referenced in the *Data Sheet*. Follow the manufacturers instructions for anchoring, assembly and leveling.

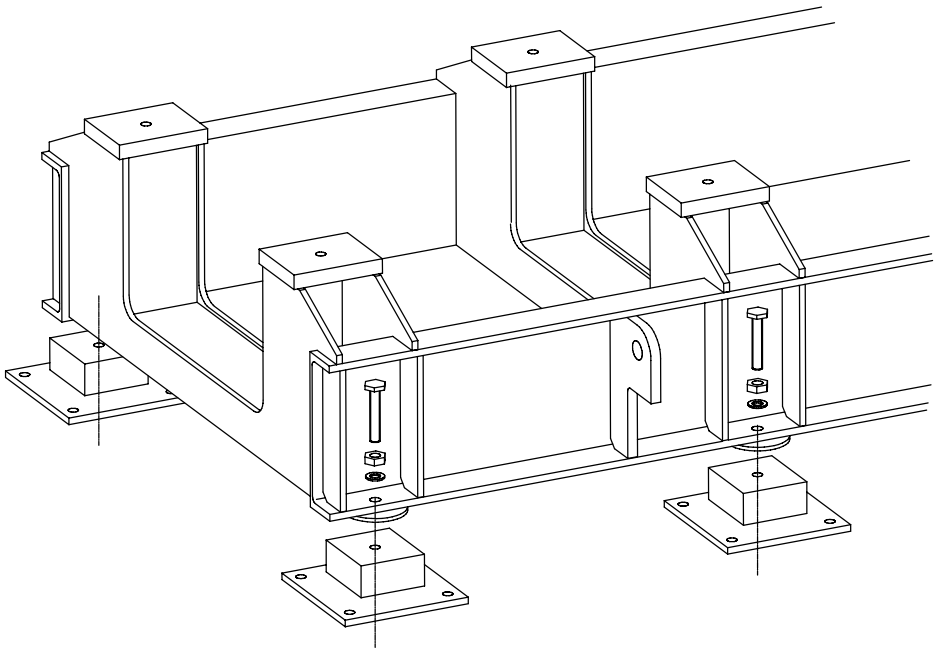

FIGURE 2-1. VIBRATION ISOLATORS

FOUNDATION

The foundation to which the genset mounts is equally as important as other parts of the installation. The foundation should provide a level, flat surface for the genset. Also, the foundation pad should be isolated from the rest of the concrete flatwork and the joint filled with a flexible caulking.

Foundation size is determined by the dimensions and weight of the equipment to be installed. The length and width should be a minimum of 18 inches longer and wider than the genset's footprint. Length and width of the genset are provided on the general assembly drawings for each specific model.

The area for the genset's foundation should be a continuous surface with no significant interruptions such as trenches for piping. Conduit stub–ups are acceptable as long as their position does not interfere with the location of the genset mounting points. The locations of the mounting points are shown on the general assembly drawings for each specific model.

The depth of the foundation is determined by the weight of the equipment to be mounted on the foundation. In order to provide sufficient strength and vibration damping ability, the foundation should be deep enough to make the weight of the foundation equal to 1.5 times the weight of installed equipment.

For example, a 1750 GQPB Genset with a P80R frame alternator is to be installed. The genset's outline drawing gives this model's dimensions as 270 inches long and 61 inches wide. By adding 18 inches to the length and width of the genset, the recommended foundation dimensions are 288 inches long by 79 inches wide. The outline drawing also provides a wet weight for the genset of approximately 50,130 pounds. Since the desired weight of the foundation is 1.5 times the weight of the genset, the foundation weight should be at least 75, 200 pounds. The density of concrete is approximately 0.084 lbs/in^3. The depth of the foundation is calculated by dividing the weight by the density times the area: 75,200 lbs ÷ (0.084 lbs/in^3 x 288 in. x 79 in) = 39 inches. Therefore, the foundation in this example has a length of 288 inches, a width of 79 inches, and a depth of 39inches.

CHECKING ELEVATION OF SPRING ISOLATOR LOCATIONS

In addition to proper size, the finish of the foundation must allow for proper mounting of the spring isolators. The foundation area should be level and flat within 0.25 inches. The spring isolators used to mount the genset are for vibration isolation and to provide movement of the genset during starting, loading, and unloading. They are not to be used to compensate for unlevel and uneven foundations.

After the foundation is installed but before the genset is in place, check the elevations of the spring isolator locations. The locations for each genset's spring isolators are provided by its general assembly drawing.

The elevation check is easily done using a transit and sight rod. To check for level along the foundation length, the difference between the elevation of the spring isolator locations at the front and rear of the genset are compared. The difference between the two locations should be 0.25 inches or less. To check for level across the width of the foundation, the elevation of the spring isolators at the front are compared to each other, and the elevation of the spring isolators at the back are compared to each other. To check the flatness of the foundation, the elevation of all spring isolator locations are compared, and the difference between all locations should be 0.25 inches or less. Refer to Figure 2-2 for an example of the measurements of spring isolator locations.

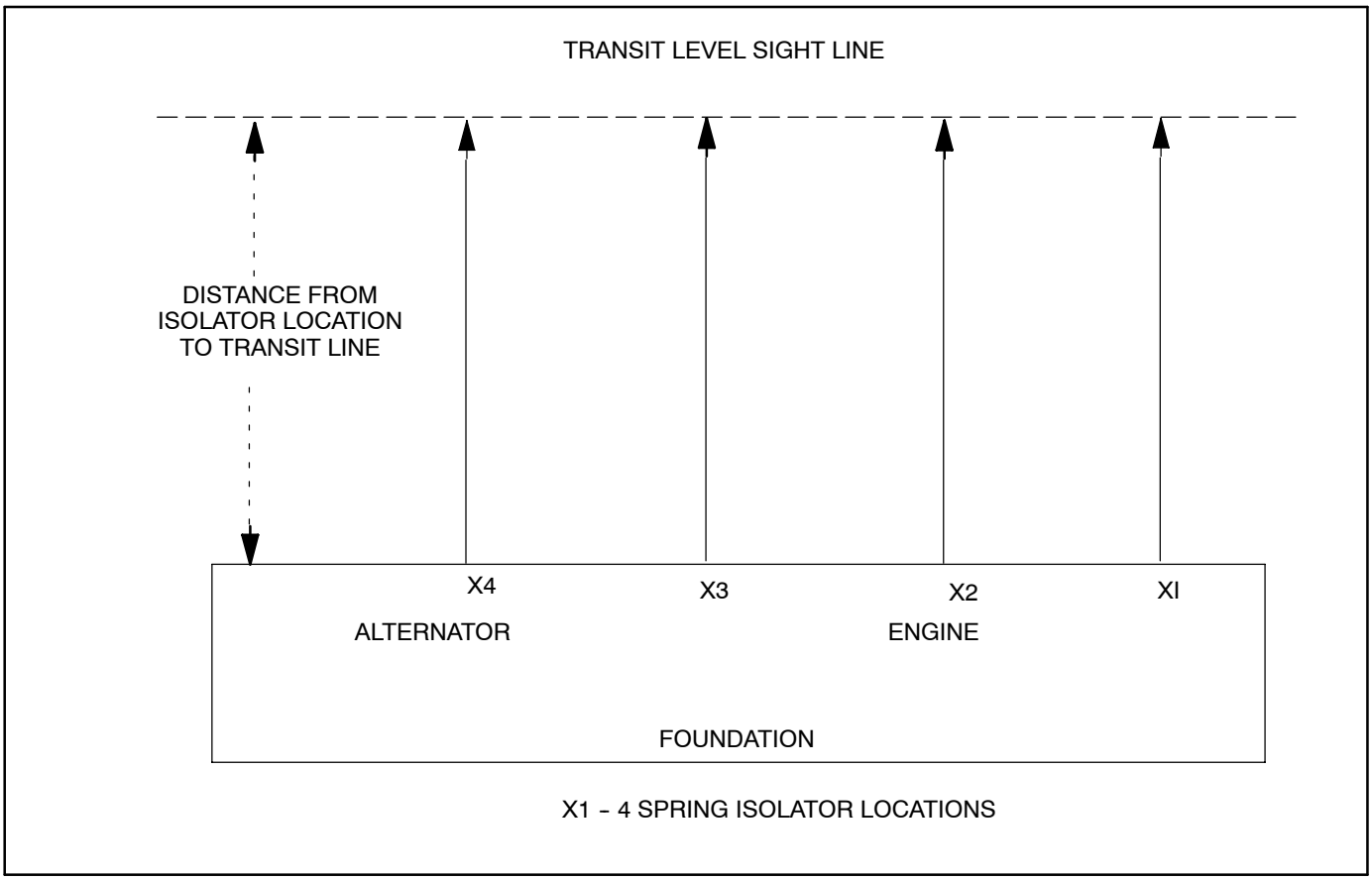

FIGURE 2-2. MEASUREMENT OF SPRING ISOLATOR ELEVATIONS

Figure 2-2 represents typical spring isolator locations for one side of the genset. The measurements at X1 and X4 are compared for level along the length. The measurements at X1 for both sides are compared, and the measurements at X4 for both sides are compared to determine level across the foundation width. The measurements at all locations for both sides are compared to determine flatness. The following measurements represent different situations.

A-BANK	B-BANK
X1 = 48 INCHES	X1 = 48.25 INCHES
X2 = 48.25 INCHES	X2 = 48 INCHES
X3 = 48.125 INCHES	X3 = 48 INCHES
X4 = 48.25 INCHES	X4 = 48.125 INCHES

Based on the preceding measurements, the foundation is level along the length of the A-Bank within 0.25 inches, and the B-Bank is level within 0.125 inches. The foundation is level across the width within 0.25 inches at the engine end and 0.125 at the alternator end. By comparing all measurements, the foundation is flat within 0.25 inches. The conditions of this example, where the foundation is level and flat within specification, is uncommon. The following set of measurements are more typical.

A-BANK	B-BANK
X1 = 48.5 INCHES	X1 = 48.25 INCHES
X2 = 48.75 INCHES	X2 = 48.5 INCHES
X3 = 48.25 INCHES	X3 = 48.625 INCHES
X4 = 48.25 INCHES	X4 = 48 INCHES

Based on the preceding measurements, the foundation is level along the length and width within specification. However, a comparison of all the measurement locations shows that the foundation is outside the specification for flatness. The measurements are graphed in Figure 2-3 to show the profile of the foundation.

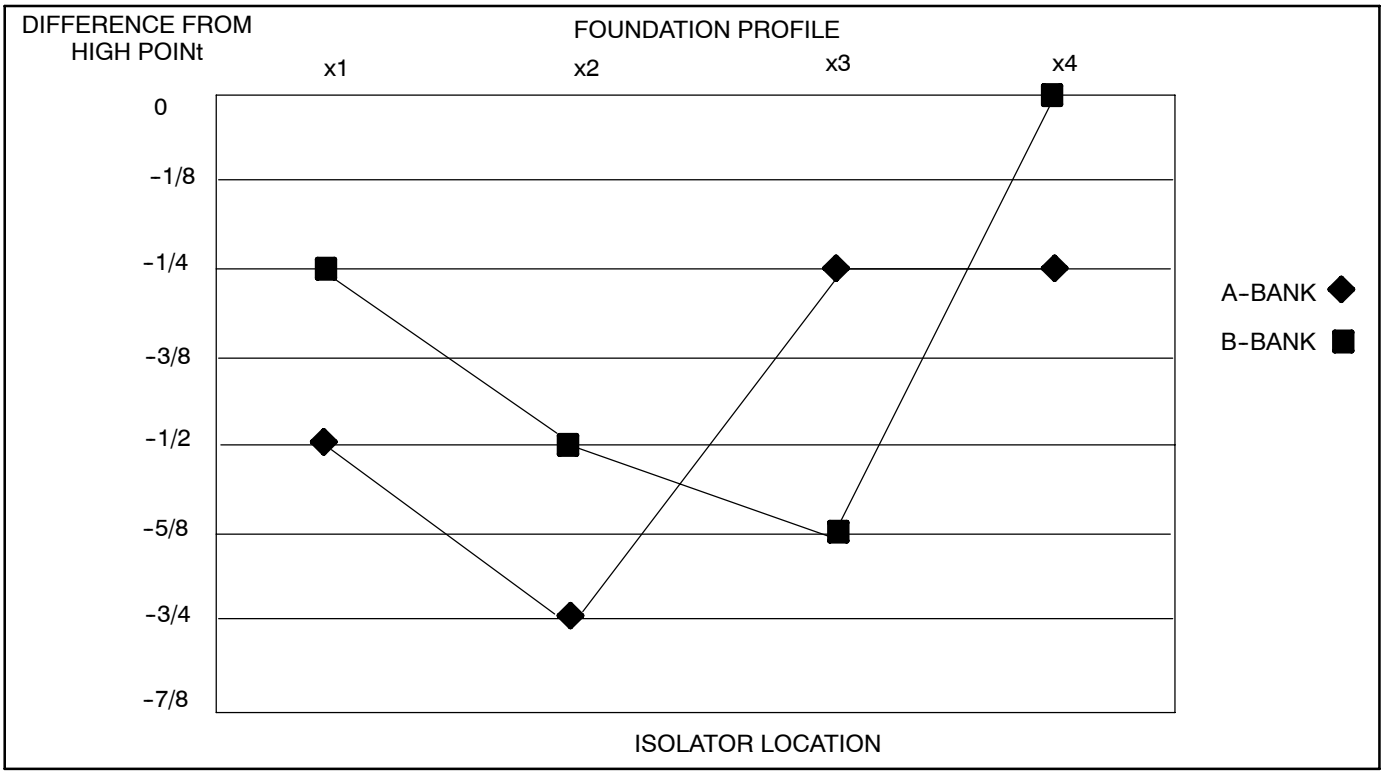

FIGURE 2-3. GRAPHICAL REPRESENTATION OF FOUNDATION PROFILE

In Figure 2-3, the values at the top of the graph represent the isolator locations, and the values on the left side of the graph show the differences from the elevation of the highest isolator location on the foundation. By using a transit to measure elevations, the recorded value is the distance to the foundation from a level line above the foundation. When measured in this way, the numerically lowest value represents the highest point on the foundation. In this example, X4 located on the B-Bank side of the genset measures 48 inches, which is the lowest numerical elevation measurement and the highest point of the foundation profile. The difference of all other locations from the highest point shows the distance each point is below it. These values are plotted to create the foundation profile. The graph shows that four of the isolator locations exceed the specification of 0.25 inches for flatness: A-Bank X1 and X2, and B-Bank X2 and X3. This is a situation where isolator locations should be adjusted to be within specification for level and flatness before the genset is installed.

SHIMMING ISOLATORS

Isolator locations can be shimmed to meet the specification for level and flatness for foundations with conditions similar to those in the preceding example. The simplest approach is to shim an isolator location before the isolators and genset are in place. The shims are placed under the isolator to raise its elevation to equal the highest point.

Returning to the preceding example and graph, the elevation of shim heights is easily determined. As the highest elevation point, there is no shim required at spring isolator location X4 on the B-bank. All of the other locations are shimmed to equal it. Shim heights at these locations are:

A-BANK	B-BANK
X1 = 1/2 INCH	X1 = 1/4 INCH
X2 = 3/4 INCH	X2 = 1/2 INCH
X3 = 1/4 INCH	X3 = 5/8 INCH
X4 = 1/4 INCH	X4 = 0 INCH

Some of the isolator locations in the example are within the level and flatness specification, but as long as shimming was necessary at certain locations, it requires minimal extra material and labor to adjust all locations. It is critical when installing shims to ensure that the size of the shim sufficiently covers the footprint of the isolator in order to provide a uniform surface beneath the isolator to support the weight it carries.

ALIGNING ENGINE, GEAR BOX AND GENERATOR

Proper alignment of the engine, gear box and generator is necessary to avoid premature wear and improper operation of the genset.

Consult an authorized Cummins representative for assistance with alignment of the gearbox generator sets.

3. Mechanical Connections

Generator set mechanical system installation includes connecting fuel, exhaust, ventilation, cooling and starting systems.

FUEL SYSTEM

Pages A-3 and A-4 illustrate typical factory available gas train kits and Page A-5 a typical installation.

⚠WARNING ***Gaseous fuels are flammable and explosive and can cause severe personal injury or death. Do not smoke if you smell gas or are near fuel tanks or fuel-burning equipment or are in an area sharing ventilation with such equipment. Keep flames, sparks, pilot lights, electrical arcs and arc-producing equipment and all other sources of ignition well away. Keep a type ABC fire extinguisher handy.***

⚠WARNING ***High gas supply pressure can cause gas leaks which can lead to fire and severe personal injury or death. Gas supply pressure must be adjusted to generator set Specifications by trained and experienced persons.***

⚠WARNING ***Gaseous fuel leaks into an inadequately ventilated space can lead to explosive accumulations of gas. Venting of gas train components and generator set room ventilation must be in accordance with local codes.***

Gaseous-fuel supply system design, materials, components, fabrication, assembly, installation, testing, inspection, operation and maintenance must comply with the applicable codes. See NFPA Standards Nos. 37 and 54.

Cleanliness is of the upmost importance in a fuel system. Make every effort to prevent the entrance of moisture, dirt or contaminants of any kind. Inspect and clean all pipework and fuel system components prior to assembly.

The gas supply system must be sized and regulated to supply the generator set at full load. Refer to the genset *Data Sheet* for fuel consumption. For low-pressure gas supply systems the pressure range is 5 to 7 psi (34 to 48 kPa). For high-pressure gas supply systems the pressure droop from engine not running to full load should not exceed 20 percent.

Note: The engine gas solenoid valve must be protected by a safety device to shut off gas flow in the event of a catastrophic failure of an upstream gas pressure regulator.

The high-pressure gas train (Page A-4) is such a safety device.

The low-pressure gas train (Page A-3) is NOT such a safety device. The installer must install a safety device upstream of the low-pressure gas train.

1. Bolt the flexible gas hose supplied in the gas train kit directly to the engine gas solenoid valve. Make sure the flange has a gasket and that flange bolts are torqued to 37 lb-ft (50 N-m). See Page A-5.
2. Bolt the gas train (Page A-3 or A-4) to the flexible hose using a flange gasket. Rigidly support both flanges of the gas train. Up to 15 feet (4.5 meters) of piping built to suit and rigidly supported on both ends may be located between the gas train and flexible hose (Page A-5). Make sure all flanges have gaskets and that flange bolts are torqued to 37 lb-ft (50 N-m).

   The flanges between which the flexible hose is bolted must line up and be spaced such that the flexible hose fits without bending or being stretched or compressed. Also, the flange on the supply end must be rigidly supported to prevent engine vibration from causing resonance in the gas train.

   ⚠WARNING ***Failure of the flexible gas hose or gas train due to faulty installation can lead to fire or explosion. The installation must be in accordance with these instructions.***
3. Weld the adapter pipe flange in the low-pressure gas train kit to the end of the supply piping.

4. The gas solenoid valve on the engine must be vented safely to the outside of the building (Page A-4). A section of flexible gas vent hose must be installed at the solenoid valve to take up engine vibration. See the generator set Outline Drawing for the location of the vent port and its fitting size. The pressure regulator in the high-pressure gas train kit must also be vented outside.
5. The pressure regulator in the gas train kit has been preadjusted at the factory to maintain 200 millibar at the gas inlet to the engine. Measure the pressure at the engine inlet test port and readjusted as necessary. The regulator manufacturer's instruction sheet is included in the kit.

EXHAUST SYSTEM

See the *Generator Set Data Sheet* for exhaust temperature, flow and maximum back pressure.

⚠WARNING ***EXHAUST GAS IS DEADLY! The exhaust system must be leak-free and convey all exhaust outside, away from windows, doors and vents. Do not use exhaust gases to heat a building or other enclosed space.***

Exhaust Piping

The exhaust system must meet local codes.

Pipe all exhaust gases outside, away from windows, doors and vents. The exhaust system must be gas tight. Exhaust gas must not be used to heat a building or other enclosed space.

The exhaust system must be supported independently of the engine. Supporting the weight of exhaust piping on the turbocharger outlet flanges can lead to turbocharger failure. Use the flanged flexible bellows-type stainless steel tubes shipped with the generator set for exhaust connections.

⚠CAUTION ***To prevent damage to the turbochargers, do not support any part of the exhaust system on the turbocharger outlet flanges. Use the flanged flexible exhaust tubes provided.***

Long runs of exhaust pipe (vertical or horizontal) should include sections of flexible, bellows-type stainless steel tube to take up thermal expansion. Flexible exhaust sections must not be used to compensate for misaligned piping or to form bends.

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for mufflers and piping.

Horizontal runs of exhaust piping should slope downwards away from the engine to a drain trap and plug, which should be located where the piping turns to rise vertically.

To prevent overheating that can lead to fire, route exhaust piping at least 12 inches (305 mm) away from combustible construction. Use approved thimbles where exhaust piping passes through combustible walls, ceilings and roofs. Where the minimum clearance cannot be maintained, piping may be shielded or insulated with material rated to withstand at least 1100°F (600°C). The surface of the insulation or shield must not exceed 160°F (71°C). Refer to Section 6-3 of NFPA 37, *Stationary Combustion Engines and Gas Turbines* for accepted design practices.

⚠WARNING ***Exhaust piping is very hot and can ignite combustible material. Route, shield or insulate exhaust piping to protect adjacent combustible materials.***

⚠WARNING ***Exhaust piping, mufflers and boilers are very hot and can cause severe burns. Shield or insulate exhaust piping and equipment where there is danger of personal contact.***

The entire exhaust system must be accessible for visual inspection and repair.

Use rain caps when exhaust pipes discharge vertically.

Exhaust Heat Recovery Boilers

For installations in the U. S. A., a heat recovery boiler must bear the appropriate ASME mark for fired hot water pressure vessels and be equipped with the appropriate pressure relief valve. The operating system must include an approved high temperature limit control.

⚠WARNING ***A heat recovery boiler explosion can cause severe personal injury or death. To reduce the risk of explosion, boiler construction, pressure relief valves and safety controls must meet all local codes and regulations.***

VENTILATION

Generator set room ventilation must remove the heat radiated to the ambient and make up the combustion air intake flow. See the *Generator Set Data Sheet*.

Locate air inlet and outlet openings to minimize the effects of wind and maximize convective air flow in the generator room. Size ventilation fans, louvers, and ducts so they are large enough to handle the required flow of air.

Forced ventilation air flow should be directed parallel with the crankshaft and flow from rear (alternator end) to the front of the engine.

The engine crankcase breather has specific routing requirements as follows:

- The EcoVent exhaust hose inner diameter must be greater or equal to 2.25 inches (EcoVent discharge diameter)
- The EcoVent exhaust must be vented to the atmosphere and never vented to the engine room
- The EcoVent exhaust hose or pipe must be monotonically rising
- The EcoVent exhaust hose or pipe should discharge a minimum of 10 feet from the engine (room) air inlet, and preferably on the down wind side of the inlet.

See *Section 4. DC Connections* for connections to operate fans, louvers and dampers when the generator set is started and running.

COOLANT SYSTEM

When designing the high temperature (HT) and low temperature (LT) cooling systems, heat recovery, radiator or other heat dump systems, refer to the *Generator Set Data Sheet* for engine coolant volumes, maximum inlet and outlet temperatures, flow rates, maximum and minimum static heads and maximum pressure drops (friction). Refer to the Operator's Manual for recommended coolant mixtures.

Page A-6 illustrates schematically a recommended coolant system configuration designed to provide the following:

- Coolant system pressurization and balancing between the HT and LT circuits
- Coolant Deaeration
- Volume for coolant thermal expansion
- Coolant pressure relief if bladder fails in the expansion tank
- Means to warn and shut down on low and high coolant pressures
- Connection for draining coolant and filling from the bottom by means of a pump
- Valves to isolate engine and heat exchangers during service
- Mechanical gauges as backup and quick reference for pressure and temperature on discharge and return loops of LT and HT circuits (On a bladder tank system a single pressure gauge is all that is needed.)

Note 1: A bladder tank is recommended for more consistent system pressurization and balancing. Automatic pressure balancing reduces crossflow between the HT and LT coolant circuits.

Note 2: Static air vents should be placed at all the high points in the system to eliminate air traps.

Note 3: Follow the pressure relief, initial bladder air pressure, and low and high pressure switch settings on Page A-6.

Note 4: The flexible coolant flange connectors provided with the generator set must be used for connection to the coolant piping system. All coolant piping must be Schedule 40 steel pipe.

AIR STARTING (OPTIONAL)

See the *Generator Set Data Sheet* for air starting system requirements. Figure 3-1 illustrates the air starter connection.

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. To prevent accidental starting, do NOT connect the air supply line until the installation has been completed and the set is ready to be started.***

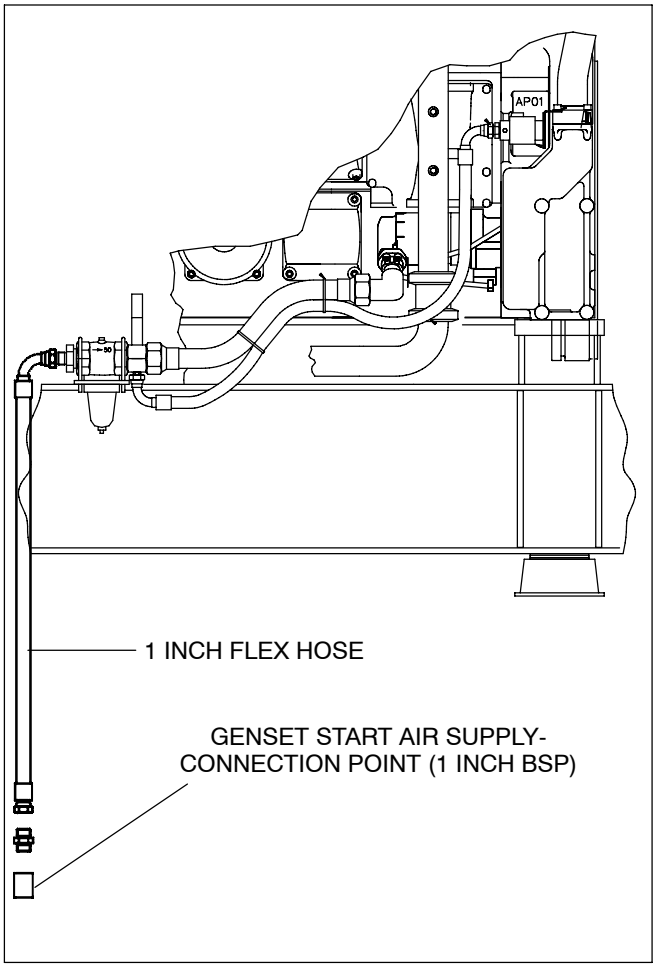

FIGURE 3-1. AIR STARTER CONNECTION

4. DC And Control Connections

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, circuit protection, 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.***

GENERATOR CONTROL PANEL (GCP)

The Generator Control Panel (GCP) is a free standing module that includes the Power Command Supervisor (PCS) and Human Machine Interface (HMI) and other customer interface features such as an emergency stop switch, gas valve switch and manual pre-lube push-button switch.

See page A-1 for an illustration of typical generator set connections, including connections to the GCP. There are two wiring harnesses that connect the GCP to the Genset Interface Box (GIB), which is mounted to the genset. The wiring harnesses are supplied by the factory and come in various lengths of 5, 10, 15, 20, 30, and 40 meters to accommodate the customer's location for the genset. Cable length must be specified when the order for the genset is placed.

CUSTOMER TERMINALS (GCP)

Customer connections to the genset are located in the GCP on customer terminal block C (see Figure 4-1), and include: fault and alarm inputs, inputs and outputs for genset and ancillary system control, connections for paralleling functions, and additional emergency stop inputs. See page A-2 for a list of customer terminals and their functions. At time of installation, check the current factory drawing for a correct list.

The modbus plus tap for connection of network communication lines is also located in the GCP.

The relay contacts for operating the remote control and annunciating devices connected at the customer terminals are rated at 5A @ 250VAC, 30VDC.

B+ fused at 6 amps (5 amps UL) is available at the customer terminals. See connection diagram on page A-2 or equivalent for correct terminal numbers.

The terminal blocks in the GCP are suitable for a maximum wire size of 16 AWG (2.5 mm^2).

Refer to Cummins 900-0366 *PowerCommand Network Installation and Operation* manual for the type/gauge wire to use for network connections.

To accommodate the motion of the generator set on its mounts, use flexible conduit and stranded conductors for all wiring that is routed to and terminates in the GIB. See page A-1.

⚠CAUTION ***Use stranded copper wiring. Generator set movement and vibration can break solid copper wire.***

⚠CAUTION ***Always run control circuit wiring in separate conduits from AC power cables to avoid inducing currents that could cause erratic control.***

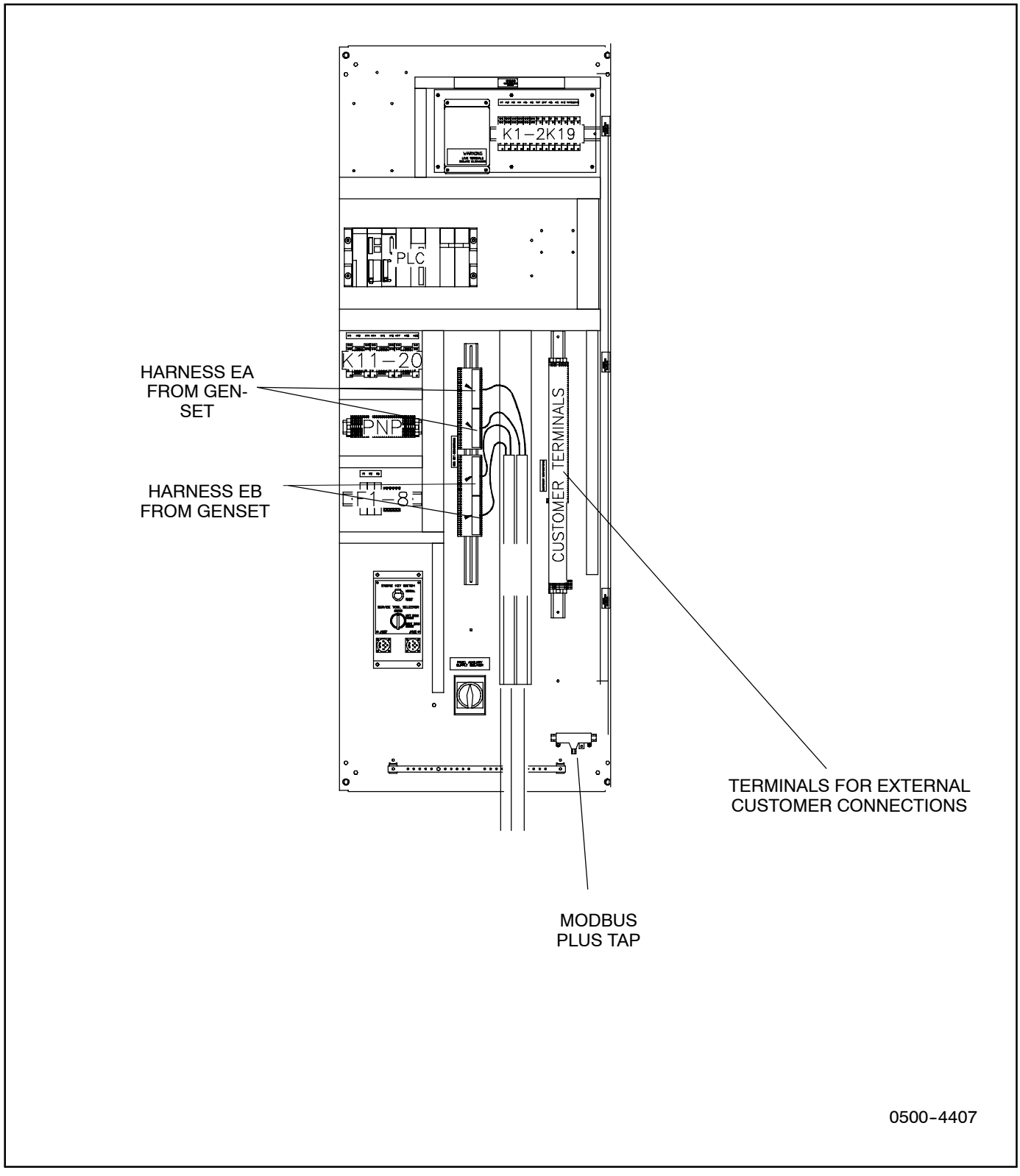

FIGURE 4-1. CUSTOMER CONNECTIONS IN THE GENERATOR CONTROL PANEL (GCP)

BATTERY STARTING SYSTEMS

See the *Generator Set Data Sheet* for starting battery requirements. Figure 4-2 illustrates the starting battery cables and connections at the batteries for 24 volt starter supply.

⚠WARNING ***Sparks can ignite explosive battery gases causing severe personal injury. Do not smoke when servicing batteries. Always wear safety glasses. To reduce sparking always turn off AC power to the battery charger and disconnect the negative (-) cables first and reconnect them last. Secure insulating boots over the positive (+) terminals at the batteries and starter.***

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. To prevent accidental starting, do not connect the negative (-) cables at the batteries until the installation has been completed and the set is ready to be started.***

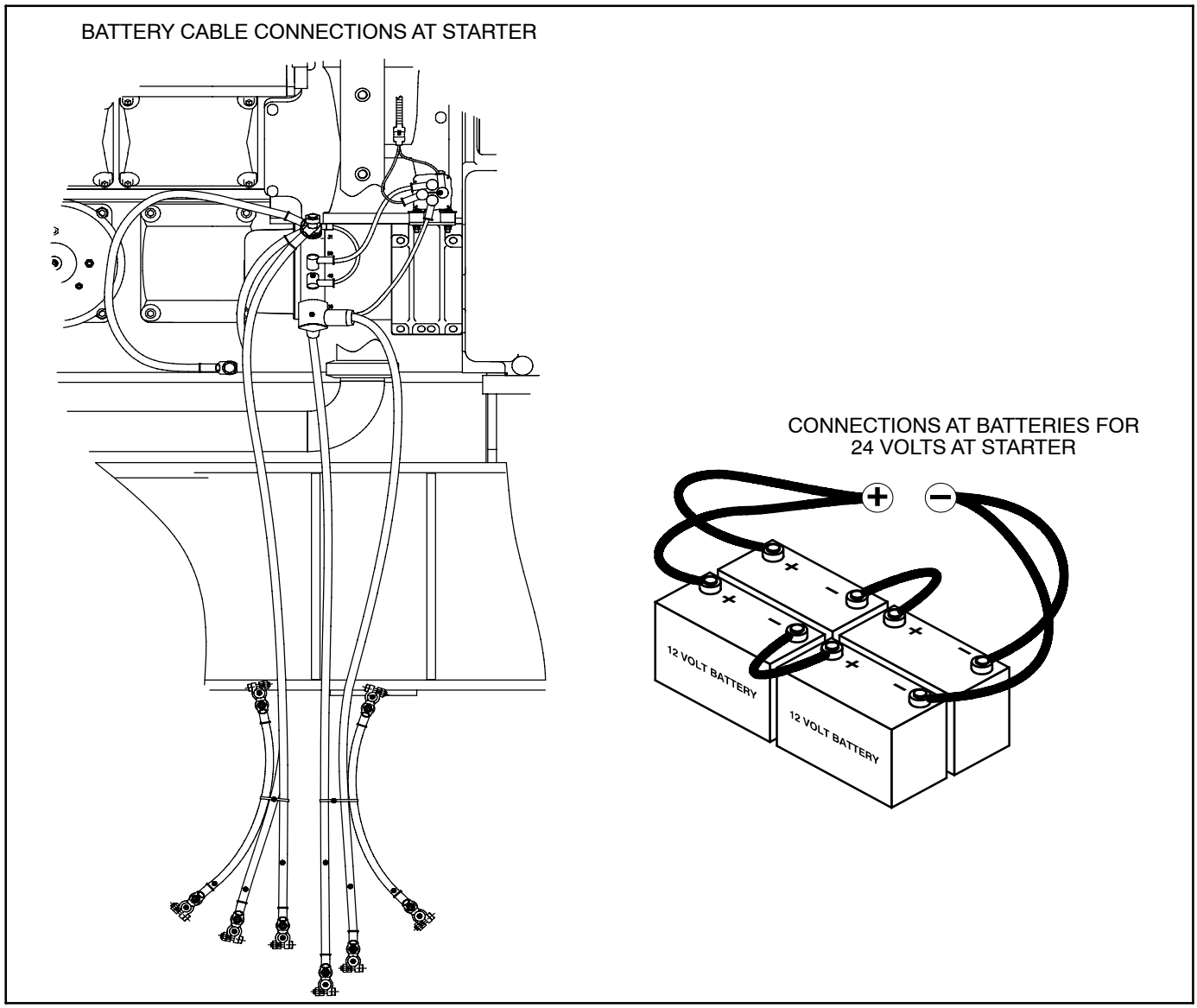

FIGURE 4-2. BATTERY CONNECTIONS

Relocation of Starting Batteries

If the batteries are mounted at a distance that is further from the starter than the standard cables allow, the cables must be designed accordingly, so that the total resistance (cables plus connections) do not result in an excessive voltage drop between the battery and the starter motor. Total cranking circuit resistance, cables plus connections, must not exceed 0.002 ohms for 24 volt systems to meet engine recommendations.

A Calculation Example

A generator set's starting system is 24 VDC powered by two 12 volt batteries connected in series. The total cable length is 35 feet, including the cable connecting the batteries. There are six cable connections. See the following sample calculation.

1. Assume a resistance of 0.0002 ohms for the starter solenoid contact ($R_{contact}$).
2. Assume a resistance of 0.00001 ohms for each of the six cable connections ($R_{connection}$).
3. Based on the formula: Maximum Allowable Cable Resistance = 0.002 – $R_{connection}$ – $R_{contact}$ = 0.002 – 0.0002 – (6 x 0.00001) = 0.00174 ohms.
4. Refer to figure 4-3 for the American Wire Gauge (AWG) or mm^2 cable resistances, which shows by the dashed lines that the smallest usable cable size is two #00 cables in parallel.

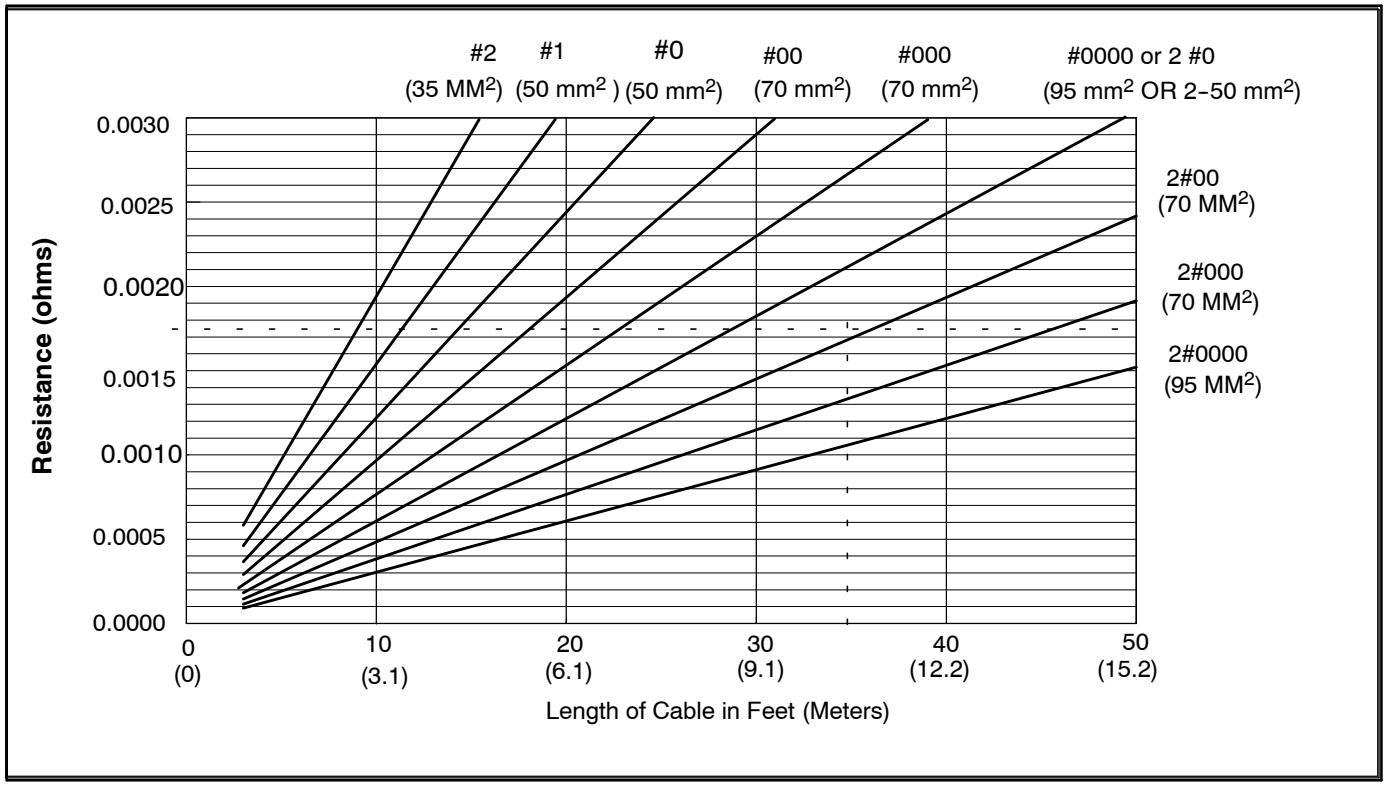

FIGURE 4-3. RESISTANCE VS LENGTH FOR VARIOUS AWG (MM^2) CABLE SIZES

5. Auxiliary Equipment Connections

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, circuit protection, 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.***

See Page A-1 for an illustration of typical generator set connections, including connections to the generator set mounted Generator Interface Box (GiB).

Auxiliary genset equipment such as engine coolant heaters, alternator heaters, oil priming pump, etc., are prewired to the GIB. AC power must be supplied to the GIB.

Two supplies are required for 60 Hz machines. One supply is 480 volts, 3–phase with a capability of 25 continuous amps. The other supply is 120 volts, single phase with a capacity of 25 continuous amps. The maximum cable size at termination for both circuits is 6 AWG (16 mm^2) with a maximum circuit breaker size of 50 amps. See Figure 5-1.

One supply is required for 50 Hz machines, a single 380–440 volt, 3–phase supply with a capacity of 42 continuous amps. The maximum cable size at termination is 6 AWG (16 mm^2) with a maximum circuit breaker size of 50 amps. See figure 5-2.

There is a single-phase supply with circuit breaker available in the GIB for customer use, which is usually used to supply the PSU. See page 5-4 for more information about the PSU.

⚠CAUTION ***Use stranded copper wiring. Generator set movement and vibration can break solid copper wire.***

STARTING BATTERY CHARGER

In most installations a battery charger will be installed to maintain the charge on the starting batteries. Capacity and size are chosen based on site conditions and may be powered by one of the customer supplies from the GIB or by another supply. The following rule of thumb may be useful to size the charger:

Required Battery Charging Amps =
1.2 X Battery Amp Hours ÷ Required Charging Hours.

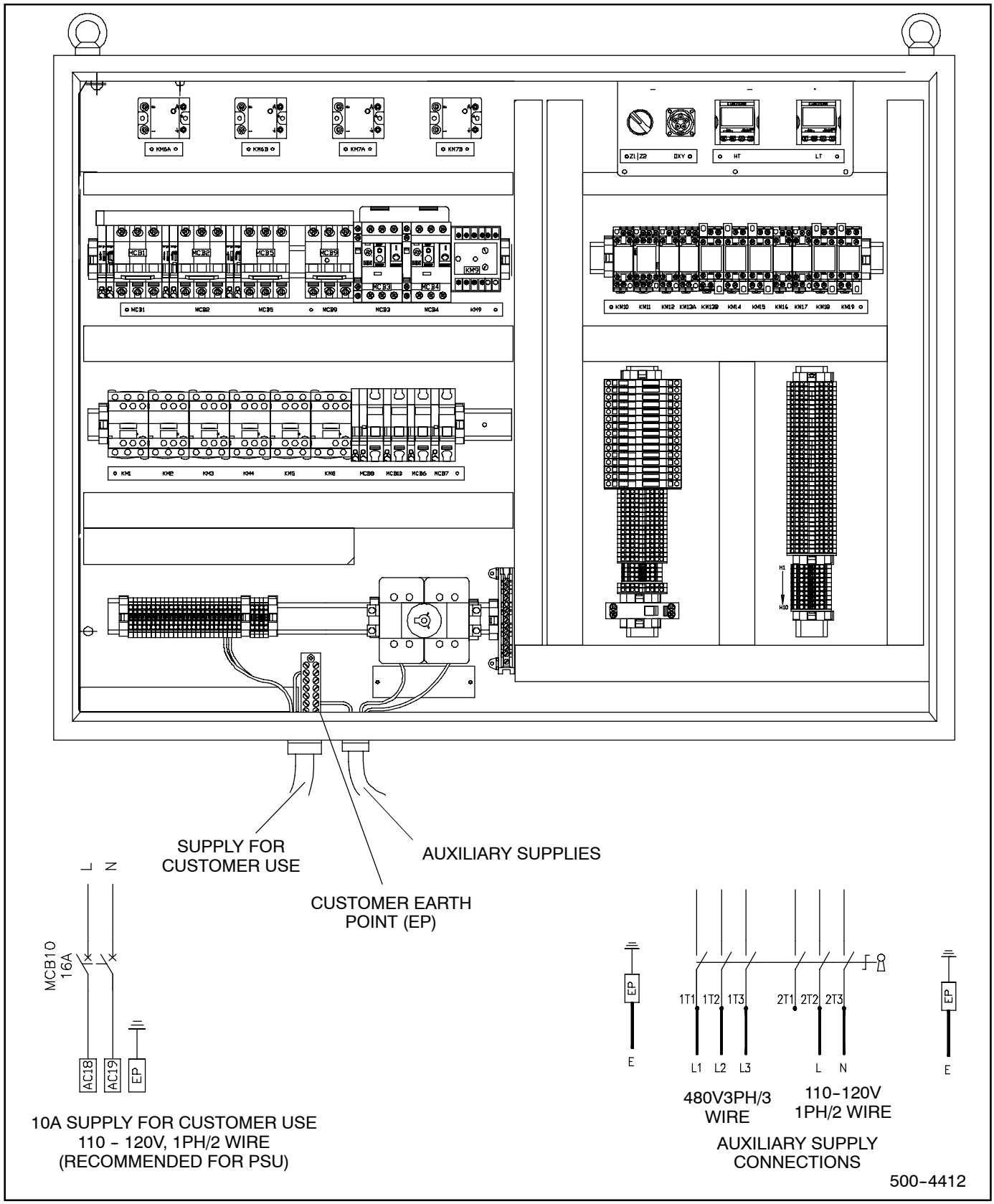

FIGURE 5-1. CUSTOMER CONNECTIONS IN THE GENSET INTERFACE BOX (GIB) FOR 60 HZ GENSETS

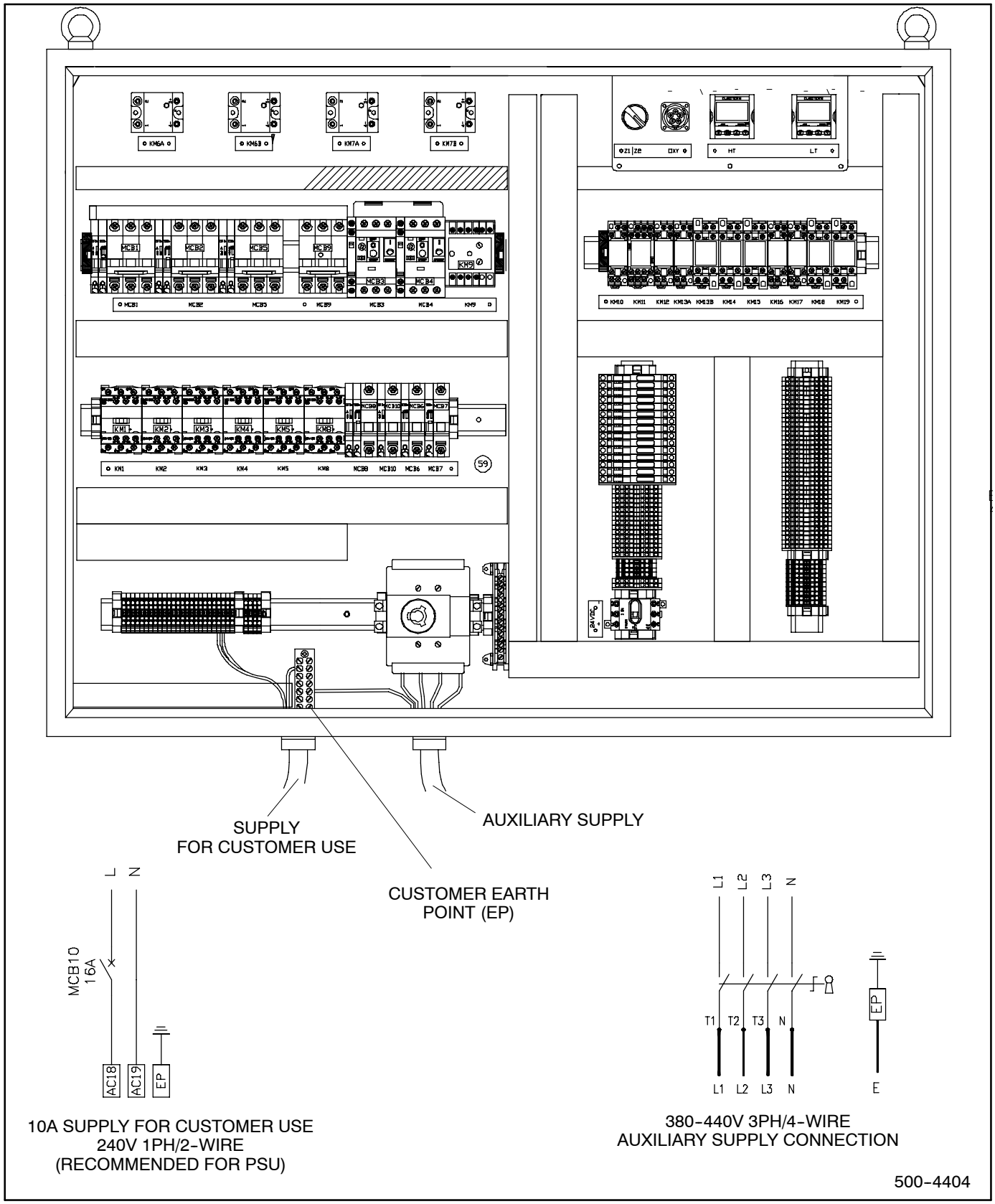

FIGURE 5-2. CUSTOMER CONNECTIONS IN THE GENERATOR INTERFACE BOX (GIB) FOR 50 HZ GENSETS

POWER SUPPLY UNIT

The Power Supply Unit (PSU) is a loose component enclosure that must be mounted as close as practical to the genset. The PSU supplies DC power for the control systems of the genset. The PSU requires an AC supply and DC wiring to the genset's GIB. See figure 5-3.

The AC supply for 60 Hz gensets is single phase, 120V, and for 50 Hz gensets, the AC supply is single phase, 220V. There is a 10 amp supply protected by a circuit breaker that is available from the GIB, and it is recommended that this supply be used to power the PSU. Maximum wire size is 12 AWG (4 mm^2).

DC wire length one way from the PSU to the GIB should not exceed 40 feet (12 meters) and must be 8 AWG (10 mm^2). If the cable length one way is less than 25 feet (eight meters), the wire size can be reduced to 10 AWG (6 mm^2).

⚠ CAUTION ***USE STRANDED COPPER WIRING. GENERATOR SET MOVEMENT AND VIBRATION CAN BREAK SOLID COPPER WIRE.***

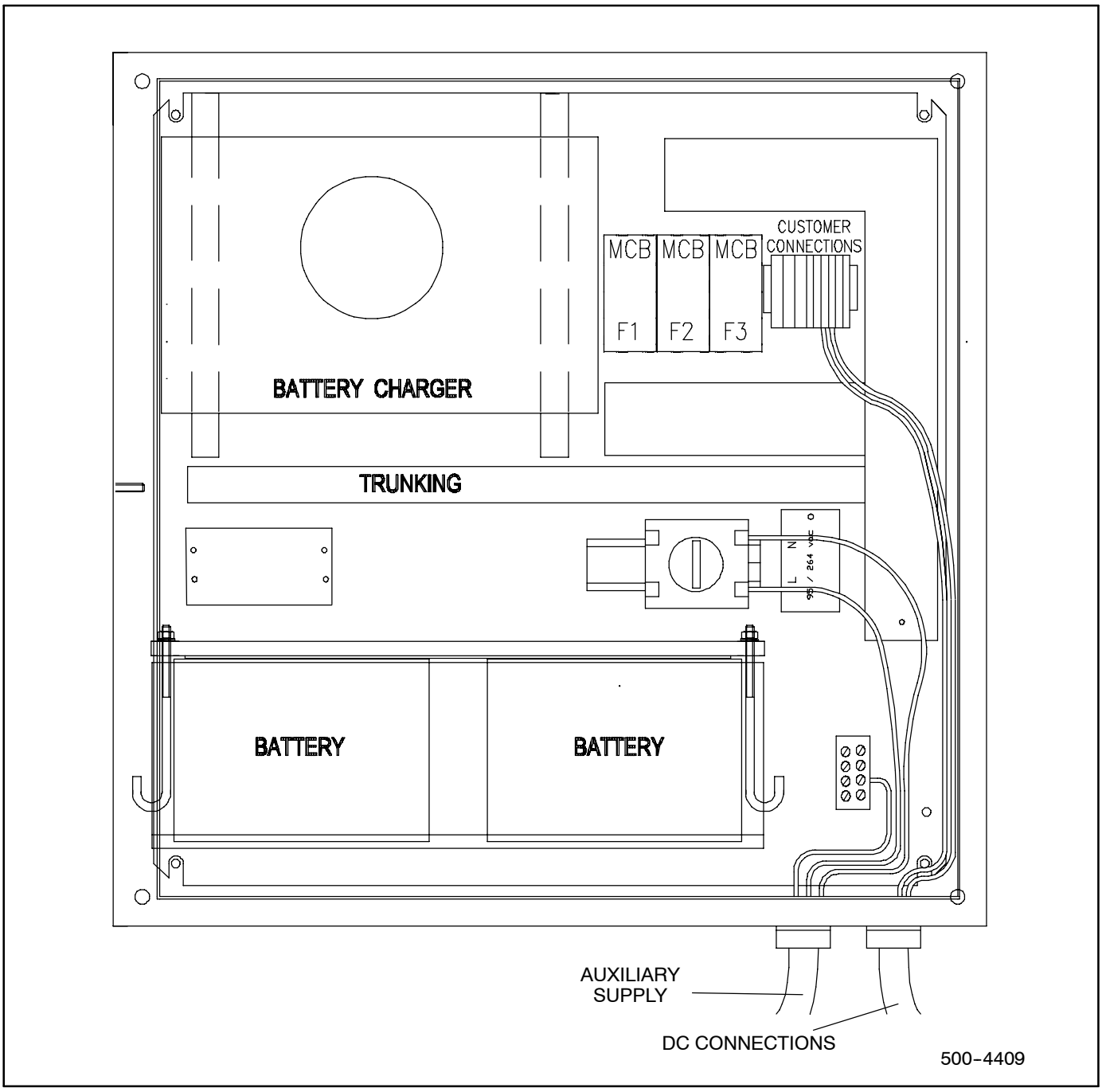

FIGURE 5-4. POWER SUPPLY (PSU) CUSTOMER CONNECTIONS

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6. AC SUPPLY AND POWER Connections

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.***

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

Before making any AC electrical connections, make certain the generator set cannot be accidentally started. Move the RUN/OFF/AUTO switch on the control panel to the OFF position.

If the generator set has the optional air starting system, close the air supply valve.

If the generator set has a battery starting system, 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.***

Ventilate battery area before working on or near battery—Wear goggles—Stop genset 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 genset AC electrical system involves:

- Load cable connection
- Flexible sections of cable and conduit
- Generator insulation check

Before starting the genset, 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 genset 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.***

AC WIRING

Generator Voltage Connections

The generator output voltage and maximum current rating 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.

The generator is connected at the factory to produce a specified voltage per customer order (they cannot be reconfigured for different voltages in the field). Before shipping, the factory tests the generator set at the specified voltage.

See Page A-1.

Load Connections

Load connections are usually made from the generator output terminals to a free standing circuit break-

er in an enclosure or to paralleling switchgear. These cables are usually protected by conduit or a raceway. There must be flexibility in the cables, conduits and/or wireway between the genset and surrounding structure. This flexibility is required to absorb the normal vibration movements of the genset. Make sure that the cables and flex conduit are not in a straight line from the genset output box to, for example, conduit in a concrete floor. Straight runs do not provide three dimensions of flexibility. Always design with an offset.

All loads are connected to the generator by lugging the **stranded** load wires and bolting to the appropriate terminals on the generator reconnection terminal block. The terminals are stamped 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).

Load Balancing

When operating in parallel to a utility grid, the generator set will supply balanced load current to the system. Any unbalance of loads will be taken up by the utility grid.

If the generator set is ever operated in Island Mode, the loads should be balanced as closely as possible across the three phases. When connecting loads to the generator set, balance the loads so 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.

Grounding

Natural gas powered lean burn design generator sets are usually connected through the use of paralleling switchgear. Some gensets will have a disconnect circuit breaker on its output in a free standing enclosure. In any case there are many configurations and sequences of operation that may affect how the genset neutral and the overall system is grounded. If ground fault sensing equipment is included in the scheme, another element for consideration is added. The grounding decision must be carefully considered by the system designer in consideration of system requirements, operational needs, and local codes and standards in force at the site.

Generally in a single genset system, the genset is connected to the system loads using either three-wire or four-wire systems. In three-wire systems, the neutral of the generator is not used (or not present in the case of delta systems). A neutral conductor is not installed from the genset to the switchgear and to the loads. The power switching equipment is therefore 3-pole. In this case the generator neutral may be ungrounded, solidly grounded or resistance grounded. See Figure 6-1 for a simplified diagram showing this configuration. In four-wire systems the neutral conductor is run from the generator and the grounding scheme depends on whether the power switching is 3-pole or 4-pole.

If the neutral is solidly connected from the genset to the service entrance and loads, and the neutral is grounded at the service entrance, then the genset neutral is grounded through that system ground. No additional neutral ground should be present at the genset (and is usually not allowed by code). This ground at the service is present whether operating the genset in parallel or in island mode. See the simplified diagram in Figure 6-1.

The grounding question becomes considerably more complex in four-wires systems if neutral is switched, which means 4-pole breakers are used. There are no straight forward rules or guidance regarding the grounding scheme. Multiple issues will affect the grounding decision such as multiple gensets operating in parallel, ground fault sensing requirements, island vs. utility parallel operation, protection schemes, and of course, safety. In these complex schemes, the grounding decision must be carefully considered and defined physically and operationally by the system designer.

⚠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.***

Typical requirements for bonding and grounding are given in the National Electrical Code, Article 250. All connections, wire sizes, etc. must conform to the requirements of the electrical codes in effect at the installation site.

Equipment Grounding (Bonding)

All equipment metallic parts must be grounded to earth or to the earth ground system of the facility. This includes the generator set frame, the GCP enclosure, the PSU enclosure, and any other equipment associated with the generation system. This bonding is important for safety to avoid the chance of metallic components becoming energized. It is also important in reduction or elimination of stray electrical noise and pulses from static charge or lightning. There is a genset bonding point located and marked as such on the bedframe (skid).

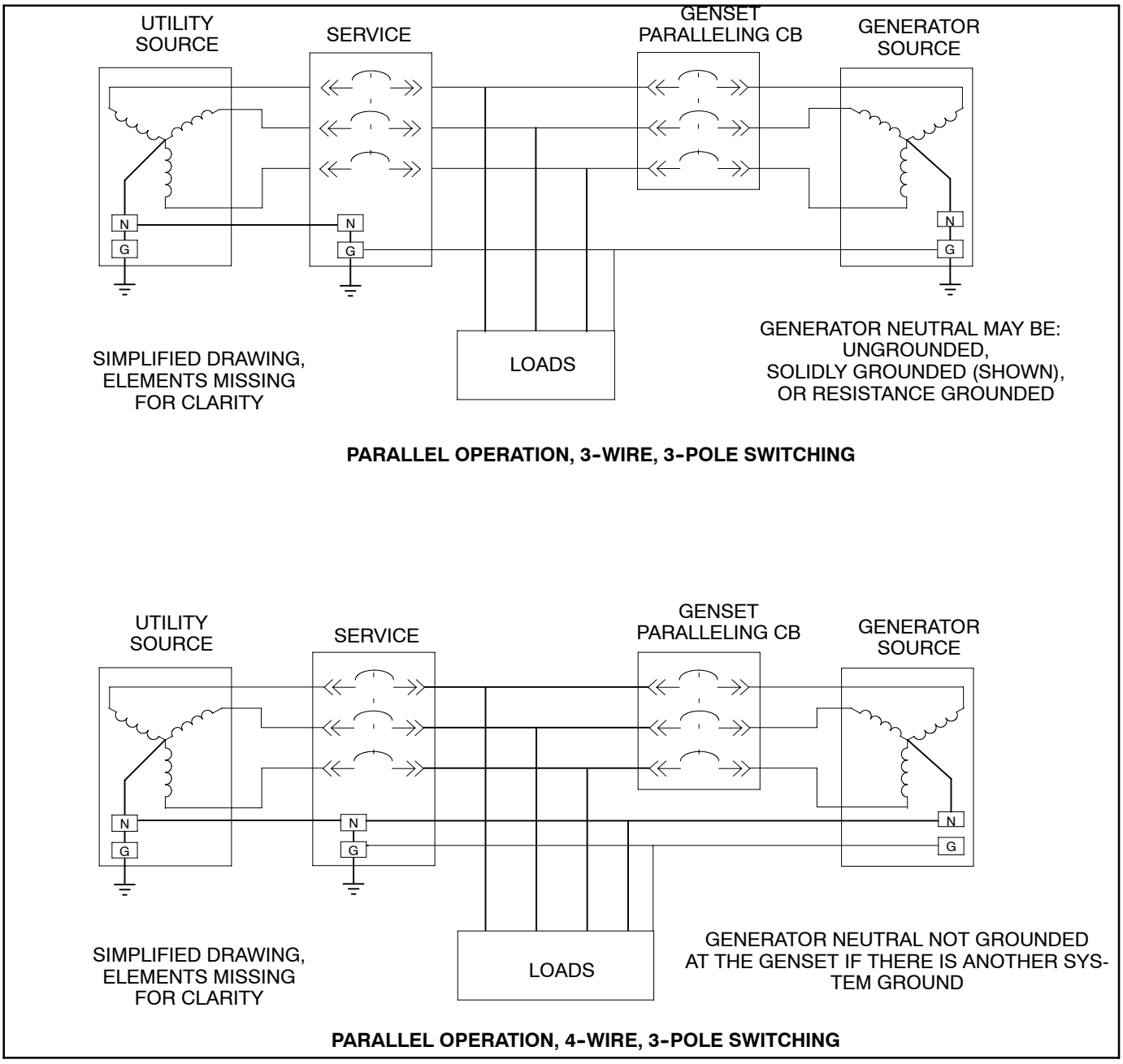

FIGURE 6-1. PARALLEL OPERATIONS FOR 3-WIRE AND 4-WIRE, 3-POLE SWITCHING

INSULATION RESISTANCE (MEGGER) & POLARIZATION INDEX (PI) TESTING

Megger and PI testing **must** be performed on all medium voltage (601 through 15,000 volts) generator sets before initial start-up. PI testing for low voltage (less than 600 volts) generator sets is recommended by Cummins Power Generation.

These tests are used to verify that the windings are dry before the generator set is operated and develops a base line for future test comparison.

Before these tests can be performed on medium voltage generator sets, you must first perform the generator grounding procedure.

Generator Set Grounding Procedure

Prior to performing service or inspection procedures that may expose personnel to conductors normally energized with voltages greater than 600 volts, the following generator set grounding procedure must be followed.

⚠ DANGER ***Do not perform these procedures unless fully trained in medium voltage grounding procedures and have necessary safety equipment. Severe injury or death due to high voltage electrical shock may result.***

1. Open, lock-out and tag-out all sources of power to the immediate work area.
2. Disable the starting system of the generator set:
   A. Move the Run/Off/Auto switch to the Off position and wait for the controller to power down (approximately 10 minutes).
   B. Disconnect the battery charger from its AC source.
   C. Remove the negative battery cable from the battery.
   D. Install a lockout device on the battery cable end. (For engines equipped with an air-powered starting system, close air valve and install valve locking device.)
3. Put on high voltage gloves with leather protectors.
4. Using two pre-tested voltage detection devices (of the proper rating), verify de-energized condition in the work area. (Retest voltage detection devices immediately after verification of de-energized condition.)
5. Remove the metal cover from the generator output box to gain access to generator load terminals.
6. Securely install the Grounding Cluster ground clamp to a verified “grounded” conductor.

   ⚠WARNING ***Hazardous voltage. Can cause severe personal injury or death. After DC voltage from the test equipment has been applied to the windings and ground, there will be a definite static charge on the windings. Reconnect Grounding Cluster to remove static charge from the winding after each generator test.***
7. With the Grounding Cluster in place, you are protected from static and/or induced charges that may have been present in the generator stator.
8. Leave grounds connected for at least one minute so static charge can dissipate. Remove ground cluster and perform PI and/or any other tests required on the stator winding. Reconnect grounds if additional generator service is necessary.
9. When work on the generator set is complete, remove the Grounding Cluster in the reverse order of installation.
10. After getting clearance from all personnel involved in the lock-out/tag-out procedure, remove all lock-out devices in reverse order of installation.

Megger and PI Test

⚠ DANGER ***Medium-voltage, 601 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may still exist, caused by induced voltage within the generator or cables. Service personnel must be well-trained/qualified to work with distribution voltages. (See Generator Set Grounding Procedures, Page 6-3.)***

⚠WARNING ***The windings of medium-voltage (601 through 15,000 volts) generator sets must be dry before the generator is operated. Failure to make sure windings are dry before start-up may result in catastrophic equipment failure, severe personal injury or death.***

Megger Test: The megger test consists of applying voltage for up to one minute. The highest resistance values shown in Table 6-1 should be obtained for a new generator with dry windings. For a set that has been in service, the resistance reading should not be less than the lower value shown.

PI Test: The PI test consists of applying a voltage between the winding and ground for ten minutes and recording resistance values at one minute and at ten minutes. The PI is the ratio of a ten minute reading in megohms divided by a one minute reading in megohms. A ratio of two or greater is considered good for new and in service sets.

If low readings are obtained, the cause should be investigated and corrected before the generator set is returned to service. If moisture is determined to be the cause of low test readings, a winding drying process will be required (refer to genset *Service* manual for drying procedure).

1. Perform the *Generator Set Grounding Procedure* in this section.
2. Open the control box door and remove connector **10** from the AVR module.
3. Disconnect the AC voltage sense leads from the generator output terminals. The AC voltage sense leads are marked 5, 6, 7 and 8.
4. If the RTD (resistance temperature detector) option is installed, ground all six RTD temperature leads. Each RTD has three leads, one red and two white leads. Total of 18 leads must be grounded.

Main Stator:

1. Remove and separate the neutral leads of the generator from the generator load terminal marked “N”.
2. Connect the megger between one phase of the stator and ground while grounding the other two phases and conduct the test. Refer to Table 6-1 for megger voltage selection and required resistance values.
3. Repeat this step in turn for the other two phases.

Main Rotor:

1. Disconnect the main rotor and voltage suppressor leads from terminals **F1+** and **F2–** on the rotating rectifier assemblies and isolate them from ground. Tag and mark each lead with its terminal number (**F1+** or **F2–**).
2. Connect the megger between one of the rotor leads and ground and conduct the test. Refer to Table 6-1 for megger voltage selection and required resistance values.

TABLE 6-1. GENERATOR INSULATION RESISTANCE

FRAME SIZE	GENERATOR VOLTAGE	MEGGER VDC SETTING	MINIMUM RESISTANCE (MEG)			
			MAIN STATOR	MAIN ROTOR	PMG	EXCITER STATOR
P7	600 VAC or less	500	10 – 1	10 – 1	10 – 1	10 – 1
P80	600 VAC or less	1000	10 – 5			
		500		200 – 100 (Combined rotors)	5 – 3	10 – 5
P80	601 thru 5000 VAC	2500	100 – 50			
		500		200 – 100 (Combined rotors)	5 – 3	10 – 5
P80	5001 thru 15000 VAC	5000	300 – 150			
		500		200 – 100 (Combined rotors)	5 – 3	10 – 5

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7. Prestart Preparations

PRESTART PREPARATIONS

Initial startup and preparation for commissioning may be performed only by a factory trained person who is qualified for commissioning of lean burn natural gas gensets from Cummins Power Generation. This work is normally performed in conjunction with the commissioning of the switchgear as well as other site equipment.

⚠ CAUTION ***Improper calibration or adjustment of the control can cause equipment malfunction or damage. Calibration and adjustment must be performed by technically qualified personnel only.***

Assuring that the site is prepared for commissioning will reduce time, mitigate issues, and assure efficient, effective commissioning efforts.

A generator set installation/prestart–up checklist is included in this chapter and is useful to help assure the site is ready. Qualified site personnel, or those responsible for the design/installation, can use this checklist during design and construction as well as precommissioning to check many aspects of the site.

A list of control and protection settings is also included in this chapter which provides descriptions and factory settings. If other settings are desired by qualified site personnel, a list of prepared setting prior to commissioning can be prepared to clarify and speed the process of setup of the control systems.

ELECTRICAL SYSTEM

Make sure 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.

Battery Connections

⚠ WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Make sure that the Run/Off/Auto switch on the control panel is set to the Off position before connecting the battery cables.***

Starting the unit requires 24 volt battery current (see *Specification* section). Connect 12 volt batteries in series (negative post of first battery to the positive post of the second battery).

Necessary battery cables are on the unit. Service batteries as necessary. Infrequent use (as in emergency standby service), may allow battery to self-discharge to the point where it cannot start the unit. If installing an automatic transfer switch that has no built-in charge circuit, connect a separate trickle charger. Cummins Power Generation automatic transfer switches include such a battery charging circuit.

⚠ 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.***

GENERATOR SET INSTALLATION/ PRE-COMMISSIONING CHECKLIST

Lean burn gas generator set

This checklist should be used to validate the completion of a generator set installation prior to commissioning. A checklist should be completed for each generator set of a multiple installation.

Project Details

Project Name:

Customer (End User):

Address of Site:

Telephone No.:

Email:

Start up date:

Generator set details

Generator set model:

Generator set serial number:

Generator set number:

Control type:

Control serial number:

System control type (if applicable):

Generator set building and services

- ☐ Building and installation work complete
- ☐ Site clean and access clear from obstruction
- ☐ Building services complete and commissioned (lightning, lighting, electrical auxiliary supplies, water, etc.)

Observations:

_____
_____
_____
_____
_____
_____
_____

Room general and safety checks

- ☐ Ensure starting is inhibited until ready
- ☐ Warn personnel of impending equipment start-up
- ☐ Generator set clean with all guards in place
- ☐ No loose materials near generator set
- ☐ Air ducts clear and clean
- ☐ Access and egress routes unobstructed and labelled
- ☐ Control and maintenance positions unobstructed
- ☐ Room secure-no unauthorized access
- ☐ Generator set is level-holding down bolts secure
- ☐ Pipework and cables are secure with trip hazards
- ☐ Overhead obstructions clearly marked and labelled
- ☐ All key components are labelled
- ☐ Pipework and services color coded and labelled
- ☐ Electrical bonding complete

Cooling System

Remote mounted radiator systems

- ☐ Header tank is adequately sized
- ☐ Overflow is clear and routed to avoid spillage
- ☐ Static/friction head is within engine/system capability
- ☐ Engine vent pipes inclined toward radiator/ header
- ☐ Header tanks, auxiliary tanks and system filled and cap(s) replaced
- ☐ Pipework avoids air locks-air bleed valves provided
- ☐ Pipework isolated from generator set vibration
- ☐ Pipework complete, cleaned, tested, and painted
- ☐ Auxiliary supply to fans correctly installed
- ☐ Electrical bonding completed

Heat exchanger and cooling tower systems

- ☐ Header tank is adequately sized

- ☐ Overflow is clear and routed to avoid spillage
- ☐ Static/friction head is within engine/system capability
- ☐ Engine vent pipes inclined toward header tank
- ☐ Pipework avoids air locks–air bleed valves provided
- ☐ Pipework isolated from generator set vibration
- ☐ Pipework complete, cleaned, tested and painted
- ☐ Secondary cooling system is complete
- ☐ Cooling tower make up supply is complete
- ☐ Auxiliary supply to fans correctly installed
- ☐ Electrical bonding completed

Gaseous fuel system

- ☐ Pipework complete, material and construction correct
- ☐ Regulator and shut off valves in correct locations
- ☐ Leak test and certification complete
- ☐ Test certificates present
- ☐ Gas present at shut off valves

Fire alarm/suppression system

- ☐ Fire alarm/suppression system complete
- ☐ Sensors protected from radiant heat
- ☐ Labelling and lock off system complete

Starting system

Battery starting

- ☐ Starting batteries correct and installed on tray or stand
- ☐ Battery cables routed correctly and secured
- ☐ Battery charger installed and wired

Compressed air/hydraulic starting

- ☐ Compressor set installed and wired
- ☐ Compressed air pipework correctly rated and installed
- ☐ Isolating valves correctly positioned and labelled
- ☐ Pipework tested, painted, and labelled
- ☐ Correct pressure regulator and HP/LP safety valves
- ☐ Flexible connection to engine fitted
- ☐ HP and LP air/hydraulic pressures checked
- ☐ Condensate drained

Exhaust system

- ☐ Installation design prevents exhaust recirculation
- ☐ Flexible connection to engine
- ☐ Support prevents load on turbocharger/manifold
- ☐ Installation allows for pipework expansion
- ☐ Pipework/muffler supported at required intervals
- ☐ Joints welded or flanges secure with correct gaskets
- ☐ Stack/tailpipe prevents rain/snow ingress
- ☐ Flues are not combined in stack
- ☐ Condensate drain provided
- ☐ Exit directed away from buildings/personnel
- ☐ System is lagged and clad as required
- ☐ Building penetration and weathering complete and sealed
- ☐ Flammable materials properly protected
- ☐ Check stack/tailpipe and rain cap are clear

Ventilation and Attenuation

- ☐ Design prevents hot air recirculation and rain ingress
- ☐ Design accounts for prevailing wind
- ☐ Air flow direction is from alternator to engine front
- ☐ Louver mechanisms complete and wired as required
- ☐ Check louvers are clear and free to operate
- ☐ Electrical bonding completed
- ☐ Bird guard is fitted to intake and outlet

Electrical System

Control system

- ☐ Field wiring to set mounted control complete
- ☐ Customer wiring to set mounted control complete

- ☐ Interconnection to remote control complete
- ☐ Emergency stop controls wired
- ☐ Select set parameters on set/system control
- ☐ Check remote control signals to set control
- ☐ Check set control signals to remote control
- ☐ Check signals to system control and switchgear
- ☐ Check emergency stop controls

Set/Switchgear/Changeover/Transfer

- ☐ Means of disconnection/isolation provided
- ☐ Switchgear installation and pretesting completed
- ☐ Power connections complete and torque–marked
- ☐ Cable tests complete and certificates available
- ☐ Verify cable flexibility at generator set
- ☐ Energize auxiliary supplies and check functionality
- ☐ Enter switchgear protection settings and record
- ☐ Utility sensing commissioned

Electrical general

- ☐ All electrical boxes clean and covers replaced
- ☐ Auxiliary electrical supply complete
- ☐ Grounding system complete and tested
- ☐ Electrical bonding of services/assemblies complete
- ☐ Utility supply available as required
- ☐ Small power and lighting circuits tested and certificated
- ☐ Alternator insulation test completed
- ☐ Small power and lighting circuits tested and certificated

Comments on any item that may affect commissioning:

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Checklist completed by:

Date:

Print name:

Company:

Note: Completion of this checklist does not relieve installer of contract obligations.

CONTROL AND PROTECTION SETTINGS

The following table provides a list of descriptions and factory settings.

TABLE 7-1. CONTROL AND PROTECTION SETTINGS LIST

DESCRIPTION	ORIGINAL SETTNG	RANGE	DESIRED NEW SETTING
SET UP			
System units	Metric		
Customer fault 4	Warning	Shutdown/warning	
Overvoltage	100%		
Language	English	Check with factory	
PARALLEL-ISO BUS			
Sync time limit	120, warning	10–120 seconds shutdown/off/warn	
Permissive window–phase	10	5–20 degrees	
Permissive window–time	0.50	0.5–5 seconds	
Fail to close	1, shutdown	0.5–5 seconds shutdown/ off/warn	
First start fail	10	5–120	
Ramp Unld time	120	5–900 Seconds	
Ramp Unld level	5	0–100%	
Ramp load time	120	5–900 Seconds	
Loss of field time	10, shutdown	2–10 Seconds	
Loss of field level	20, shutdown	16–41% kVAR	
Reverse power limit (%)	5, shutdown	5–15% KW	
Reverse power limit (time)	5, shutdown	1–15 Seconds	
PARALLEL- UTILITY			
Base load %	20	20–100%	
PF level	.97	0.8 lag–1.0	
Multiple/Single	Multiple	Multiple/Single	
Ramps–same as ISO Bus			
AmpSentry			
Overcurrent	AmpSentry time–overcurrent calculation		
Overload	AmpSentry time–overcurrent calculation		
High AC volts	110% for 10 seconds, shutdown, 130% no delay, shutdown		
Low AC volts	85% for 10 seconds, shutdown		
Underfrequency	90% for 20 seconds, shutdown		

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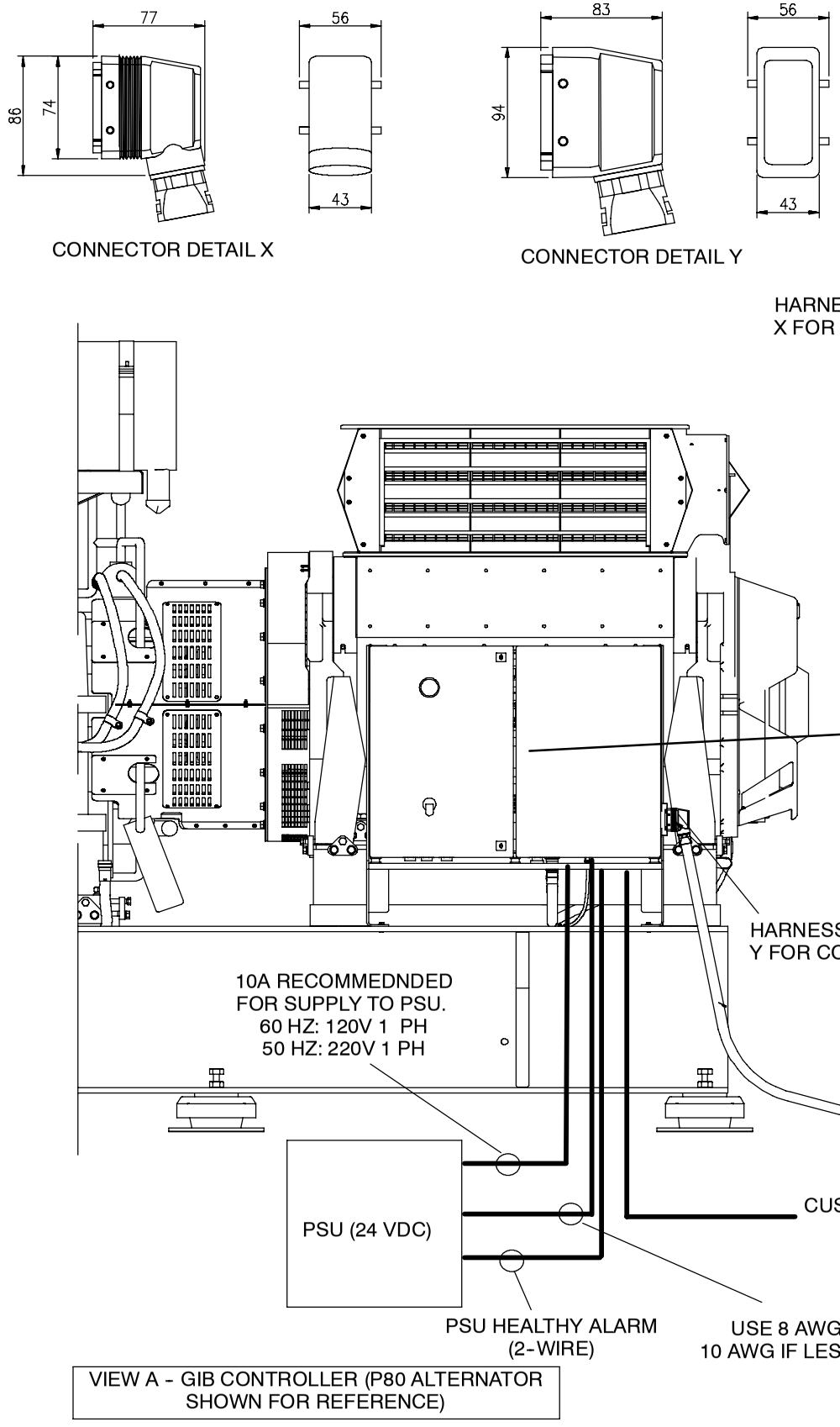
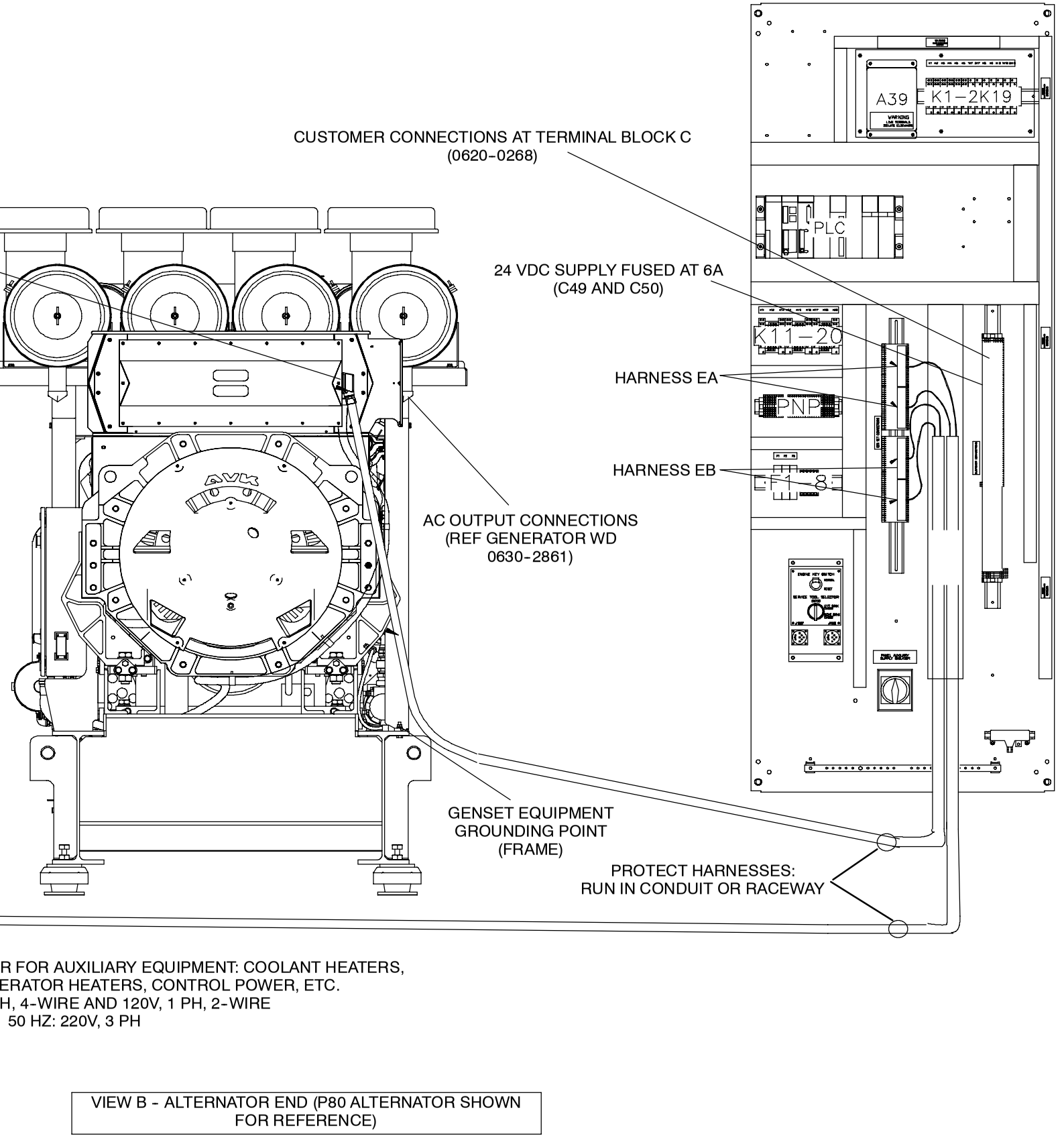


VIEW A - GIB CONTROLLER (P80 ALTERNATOR SHOWN FOR REFERENCE)

CONNECTOR DETAIL X

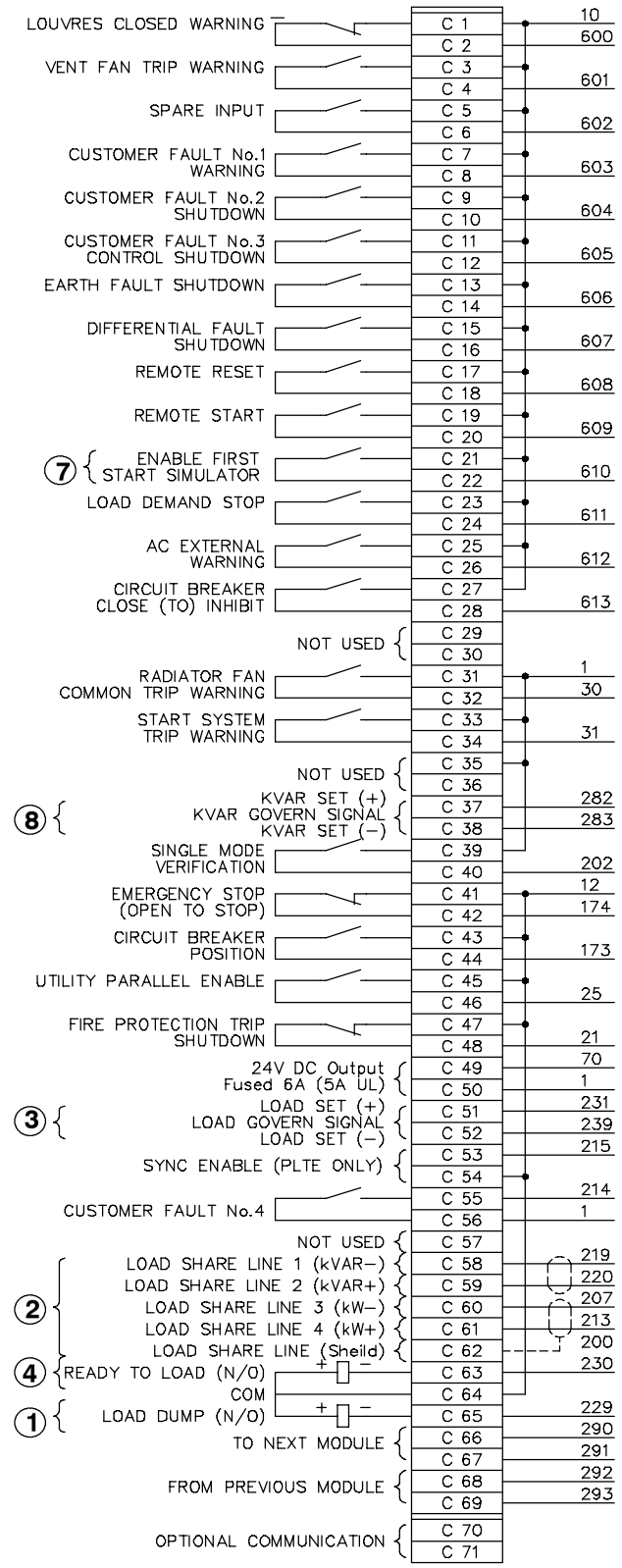
CONNECTOR DETAIL Y

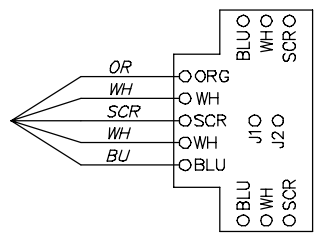


VIEW B - ALTERNATOR END (P80 ALTERNATOR SHOWN FOR REFERENCE)

TYPICAL GENSET WIRING CONNECTIONS

CUSTOMER SIDE CONNECTION

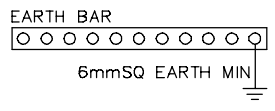




MODBUS PLUS TAP

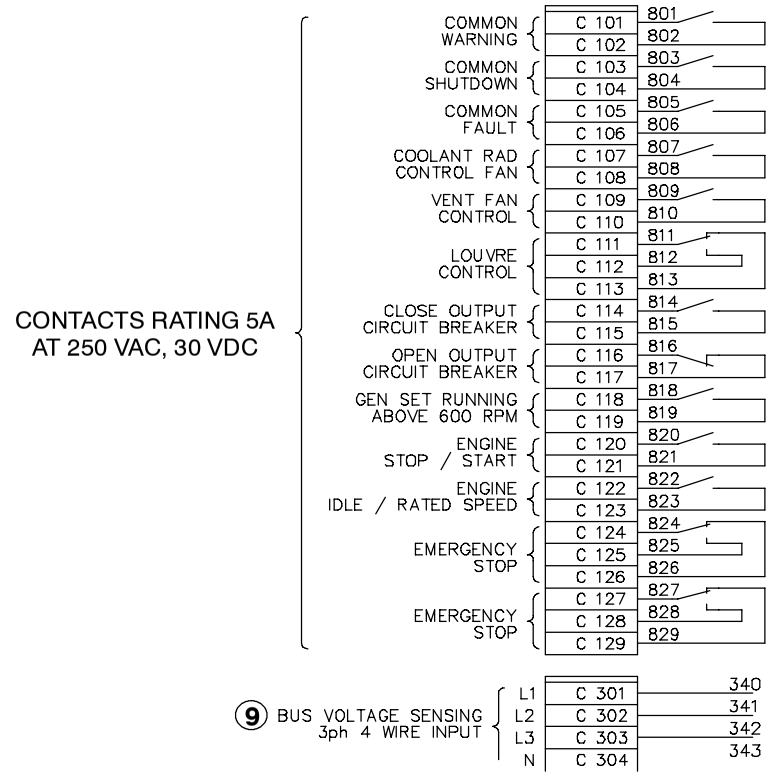
⑪

(FOR DETAILS OF CONFIGURATION AS A THROUGH CONNECTOR OR TERMINATOR CONNECTOR, REFER TO NETWORK CONFIGURATION IN DIGITAL MASTER CONTROLLER)



CUSTOMER SIDE CONNECTION

CONTACTS RATING 5A AT 250 VAC, 30 VDC



CUSTOMER CONNECTION NOTES:

1. 0V DC OUTPUT (SWITCHED). OUTPUT GOES HIGH IF AN OVERLOAD OR FREQUENCY CONDITION OCCURS (MAX RATING 2A.)
2. PARALLEL LOAD SHARE LINES (0-1MA). USE 4 CONDUCTOR SHIELDED CABLE, 1 MM^2 STRANDED (MAXIMUM RUN 152 METERS).
3. ANALOGUE 0-5V DC INPUTS TO CONTROL GENSET LOAD IN UTILITY PARALLELING MODE.
4. 0V DC OUTPUT (SWITCHED). OUTPUT GOES HIGH WHEN GENSET IS READY TO LOAD, I.E. UP TO SPEED AND VOLTS (MAX RATING 2A).
5. TERMINALS ARE SUITABLE FOR CABLE UP TO A MAXIMUM SIZE OF 2.5 MM^2 (16 AWG).
6. TERMINALS MARKED ▤ HAVE CODING FINGERS REMOVED FOR EASE OF INSTALLATION.
7. LINK C21/22 TO ENABLE MASTER FIRST START SIMULATOR FUNCTION. ONLY ENABLE ON SINGLE GENSET/PLTE APPLICATIONS.
8. ANALOGUE 0-5V DC INPUTS TO CONTROL GENSET KVAR IN UTILITY PARALLELING MODE.
9. BUS SENSING SHOULD BE FUSED WITH 4A FUSE.
10. ADD A 100 OHM RESISTOR IF THERE IS NOT BEARING RTD BETWEEN 217-218 AND LINK 218-219.
11. USED 1 PAIR 24 AWG SHIELDED AS PER E108998 OR AWM2919 OR CM1308 (MAXIMUM RUN 450 METERS).

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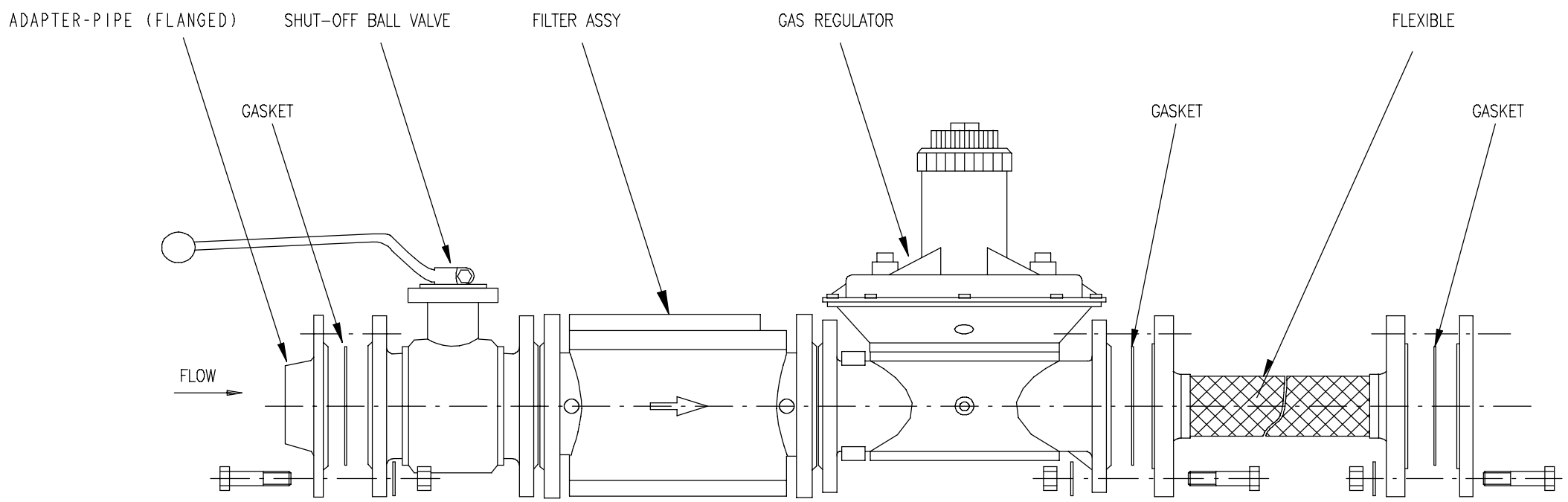
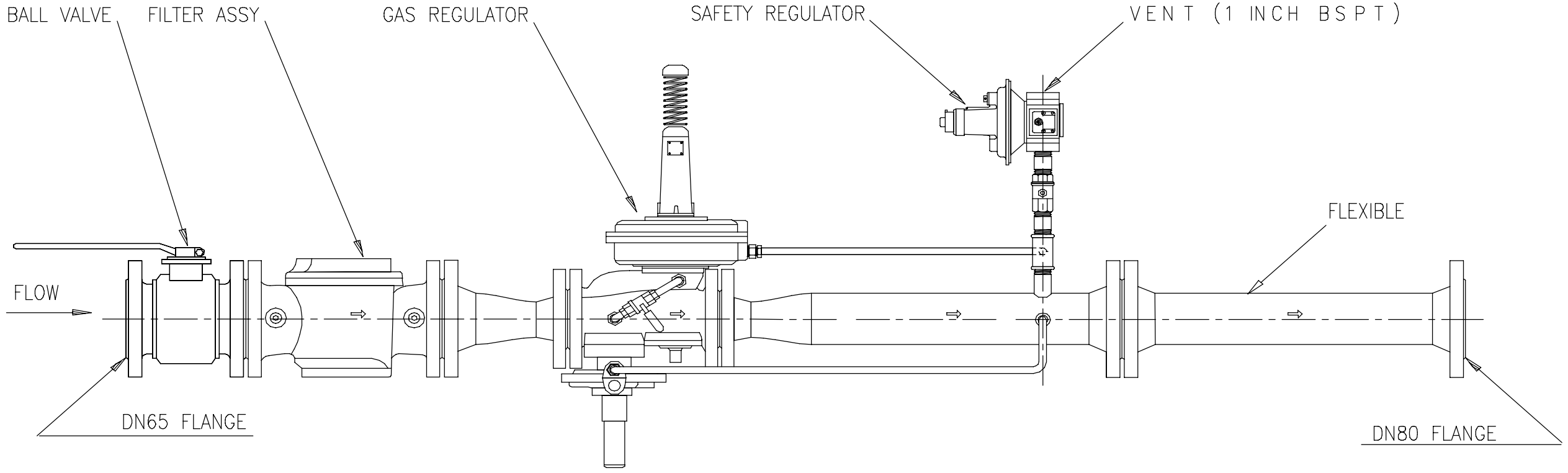
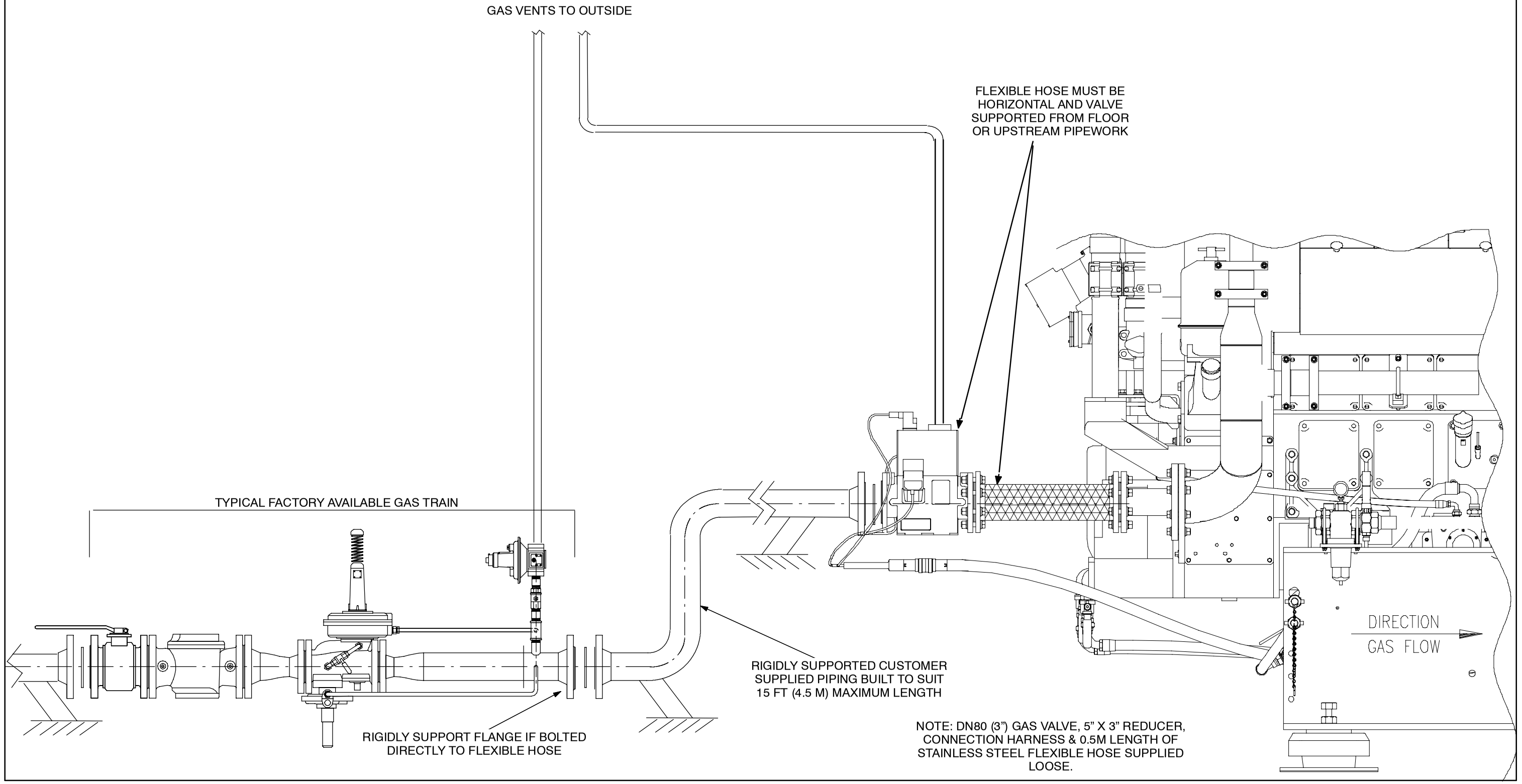


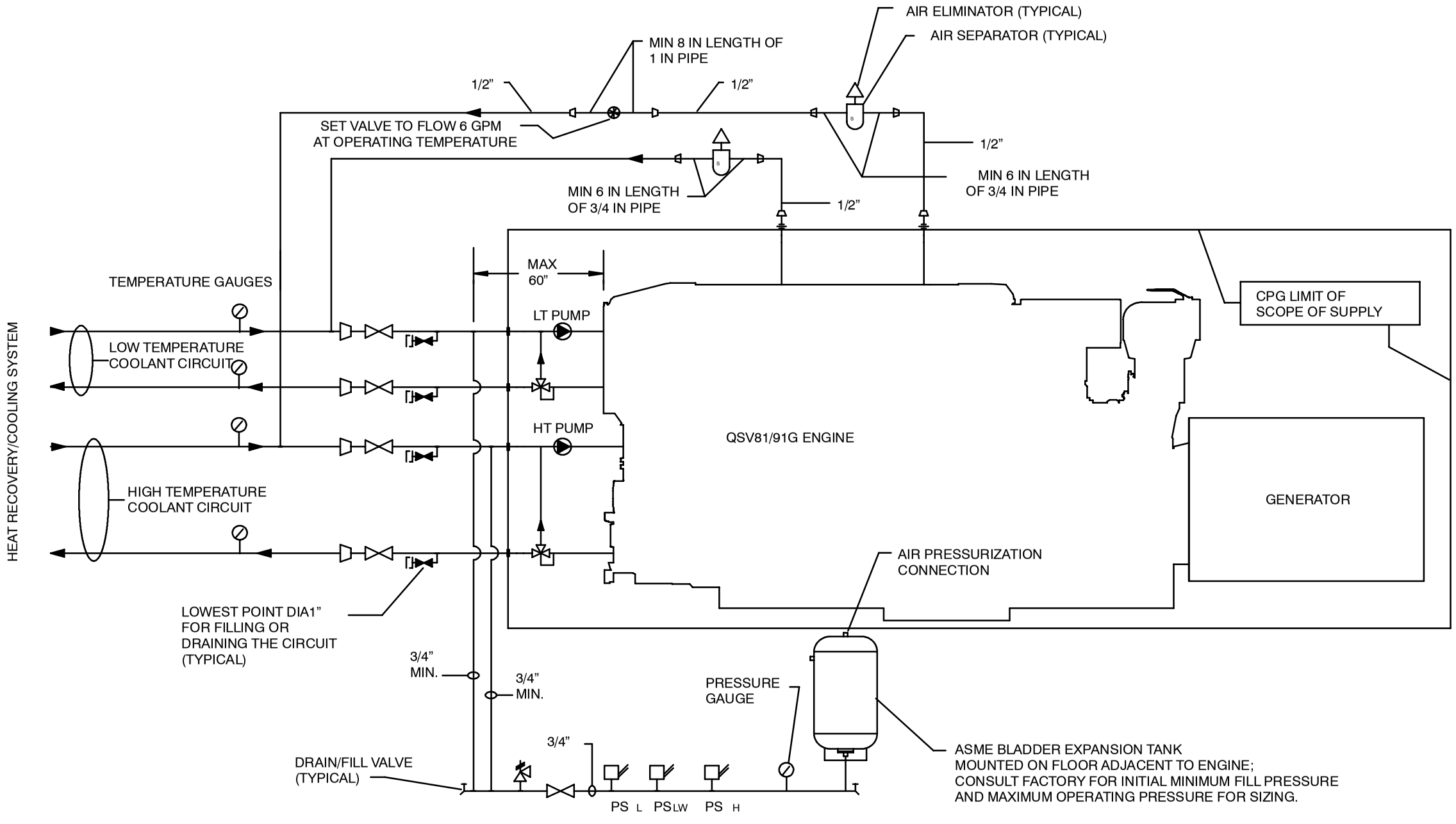
TYPICAL LOW-PRESSURE GAS TRAIN (7 PSI MAXIMUM)



TYPICAL HIGH-PRESSURE GAS TRAIN



TYPICAL GAS TRAIN INSTALLATION

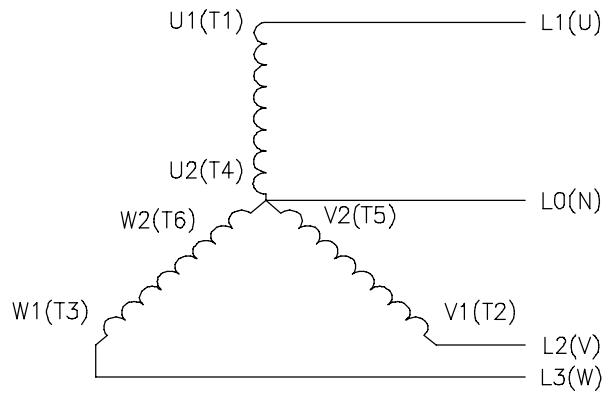


DESIGNATION	SYMBOLS
PIPE REDUCER	
VALVE (OPEN)	
VALVE (CLOSED)	
CROSSING PIPES NOT CONNECTED	
FLEXIBLE PIPE	
FLANGES	
BLANK FLANGE	
UNIONS COUPLING	
QUICK RELEASE	
ORIFICE	
CAP	
THERMOSTATIC VALVE	
CONNECTION ITEM	
LOW PRESSURE SHUTDOWN SWITCH	
LOW PRESSURE WARNING SWITCH	
HIGH PRESSURE LIMIT SWITCH	
PRESSURE RELIEF VALVE	
PUMP	
BALANCING VALVE	

RECOMMENDED COOLANT SYSTEM SCHEMATIC

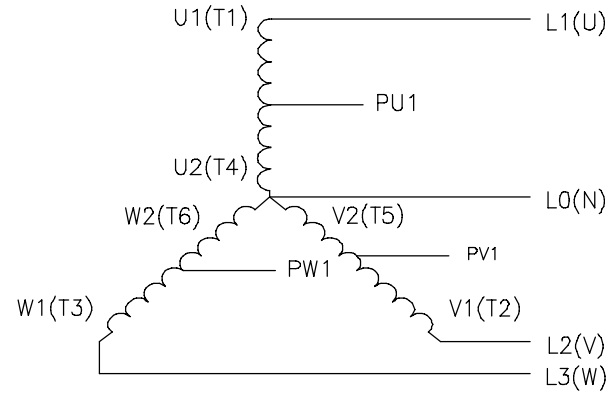
FRAME 7 – LOW VOLTAGE

277/480V, 60Hz (R002)
240/416V, 60Hz (R003)
255/440V, 60Hz (R023)
230/400V, 60Hz (R029)
220/380V, 60Hz (R099)
347/600V, 60Hz (R114)



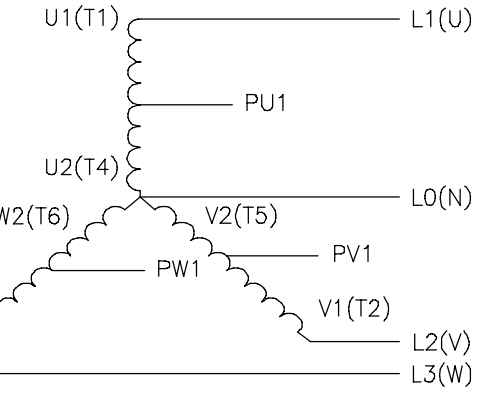
FRAME 7 – MEDIUM VOLTAGE

2400/4160V, 60Hz (R107)
1905/3300V, 50Hz (R108)



FRAME 8 – HIGH VOLTAGE

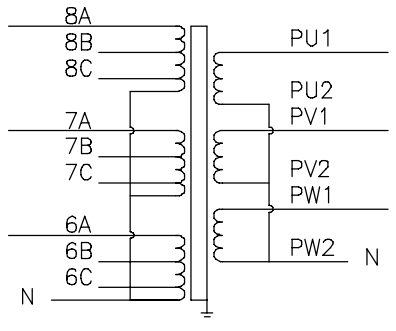
3810/6600V, 50Hz (R139)
3640/6300V, 50Hz (R140)
6350/11000V, 50Hz (R143)
7200/12470V, 60Hz (R144)
7621/13200V, 60Hz (R132)
7970/13800V, 60Hz (R130)



PRIMARY JUMPERS

PV2 – PW2 – PU2

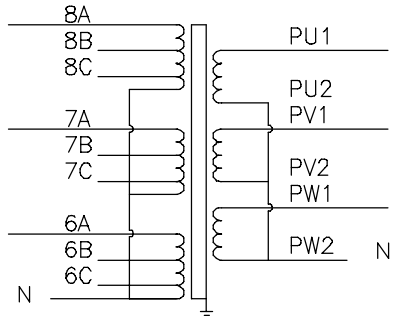
VOLTAGES	Tapping position
4160V	A
3300V	B



PRIMARY JUMPERS

PV2 – PW2 – PU2

VOLTAGES	Tapping position
6300V	A
6600V	A
11000V	B
12470V	A
13200V	A
13800V	A



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