

Cummins **Onan**



# **Installation Manual**

## **Marine Generator Set**

MDKBH (Spec A-E)

**California**

**Proposition 65 Warning**

**Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.**

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# 1 Safety Precautions

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## 1.1 Overview

Thoroughly read the Operator Manual before operating the generator set. It contains important instructions that should be followed during operation and maintenance. Safe operation and top performance can only be achieved when equipment is properly operated and maintained. The owners and operators of the generator set are solely responsible for its safe operation.

Generator set operation, maintenance, and installation must comply with all applicable local, state, and federal codes and regulations. Electricity, fuel, exhaust, moving parts, and batteries present hazards which can result in severe personal injury or death. Only trained and experienced personnel with knowledge of fuels, electricity, and machinery hazards shall perform generator set installation or adjustment procedures. Also, only trained and experienced personnel with knowledge of fuels, electricity, and machinery hazards shall remove, dismantle, or dispose of the generator set.

SAVE THESE INSTRUCTIONS.

### WARNING

*This generator set is not a life support system. It can stop without warning. Children, persons with physical or mental limitations, and pets could suffer personal injury or death. A personal attendant, redundant power, or alarm system must be used if generator set operation is critical.*

### WARNING

*This generator set is not be the main source of power for communication and steering systems. It can stop without warning.*

## 1.2 Precaution Symbols

The following symbols used in this manual alert you to potential hazards to operator, maintenance personnel, and equipment.

### DANGER

*Indicates a hazardous situation that, if not avoided, will result in death or serious injury.*

### WARNING

*Indicates a hazardous situation that, if not avoided, could result in death or serious injury.*

### CAUTION

*Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.*

### NOTICE

*Indicates information considered important, but not hazard-related (e.g., messages relating to property damage).*

## 1.3 General Safety Precautions

### WARNING

*Hot, moving, and electrically live parts can cause severe personal injury or death. Keep children away from the generator set.*

### WARNING

*Hot, moving, and electrically live parts can cause severe personal injury or death. Only trained and experienced personnel should make adjustments while the generator set is running.*

### WARNING

*Operation of equipment is unsafe when mentally or physically fatigued. Do not operate equipment in this condition, or after consuming any alcohol or drug.*

### WARNING

*Maintaining or installing a generator set can cause severe personal injury. Wear personal protective equipment such as safety glasses, protective gloves, hard hats, steel-toed boots, and protective clothing when working on equipment.*

### WARNING

*Moving parts can cause severe personal injury or death and hot exhaust parts can cause severe burns. Make sure all protective guards are properly in place before starting the generator set.*

### WARNING

*Running the generator set without the cover or service door can cause severe personal injury or equipment damage. Do not operate the generator set with the cover or service doors removed.*

### WARNING

*Coolants under pressure can cause severe scalding. Do not open a radiator or heat exchanger pressure cap while the engine is running. Let the engine cool down before removing the coolant pressure cap. Turn the cap slowly and do not open it fully until the pressure has been relieved.*

### WARNING

*Hot metal parts can cause severe burns. Avoid contact with the radiator, turbo charger, and exhaust system.*

### WARNING

*Flammable liquids can cause fire or explosion. Do not store fuel, cleaners, oil, etc. near the generator set.*

### WARNING

*Starting fluids, such as ether, can cause explosion and generator set engine damage. Do not use.*



**⚠ WARNING**

*Ethylene glycol, used as engine coolant, is toxic to humans and animals. Clean up coolant spills and dispose of used antifreeze in accordance with local environmental regulations.*

**⚠ WARNING**

*Used engine oils have been identified by some state and federal agencies to cause cancer or reproductive toxicity. Do not ingest, breathe the fumes, or contact used oil when checking or changing engine oil.*

**⚠ WARNING**

*Inhalation of carbon monoxide can cause severe personal injury or death. Test and confirm that all carbon monoxide detectors are working in accordance with the manufacturer's instructions or owner's manual prior to every startup, and after 8 hours of running.*

**⚠ WARNING**

*Substances in exhaust gases have been identified by some state and federal agencies to cause cancer or reproductive toxicity. Do not breathe in or come into contact with exhaust gases.*

**⚠ CAUTION**

*To prevent accidental or remote starting while working on the generator set, disconnect the negative (–) battery cable at the battery using an insulated wrench.*

**⚠ CAUTION**

*Unsecured or loose fasteners can cause equipment damage. Make sure all fasteners are secure and properly torqued.*

**⚠ CAUTION**

*Oily rags and other material can cause fire and restrict cooling. Keep the generator set, drip pan, and compartment clean.*

**⚠ CAUTION**

*Accumulated grease and oil can cause overheating and engine damage presenting a potential fire hazard. Keep the generator set clean and repair any oil leaks promptly.*

**NOTICE**

**Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth. Class B fires involve combustible and flammable liquid fuels and gaseous fuels. Class C fires involve live electrical equipment. (Refer to NFPA No. 10 in applicable region.)**

## 1.4 Electrical Shocks and Arc Flashes Can Cause Severe Personal Injury or Death

### WARNING

*Any work with exposed energized circuits with potentials of 50 Volts AC or 75 Volts DC or higher poses a significant risk of electrical shock and electrical arc flash. These silent hazards can cause severe injuries or death. Refer to standard NFPA 70E or equivalent safety standards in corresponding regions for details of the dangers involved and for the safety requirements.*

Guidelines to follow when working on de-energized electrical systems:

- Use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- De-energize and lockout/tagout electrical systems prior to working on them. Lockout/Tagout is intended to prevent injury due to unexpected start-up of equipment or the release of stored energy. Please refer to the lockout/tagout section for more information.
- De-energize and lockout/tagout all circuits and devices before removing any protective shields or making any measurements on electrical equipment.
- Follow all applicable regional electrical and safety codes.

Guidelines to follow when working on energized electrical systems:

### NOTICE

It is the policy of Cummins Inc. to perform all electrical work in a de-energized state. However, employees or suppliers may be permitted to occasionally perform work on energized electrical equipment only when qualified and authorized to do so and when troubleshooting, or if de-energizing the equipment would create a greater risk or make the task impossible and all other alternatives have been exhausted.

### NOTICE

Exposed energized electrical work is only allowed as per the relevant procedures and must be undertaken by a Cummins authorized person with any appropriate energized work permit for the work to be performed while using proper PPE, tools and equipment.

In summary:

- Do not tamper with or bypass interlocks unless you are authorized to do so.
- Understand and assess the risks - use proper PPE. Do not wear jewelry and make sure that any conductive items are removed from pockets as these items can fall into equipment and the resulting short circuit can cause shock or burning. Refer to standard NFPA 70E for PPE standards.
- Make sure that an accompanying person who can undertake a rescue is nearby.

## 1.5 Generator Voltage Is Deadly

- Generator electrical output connections must be made by a trained and experienced electrician in accordance with applicable codes.
- Use caution when working on live electrical equipment. Remove all jewelry, make sure clothing and shoes are dry, stand on a dry wooden platform or rubber insulating mat, and use tools with insulated handles.

## 1.6 Engine Exhaust Is Deadly

- Properly working carbon monoxide detectors must be located in all living areas of the boat.
- Never occupy the boat while the generator set is running unless the boat is equipped with properly working marine carbon monoxide detectors.
- The exhaust system must be installed in accordance with the generator set Installation Manual and be free of leaks.
- Prior to every startup and after every eight hours of running, all carbon monoxide detectors must be tested and confirmed to be working in accordance with the manufacture's instructions or owner's manual.
- Make sure the bilge is adequately ventilated with a power exhauster or blower.
- Inspect for exhaust leaks at every startup and after every eight hours of operation.
- For more information about carbon monoxide see American Boat and Yacht Council (ABYC) publication TH-22—*Educational Information About Carbon Monoxide*.

## 1.7 Diesel Fuel is Combustible

- Do not smoke or turn electrical switches on or off where fuel fumes are present or in areas sharing ventilation with fuel tanks or equipment. Keep flames, sparks, pilot lights, arc-producing equipment, and all other sources of ignition well away.
- Fuel lines must be secured, free of leaks, and separated or shielded from electrical wiring.

## 1.8 Battery Gas is Explosive

- Wear splash-proof safety glasses.
- Do not smoke or permit flames or sparks to occur near the battery at any time or anywhere near the generator set.
- To reduce arcing when disconnecting or reconnecting battery cables, always disconnect the negative (–) battery cable first and reconnect it last.

## 1.9 Moving Parts Can Cause Severe Personal Injury Or Death

- Do not wear loose clothing or jewelry near moving parts such as PTO (power take-off) shafts, fans, belts, and pulleys.

- Keep hands away from moving parts.
- Keep protective guards in place over fans, belts, pulleys, and other moving parts.

## 1.10 Flammable Vapor Can Cause a Diesel Engine to Overspeed

### WARNING

*Flammable vapor can cause an engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury, and death. Do not operate a diesel- or gasoline-powered generator set where a flammable vapor environment can be created by fuel spill, leak, etc.*

The owners and operators of the generator set are solely responsible for operating the generator set safely.

## 1.11 Hazards of Carbon Monoxide

### WARNING

*Engine-driven generators can produce harmful levels of carbon monoxide causing nausea, fainting, or death. It is possible to be harmed by this poisonous gas despite good generator set maintenance and proper ventilation.*

### 1.11.1 Carbon Monoxide Poisoning

Carbon Monoxide (CO) is an odorless, colorless, tasteless, and non-irritating gas. You cannot see it or smell it. Exposure, even to low levels of CO, for a prolonged period can lead to asphyxiation (lack of oxygen) resulting in death.

Mild effects of CO poisoning include:

- eye irritation
- dizziness
- sleepiness
- headaches
- fatigue
- inability to think clearly

More extreme symptoms include:

- vomiting
- seizures
- collapse

### 1.11.2 Special Risks of CO on Boats

Depending on air temperature and wind, CO can accumulate between hulls, under an overhanging deck or rear swimming platform, and in and around the boat. A swimmer can be exposed to lethal levels of CO when the generator set is running. Passengers on deck and in the living quarters can also be exposed, especially when the boat is docked, beached, or tied to a neighboring boat.

The risk of exposure to CO can be multiplied greatly by the "station wagon" effect, obstructions that block exhaust dissipation, and infiltration from neighboring boats. To protect against all three situations, it is recommended that reliable and approved marine CO detector alarms be installed on your boat.

- **The Station Wagon Effect:** A boat pushes aside the air through which it is moving, causing a zone of low pressure in the back of the boat and cabins into which exhaust gases can be drawn (see figure below). A breeze across an anchored boat can have the same effect. Opening doors and windows so that air can flow through the boat can reduce the effect.

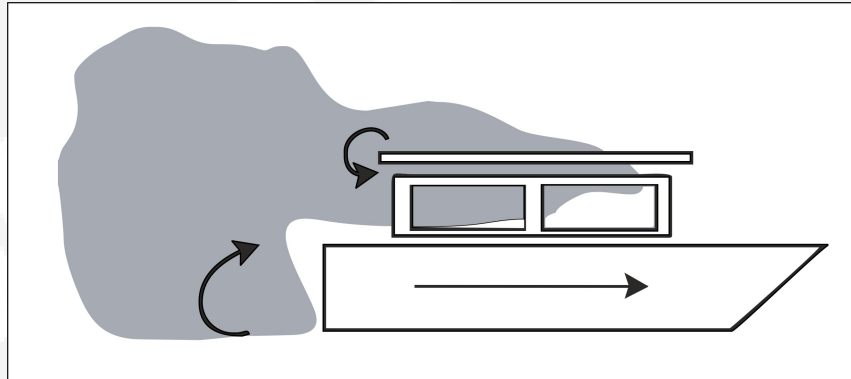


FIGURE 1. STATION WAGON EFFECT

- **Obstructions:** Anchoring near a large object such as a boat house or sea wall, or in a confined space such as a canyon, can cause exhaust gases to accumulate in and around the boat despite good generator set maintenance and proper ventilation. Don't run the generator set when anchored in such places.
- **Exhaust from Neighboring Boats:** When boats are anchored in close quarters, exhaust from neighboring boats can accumulate in and around yours.

### 1.11.3 Protection From CO Poisoning

- Constantly watch for swimmers when the generator set is running.
- Make sure exhaust cannot get under the deck, between hulls, or enter the living quarters through a window, vent, or door.
- Make sure all CO detectors are working properly.
- Pay attention to the signs of CO poisoning.
- Check the exhaust system for corrosion, obstruction, and leaks each time you start the generator set and every eight hours if you run it continuously.

## 1.12 Substances Hazardous to Health

Generator sets use substances, and emit and create wastes, that can cause health risks. Generator set operators must use appropriate personal protective equipment (such as clothing, gloves, protective glasses, goggles, and respiration equipment) when lungs, eyes, or skin are exposed to fuel, oil, coolant, wet batteries, grease, cleaning agents, or other substances. Use appropriate containers for transport, storage, and disposal of waste substances. Follow local regulations for disposal and recycling.

### 1.12.1 Antifreeze (Fleetguard - ES Compleat and EG Premix)

This antifreeze is also known as an ethylene glycol based coolant, summer coolant, coolant additive. It is a purple-colored viscous liquid with a mild chemical odor, is soluble in water, and is harmful under certain conditions. It contains ethylene glycol and diethylene glycol. Ethylene glycol is a potentially hazardous constituent.

The substance has a boiling point of 107 °C (224.6 °F) and a flash point of 121 °C (249.8 °F).

It is used as an engine coolant additive and can be found in engine cooling systems and heat exchangers. Installers, operators, and maintainers are likely to encounter this substance.

#### 1.12.1.1 Hazardous Reactions

Ethylene glycol is combustible when exposed to heat or flame and can react vigorously with oxidants.

- It is a moderate explosive hazard in the form of vapor when exposed to heat or flame. Hazardous products resulting from combustion or decomposition include carbon monoxide, carbon dioxide, and acid smoke. Self-contained breathing apparatus must be worn in the event of fume build up.
- It is incompatible with sulfuric acid, nitric acid, caustics, and aliphatic amines. Avoid any strong oxidizing agents.
- It may cause neurological signs and symptoms, kidney damage, and is a skin and eye irritant.
- It is very toxic in particulate form upon inhalation.
- It is harmful if swallowed. A lethal dose for humans is reported to be 100 ml.

#### 1.12.1.2 Protective Measures

Refrain from eating, drinking, or smoking when using the product. Adopt a high standard of personal hygiene. In case of skin contact, wash immediately with soap and water.

Ensure good ventilation and avoid heat sources. Avoid breathing mist. If there is a risk of vapor or particulate, use a suitable organic vapor mask.

Eye protection, gloves, overalls, and an impervious apron should be worn. Avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly.

#### 1.12.1.3 Storage and Transport

Store and transport only in correctly marked containers. Keep containers closed when not in use. Keep cool, out of sunlight, and away from naked flames and strong acids. Do not freeze. Store well away from food-stuffs and drinking water. Take special care to avoid discharge into drains, sewers, and water-course.

Contain leaks and spills with sand, earth, or non-combustible absorbent material to prevent entry of substance into drains (sewage systems), water-courses, and land. Eliminate all ignition sources. Use a plastic shovel to transfer to a suitable container. Dispose of unwanted or absorbed substance through an authorized contractor to a licensed site.

#### 1.12.1.4 Emergency Action

- Fire - Fire fighters are to use self contained breathing apparatus. Keep fire-exposed containers cool. Prevent run-off from entering waterways, drains, and drinking water supplies. Extinguishing media: CO<sub>2</sub>, alcohol resistant foam, dry powder, or water spray.
- Ingestion - Toxic by ingestion. If swallowed, contact a doctor or poison control center. Induce vomiting only under the advice of a doctor or poison control center. Delayed treatment may result in fatality.
- Inhalation (of vapor) - Remove from further exposure. In case of irritation to lungs or throat, seek medical advice.
- Aspiration (inhalation of liquid) - Obtain immediate medical assistance.
- Eyes - Flush copiously with water or preferably eye-wash solution for at least five minutes. Seek medical advice.
- Skin - Wash thoroughly with soap and water and seek medical attention if irritation develops. Change clothing if necessary and wash clothing before re-use.
- Spillage - Soak up using an absorbent material and dispose of as directed under Storage and Transport.

### 1.12.2 Gas Oil

This product is also known as red diesel, fuel oil, and type A1 or A2. It can be pale red or clear liquid with a characteristic mild odor. It contains catalytically cracked oil, petroleum distillates, quinizarin, and gas oil maker dye red. The catalytically cracked oil and petroleum distillates are potentially hazardous constituents.

The substance has an initial boiling point of 180 °C (345 °F), a flash point greater than 56 °C (132.8 °F), a vapor pressure less than 0.7 mm Hg at 20 °C (68 °F), and has negligible solubility in water.

It is used as a fuel for off-road diesel powered vehicles and stationary engines and can be found in fuel tanks, pipes, and injection systems. The substance should not be used for any other purpose without contacting the manufacturer or supplier. Installers, operators, and maintainers are likely to encounter this substance.

#### 1.12.2.1 Hazardous Reactions

This liquid is flammable. Avoid smoking, heat sources - such as welding and naked flames - sparks, and static electricity build-up. Thermal decomposition products are hazardous, containing CO<sub>x</sub>, NO<sub>x</sub>, and SO<sub>x</sub> compounds.

The vapor is explosive. High vapor concentrations can cause respiratory irritation, dizziness, nausea, and loss of consciousness. Excessive and prolonged exposure to the mist can cause chronic inflammatory reaction of the lungs and a form of pulmonary fibrosis.

Avoid strong oxidizing agents such as chlorates which may be used in agriculture.

Gas oil is slightly irritating to the skin and has a de-fatting action. Toxicity following single exposure to a high level of gas oil is of low importance. Prolonged, repeated skin contact may de-fat the skin resulting in possible skin irritation and dermatitis. In some cases warty, cancerous growths have occurred.

### **1.12.2.2 Protective Measures**

Ensure good ventilation and avoid heat sources. Observance of good housekeeping rules will ensure general safety. Do not smoke. Avoid breathing mist.

When working on or testing injection equipment, special care is required to avoid perforation of skin by high pressure fuel. Use eye protection in the event of suspected high pressure leak.

Adopt a high standard of personal hygiene. In the case of skin contact, wash well with soap and water.

Use gloves, overalls, and eye protection if there is a risk of splashing. Use oil-impervious gloves and avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly. Contaminated clothing should be removed, soaked with water, and laundered before re-use.

No special respiratory precautions are necessary in normal use.

Do not use as a solvent for removing dirt and grease, etc, from skin.

### **1.12.2.3 Storage and Transport**

Store and transport only in correctly marked containers. Keep containers closed when not in use. Keep cool, out of sunlight, and away from naked flames. Electrical continuity is required between the transport and storage vessels during product transfer.

Contain leak or spill with sand, earth, or other suitable material, and prevent entry of substance into drainage (sewage system), water-courses, and land. Dispose of unwanted or absorbed substance through an authorized contractor to a licensed site.

Inform fire and local authorities should the product reach waterways, drains, etc.



### 1.12.2.4 Emergency Action

- Fire - Avoid making sparks. Fire fighters are to use self-contained breathing apparatus. Keep fire-exposed containers cool, using water fog or spray. Prevent run-off from entering waterways, drains, and drinking water supplies.
  - Extinguishing media for large fire: Foam or water fog. Never use water jet.
  - Extinguishing media for small fire: Foam or dry powder, AAF, CO<sub>2</sub>, sand, earth.
- Ingestion - Do not induce vomiting. Wash mouth out with water and send to hospital immediately.
- Inhalation (of vapor) - Remove from further exposure. Obtain medical assistance immediately.
- Aspiration (inhalation of liquid) - If, following ingestion of gas oil, vomiting occurs, there is danger of aspiration into the lungs. This would cause intense local irritation and chemical pneumonitis that can be fatal. Obtain immediate medical assistance.
- Eyes - Irrigate copiously with water or preferably eye-wash solution for at least five minutes. If irritation persists seek medical advice.
- Skin - Wash thoroughly with soap and water. Change clothing if necessary. If high pressure injection has occurred prompt surgical attention is required.
- Spillage - Absorb using sand, earth, or other suitable material. Dispose of unwanted or absorbed flammable material as directed under Storage and Transport.

### 1.12.3 Lubricant Oil - Premium Blue E 15W40

Also known as oil, lube oil, sump oil. New oil is a dark, viscous liquid with a slight characteristic odor. The base oil contains distillates (petroleum) and solvent-dewaxed heavy paraffinic. It is not classified as dangerous according to Directive 1999/45/EC and its amendments, and is not classified according to the EU regulations.

It has a boiling point greater than 150° C (302 °F), and a flash point Open Cup of 220° C (438 °F) (Cleveland) and is insoluble in cold water.

It is used in engine lubricant oil systems, sump pan and filters, make-up tanks, and piping systems as a lubrication oil for use in a wide range of diesel engines operating under severe conditions. Installers, operators, and maintainers are likely to encounter this product.

#### 1.12.3.1 Hazardous Reactions

This product is stable, although slightly re-active, with oxidizing agents. Results of decomposition are carbon oxides (CO, CO<sub>2</sub>) and water.

Although harmful if ingested (swallowed) or aspirated (breathed in), repeated or prolonged exposure is not known to aggravate medical conditions.

Used oil may contain harmful combustion by-products and un-burnt fuel that will cause skin reactions as detailed for fuel. Particular care must be taken if oil from a severely overheated engine is handled. Use impervious gloves, lab coat, and safety glasses. Do not breathe vapor or spray.

#### 1.12.3.2 Protective Measures

Ensure good ventilation and avoid heat sources.

Adopt a high standard of personal hygiene. In case of skin contact, wash thoroughly with soap and water.

Use safety glasses, impervious gloves, and lab coat. Avoid contamination inside the gloves. If overalls become contaminated, discontinue use and clean thoroughly.

No special respiratory precautions are necessary in normal use. Do not breathe vapor or spray when handling hot materials.

### 1.12.3.3 Storage and Transport

Store and transport only in correctly marked containers. Keep containers tightly sealed when not in use. Keep in cool, well ventilated area, out of sunlight and away from naked flames. Store well away from food-stuffs and drinking water.



Wear splash goggles, full suit, boots, and gloves. Absorb leaks or spills with an inert material and dispose of unwanted or absorbed substance through an authorized contractor to a licensed site. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.



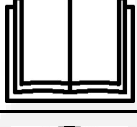






### 1.12.3.4 Emergency Action

- Fire - Fire-fighters are to use self contained breathing apparatus and full turnout gear. Keep fire-exposed containers cool.
  - Extinguishing media for large fire: Use water spray, fog or foam. Do not use water jet.
  - Extinguishing media for small fire: Use dry chemical powder or CO<sub>2</sub>.
- Ingestion - Do not induce vomiting. Obtain medical advice immediately.
- Inhalation (of vapor) - Remove from further exposure. Obtain medical attention.
- Aspiration (inhalation of liquid) - Obtain immediate medical assistance.
- Eyes - Flush copiously with water or preferably eye-wash solution for at least fifteen minutes. Obtain medical advice.
- Skin - Wash thoroughly with soap and water. Obtain medical advice if irritation develops. Change clothing if necessary and wash before re-use.
- Spillage - Absorb with an inert material and dispose of as directed under Storage and Transport.

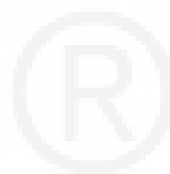
### 1.12.4 Generator Set Warning Labels

Warning signs are provided on the generator set at or near the point of risk. To avoid injury, always take the necessary precautions as indicated on the sample signs shown below.

	Caution or Warning. Indicates a risk of personal injury.
	Caution or Warning of Temperature Hazard. Indicates a risk of personal injury from high temperature.

	Caution or Warning of High Voltage Hazard. Indicates a risk of personal injury from electric shock or electrocution.
	Caution or Warning of Engine Coolant Pressure Hazard. Indicates a risk of personal injury from hot pressurized engine coolant.
	Caution or Warning. Indicates to read Operator Manual for additional information.
	Caution or Warning of No Step. Indicates a risk of personal injury or equipment damage from stepping on equipment.
	Caution or Warning of Combustion or Explosion Hazard. Indicates a risk of personal injury from explosion.
	Caution or Warning of Belt and Rotating Part Hazard. Indicates a risk of personal injury from entanglement in moving parts.
	Caution or Warning of Chemical (ingestion or burn) Hazard. Indicates a risk of personal injury or asphyxiation from poisonous fumes or toxic gases.
	Caution or Warning of High Voltage or Current Source Hazard. Indicates a risk of personal injury from electrical shock or electrocution.
	Caution or Warning of Fan and Rotating Part Hazard. Indicates a risk of personal injury from entanglement in moving parts.

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## 2 Introduction

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### WARNING

***Improperly connected generator electrical output connections can cause equipment damage, severe personal injury or death and therefore must be made by a trained and experienced electrician in accordance with the installation instructions and all applicable codes.***

### WARNING

***Improper installations can cause equipment damage, severe personal injury or death and therefore all installations must be conducted by a trained and experienced person in accordance with the installation instructions and all applicable codes.***

## 2.1 About this Manual

This manual is a guide for the installation of the generator set or sets listed on the front cover. Proper installation is essential for top performance. Read through this manual before starting the installation.

This manual addresses the following aspects of the installation:

- location and mounting
- accessibility for operation and maintenance
- selection of ignition protected devices for areas where gasoline vapors can accumulate (ignition protection is not included on all generator sets).
- generator set compartment ventilation
- fuel connections
- engine cooling
- engine exhaust discharge and silencing
- preventing the migration of exhaust gases and fuel vapors into the living quarters
- electrical connections
- bonding for grounding
- batteries
- noise and vibration

See the generator set Operator Manual for operation and maintenance information and the Service Manual for service information.

The information contained within the manual is based on information available at the time of going to print. In line with Cummins Power Generation policy of continuous development and improvement, information may change at any time without notice. The users should therefore make sure that before commencing any work, they have the latest information available. The latest version of this manual is available on QuickServe Online (<https://qsol.cummins.com/info/index.html>).

## 2.2 Related Literature

Before any attempt is made to operate the generator set, the operator should take time to read all of the manuals supplied with the generator set, and to familiarize themselves with the warnings and operating procedures.

### CAUTION

***A generator set must be operated and maintained properly if you are to expect safe and reliable operation. The Operator manual includes a maintenance schedule and a troubleshooting guide. The Health and Safety manual must be read in conjunction with this manual for the safe operation of the generator set:***

- Health and Safety Manual (0908-0110)

The relevant manuals appropriate to your generator set are also available, the documents below are in English:

- Operator Manual (0981-0180)
- Installation Manual (0981-0647)
- Service Manual (0981-0542)
- Parts Manual (0981-0282)
- Engine Service Manual (0981-0550)
- Specification and Data Sheet (A1475)
- Standard Repair Times - AW Family (0900-0620)
- Warranty Manual (F1117-0005)
- Global Commercial Warranty Statement (A028U870)

## 2.3 Standards for Safety

### WARNING

***This generator set is not a life support system. It can stop without warning. Children, persons with physical or mental limitations, and pets could suffer personal injury or death. A personal attendant, redundant power, or alarm system must be used if generator set operation is critical.***

### WARNING

***This generator set is not be the main source of power for communication and steering systems. It can stop without warning.***

You must find out which standards for safety are applicable. Compliance with United States Coast Guard (USCG) regulations is mandatory for boats in U.S. waters. The American Boat and Yacht Council (ABYC) and the National Fire Protection Association (NFPA) are typical of U.S. agencies that publish safety standards for the construction and installation of marine equipment. It is suggested that you obtain the following standards:

- USCG regulations are under Titles 33 and 46 of the *Code of Federal Regulations* (CFR),  
U.S. Government Printing Office

Washington, D.C. 20404.

- NFPA No. 302, *Pleasure and Commercial Motor Craft*,  
National Fire Protection Association  
Batterymarch Park  
Quincy, MA 02269
- *Standards and Recommended Practices For Small Craft*,  
American Boat and Yacht Council, Inc.  
613 Third Street, Suite 10  
Annapolis, MD 21403

Particular attention should be paid to ABYC P-1, *Installation of Exhaust Systems for Propulsion and Auxiliary Machinery*; ABYC E-11, *AC and DC Electrical Systems on Boats*; and ABYC A-27, *Alternating Current (AC) Generator Sets*.

### 2.3.1 Ignition Protection

The generator set is suitable for installation in accordance with USCG Pleasure Craft Regulations and ISO Small Craft Standards.

## 2.4 Outline Drawings

See the applicable outline drawing in [Appendix B on page 61](#) to check for installation details such as:

- mounting bolt hole locations
- connection points (fuel, battery, raw water, exhaust, remote control, AC output)
- sizes and types of fittings
- overall dimensions

See your Cummins Onan Distributor for large-scale copies of the applicable drawings.

#### **WARNING**

***Improper installation can result in severe personal injury, death, and equipment damage. The installer must be qualified to perform installation of electrical and mechanical equipment....***

## 2.5 Noise

Generator sets emit noise. As noise level and time of exposure increase, risk of hearing damage increases. [Chapter 9 on page 51](#) includes specific noise level information for these generator sets. Use personal hearing protection appropriate for your exposure to generator set noise.

When used in countries where compliance to the EU Noise directive is required: This generator set has not been evaluated and is not marked for use in open air. Install the generator set in accordance with the Installation Manual. Obey local noise restrictions when you operate the generator set.

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## 2.6 Electromagnetic Compatibility Compliance

Generator sets emit and receive electromagnetic (radio frequency) energy. If the generator set affects operation of nearby devices, or nearby devices affect generator set operation, increase the distance between them.

When used in countries where compliance to the EMC directive is required: This generator set has been evaluated for use in the residential, commercial, and light industrial environments.



## 3 Location and Mounting

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### 3.1 Installation Location Considerations

The generator compartment should be located as far from living quarters as practical because of noise, vibration, and fumes. The housing on some models is for reducing noise, not for protection against weather or water. Because of this, be sure to locate the generator set where it will be protected from weather and splashing or dripping water.

Make sure there is access for the following (when applicable):

- starting and stopping the generator set
- resetting the line circuit breakers, if applicable
- checking, filling, and draining engine oil
- changing the engine oil filter
- checking, filling, and draining engine coolant
- replacing coolant and exhaust hoses
- replacing the raw water pump impeller, if applicable
- replacing the V-belt
- changing the fuel filter or filters
- making fuel connections
- making battery and ground connections
- making AC connections
- making remote control connections
- inspecting the drive belt system and generator bearing
- changing engine air filter
- servicing heat exchanger

Locate the generator set where there will be enough room to perform periodic maintenance and service.

#### 3.1.1 Ignition Protection

This generator set is ignition protected. It is permitted under USCG regulation 33CFR183 to be located in a gasoline fuel environment.

All electrical devices such as switches, circuit breakers, meters, and control panels used in areas where gasoline vapors can accumulate must be ignition protected.

### 3.2 Installation Specifications

Locate the generator set where there will be enough room to perform periodic maintenance and service.

- The back should have at least 51 mm (2 inches) of clearance.

- The left side and front should have at least 25 mm (1 inch) of clearance for air flow.
- The top must have at least 51 mm (2 inches) of clearance to unlatch the access door.
- The right side must have enough clearance to remove the side panel for adjusting the V-belt, replacing the pump impeller and servicing the heat exchanger. See [Appendix B on page 61](#).

### 3.3 Lifting the Generator Set

The generator set has one (or two) lifting eyes on the top of the set, accessible by removing the top access cover or covers of those sets with an enclosure. See [Chapter 9 on page 51](#) for the weight of the generator set and make provisions accordingly for safe handling.

- Use both lifting eyes, if so equipped.
- Use proper equipment for safe handling.

Save the steel clamps that secured the generator set to the shipping skid if they are to be used for securing the generator set to the floor or frame of the vehicle.

See [Section 3.4 on page 20](#).

#### WARNING

***Installation of the generator set requires lifting apparatus. Make sure that correctly rated lifting slings with suitable attachments are available prior to commencing work. Lifting and lowering operations should only be carried out by properly trained personnel. Do not exceed the rating of any lifting component. Wear head, eye, hand, and foot protection during lifting operations.***

### 3.4 Mounting The Generator Set

The generator set has integral vibration isolators. The supporting structure underneath should be level and able to support the weight of the generator set. The floor must extend under the whole base pan for support. Floor or frame stiffness should be greatest under the vibration isolators. The generator set must be secured to the floor.

See the appropriate outline drawing in [Appendix B on page 61](#) to locate the mounting bolt holes. To reduce noise, plug the unused clamp openings in the drip pan with the four rubber plugs shipped in the literature packet.

Secondary vibration isolators may be available from Cummins Onan as a kit for an increased degree of vibration isolation. The four isolators are secured under the generator set at each mounting bolt hole. Install them in accordance with the instructions in the kit.

## 4 Mechanical Connections

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.

### 4.1 Ventilation

#### 4.1.1 Ventilation of Exhaust System

##### WARNING

***Exhaust gas is deadly. Fuel vapors are explosive. Failure to provide proper ventilation can result in asphyxiation, fire, and explosion. The ventilation system must meet applicable standards and regulations, including USCG, NFPA, and ABYC.***

Ventilation is required to prevent dangerous concentrations of fuel vapors and exhaust fumes, to hold down compartment temperatures, and to provide combustion air. The highest compartment temperatures can occur just after the boat has been docked and the engines have been shut down. See [Section 2.3 on page 16](#) for additional information.

To promote convection, good air exchange, fresh air for combustion and cooling, and ensure proper engine cooling:

- Ventilating air should enter the air inlet at the front of the compartment near the bottom and exit the air outlet at the rear of the compartment near the top.
- For engine room air flow and ventilation design reference the specification table [Chapter 9 on page 51](#) to find combustion airflow and heat radiated to ambient. For best performance, the engine room temperature should be maintained at 40 °C (104 °F) or less.
- Do not use flush air inlets or louvered transom outlets, which are easily blocked.
- Make sure that the flow of cooling and ventilating air does not recirculate back into the generator set causing further heating of the generator set.
- The main rotor and stator of the generator is air cooled. Measure cooling air temperature at the generator set air inlet. Inlet air temperature should not exceed 50 °C (122 °F) when the generator set is running under full load. The inlet air temperature at the generator set may exceed 50 °C (122 °F) briefly after the main engines have been shut down.

Operating a generator set in ambient temperatures above 40 °C (104 °F) will result in noticeable loss of power. Operating a generator set in ambient temperatures higher than 50 °C (122 °F) will reduce the life of electrical components, generator windings, rubber, and other construction materials.

#### 4.1.2 Carbon Monoxide (CO)

All openings and feed-through holes for wiring, conduit, pipe, and hose must be sealed to prevent exhaust gases from entering the rest of the boat. Wiring conduit must be sealed inside as well as outside.

Cabin plumbing drains must have approved traps to prevent the entrance of exhaust gases from outside.

Carbon monoxide (CO) detector-alarms, listed for marine applications, must be installed in the living quarters of the boat. Wind shifts, boat motion, exhaust from other boats at dockside, and other conditions can cause exposure to harmful concentrations of carbon monoxide even when proper ventilation is provided and living quarters are sealed off from engine rooms.

## 4.2 Fuel

### 4.2.1 Fuel and Tanks

See [Chapter 9 on page 51](#) for fuel recommendations, see the Operator Manual for additional information on fuel types, and see [Section 2.3 on page 16](#) for more information on safety regulations.

#### WARNING

***Diesel fuel is combustible and can cause severe personal injury or death. Do not smoke near fuel tanks or fuel-burning equipment or in areas sharing ventilation with such equipment. Keep flames, sparks, pilot flames, electrical arcs and switches, and all other sources of ignition well away. Keep a multiclass fire extinguisher handy.***

#### WARNING

***Improper storage and handling of diesel fuel can lead to fire. Fuel tank construction, location, installation, bonding for grounding, ventilation, piping inspection, and lead testing must be in accordance with applicable standards and regulations, including USCG, NFPA, and ABYC.***

#### CAUTION

***Do not use galvanized fuel tanks or piping. The trace of sulfur in diesel fuel attacks galvanized (zinc) coatings causing debris that can clog fuel filters, pumps, and injectors.***

### 4.2.2 Fuel Filters

It is recommended that a 10 to 30 micron water-separator fuel filter be installed in the fuel supply system to protect the fuel lift pump.

The generator set may be equipped with a secondary fuel filter, used in conjunction with an auxiliary fuel lift pump. A 50 to 75 micron filter should be installed in the supply line to protect this pump.

### 4.2.3 Fuel Fittings

Two 1/4-18 NPTF fittings may have been provided for fuel supply and return connections, or a barbed fuel inlet fitting may be mounted on the right side of the drip pan, for use with a 1/8 inch I.D. fuel fitting. See the appropriate outline drawing in [Appendix B on page 61](#) for specific locations, if applicable. Fuel hose adapter fittings are available from Cummins Onan.

## 4.2.4 Fuel Hoses

### WARNING

***Fire can result when fuel lines carry cranking current. Use non-conductive fuel hoses for connections at the generator set to prevent the fuel lines from becoming paths for cranking current.***

Use USCG TYPE A1 or ISO 7840-A1 fuel hoses. See Fuel Line Sizing in this section for recommended sizing.

The fuel hoses connected at the generator set must be non-conductive so that the fuel lines do not become paths for cranking current. (Because the fuel tanks are required to be bonded to the common negative [-] grounding system of the boat, conductive fuel lines connected directly to the generator set will carry cranking currents.)

Flexible fuel hoses must be used for connections at the generator set because of the movement allowed by the vibration isolators.

The fuel hoses connected at the generator set can be routed through holes in the sides and bottom of the base. Use the rubber grommets provided to protect the hoses from chafing and seal noise inside when an enclosure is provided. Make sure all of the unused hose and cable entrance and exit holes around the base are capped or sealed.

## 4.2.5 Fuel Line Sizing

Fuel line size should be chosen such that the total restriction of the fuel lines, fuel fittings, fuel filters, and vertical lift do not create restriction in excess of that listed in the specifications table ([Chapter 9 on page 51](#)) for your generator model.

When appropriate, an inside diameter of 8 mm (5/16 inch) is recommended for fuel lines and hoses, and no larger than 9 mm (3/8 inch). An inside diameter of 7 mm (1/4 inch) should be considered in applications where fuel lines are short and lift is minimal (see the Fuel Lift section below). Larger diameter fuel lines are harder to prime and keep primed and are more likely to cause disruption of generator set service.

Run fuel lines as directly as possible avoiding dips and crests that trap air and cause hard priming.

## 4.2.6 Fuel Pickup Tube

A separate fuel pickup tube and supply line is recommended for the generator set. Shared pickup tubes and distribution manifolds can lead to fuel starvation and difficult priming.

See Fuel Line Sizing in this section for recommended sizing.

In a common fuel supply tank the generator set pickup tubes should be shorter than the propulsion engine pickup tubes to prevent the generator sets from being able to empty the fuel tanks.

Make sure the fuel tanks are large enough to cool the returning fuel and that the supply and return pickup tubes are separated by at least 254 mm (10 inches) to reduce the recirculation of hot fuel.

## 4.2.7 Fuel Shutoff Valves

A fuel shutoff valve is required at the fuel tank if the end of the fuel line is located below the highest level of fuel in the tank in order to prevent accidental discharge of fuel.

An approved method is required to prevent flow when the engine is not running if the highest level of fuel in the supply tank is above the fuel injectors.

## 4.2.8 Fuel Lift

The fuel lift pump on the generator set has a maximum inlet restriction. Restriction values are listed in the specifications table [Chapter 9 on page 51](#). Note that the pump must overcome the resistance to fuel flow in hoses, tubing, fittings, valves, and filters as well as actual lift in elevation.

## 4.3 Cooling

### 4.3.1 Cooling System Overview

The engine is cooled by a pressurized closed-loop liquid cooling system in which coolant is pumped through passages in the engine block, head, and exhaust manifold. Heat is carried away from the coolant by a keel cooler or raw water (sea water, flotation water) heat exchanger. A raw water pump is provided if the generator set has a heat exchanger or keel cooler with wet exhaust. See the appropriate outline drawing in [Appendix B on page 61](#) for connection points and fitting sizes.

The heat exchanger may be mounted inside the exhaust manifold, which also serves as the engine coolant reservoir. Raw water is pumped through tubes in the heat exchanger to cool the engine coolant and then is passed through a hose into the exhaust-water mixer to cool the exhaust gases. The raw water is expelled from the boat along with the exhaust gases.

### 4.3.2 Raw Water Pump

The raw water pump can deliver the required flow of cooling water against a maximum inlet restriction measured at the raw water inlet connection point to the generator set. See [Chapter 9 on page 51](#) for maximum raw water inlet restriction values.

Lift is a combination of the actual vertical lift and the resistance to flow caused by the hoses, strainer, sea cock, and through-hull fitting.

The pump impeller must be wetted with water to establish initial pump lubrication and suction. See the generator set Operator Manual.

### 4.3.3 Raw Water Hose

Use SAE 20R4, 20R3 or equivalent hose that is able to resist a vacuum of 30 kPa (4.35 psi) without collapsing. The fitting for the raw water inlet connection varies by model. See the outline drawing in ([Appendix B on page 61](#)) for hose ID requirements. All of the hoses, pipes, and fittings in the raw water pickup line should have the same internal diameter as the hose connected to the generator set raw water inlet. When an enclosure is installed route the raw water hoses through the holes provided and use grommets to protect the hose from chafing and to seal noise inside.

### 4.3.4 Raw Water Strainer

The raw water (sea water or flotation water) strainer should be located below and as close to the raw water pump as practical. The basket must be removable for cleaning. The strainer should not allow debris larger than 4.5 mm (3/16 inch) to enter the cooling system. If the raw water strainer is above the water line, fill it for faster priming at startup.

### 4.3.5 Sea Cock

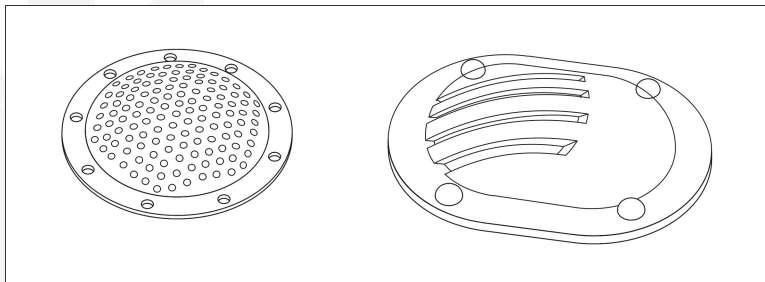
Install a bronze, full-flow sea cock on the through-hull fitting.

### 4.3.6 Through-Hull Fitting and Strainer

The through-hull fitting should be as close to the generator set as possible. If the strainer has slotted openings, the slots must be parallel to the keel for best flow when the boat is under way. Through-hull fittings should be staggered along the keel so that downstream fittings are not starved.

#### **⚠ CAUTION**

***Do not use a scoop-type through-hull fitting. A forward-facing scoop can develop enough ram pressure to flood the engine. A rear-facing scoop can develop enough suction to impede flow.***



**FIGURE 2. RAW WATER STRAINER**

### 4.3.7 Coolant Recovery Tank

#### **⚠ CAUTION**

***Running the engine without coolant can cause damage not covered by warranty.***

The coolant recovery tank kit shipped with the generator set must be installed for proper operation of the cooling system. Follow the instructions in the kit.

The tank must be accessible for daily inspection and refilling. The generator set enclosure (if provided) has holes for mounting the tank on either end. For generator sets not provided with an enclosure, mount the tank on a bulkhead within reach of the hoses and slightly above or at the same height as the pressure cap. Make sure the overflow hose terminates in the drip pan where it will not splash coolant on electrical components. Fill the tank in accordance with the Operator Manual.



**Initial Coolant Fill** - The generator set is normally shipped from the factory with coolant, unless prohibited by shipping regulations. Fill the system, if necessary, in accordance with the Operator Manual.

**NOTICE**

**Keel-cooled generator sets are only partially filled with coolant. Coolant must be added to fill the keel cooler and expansion tank.**

### 4.3.8 Siphon Break

Conduct the following Raw Water Pickup Test to determine whether a siphon break is required to prevent the muffler and engine from being flooded with raw water (sea water or flotation water). The top or end panel of an enclosed generator set has knockouts for the hoses to pass through. The hoses in the kit replace the hose between the engine heat exchanger and exhaust-water mixer. A siphon break kit is available from Cummins Onan. It may be found in the Accessories Catalog (F1379).

To prevent dripping or spray from the siphon break do not mount the siphon break directly above the generator set. If space is available locate the siphon break at least 12 inches away from the generator set or any other equipment in the engine room that should not get wet.

**⚠ CAUTION**

***Engine damage due to flooding as a result of failing to install a required siphon break is not covered by warranty.***

#### 4.3.8.1 Raw Water Pickup Test

**Objective:** To determine the elevation of the water line relative to the generator set under all anticipated uses and speeds of the boat.

**Method:** Conduct this test during sea trials in conjunction with [Section 4.4.1.7 on page 30](#). When the boat is ready for its sea trials and loaded to its maximum rated capacity:

1. Close the sea cock and disconnect the raw water pickup hose from the generator set. Alternatively, connect a clear plastic hose to the strainer or sea cock.
2. Raise the end of the hose above expected water level and open the sea cock. The water line is at the level visible in the clear plastic hose or where water just begins to spill as the end of the hose is lowered. While the boat is still docked, mark the level on the generator set or enclosure.
3. Operate the boat through its speed range in forward and reverse speeds. While the boat is operating, have someone monitor the water level in the hose and mark the highest level on the generator set.

**Requirement:** A siphon break must be installed if the siphon point is not at least 152 mm (6 inches) above the highest marked water line (docked or moving).

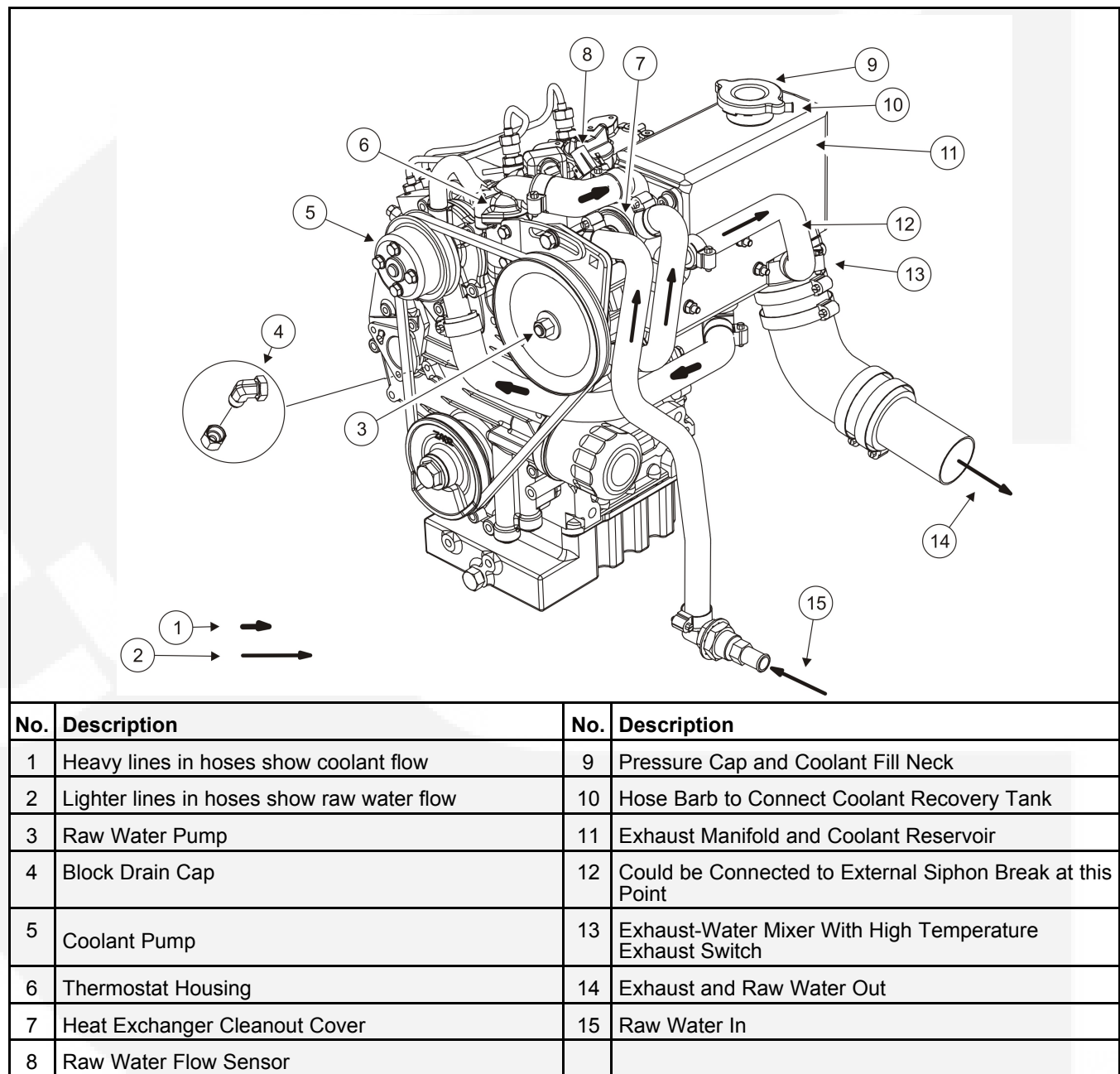


**NOTICE**

If the water line when the boat is moving is much higher than when the boat is docked, the difference could be due to the through-hull fitting or its location. If the through-hull fitting is of the forward-facing scoop-type designed to create ram pressure, replace it with a flush fitting. Another possibility might be to move the fitting to a location where the dynamic hull pressure is less.

### 4.3.9 Cooling System Illustration(s)

#### 4.3.9.1 Cooling System



**FIGURE 3. COOLING SYSTEM**

## 4.4 Exhaust

### 4.4.1 Wet Exhaust Systems

#### WARNING

***Exhaust gas is deadly. The exhaust system must be leak-free and convey all exhaust outside, away from windows, doors, and vents.***

See [Section 4.4.2 on page 31](#) for illustration showing typical installation of a wet exhaust system. See [Section 4.3 on page 24](#) regarding raw water connections. The installation must comply with applicable standards and regulations, including those of the USCG and ABYC.

A separate engine exhaust system must be installed for each generator set. It must be isolated from all other engine exhaust systems. Do not "T" into any other engine exhaust system. Run the exhaust piping all the way to the hull and terminate it flush with or extended slightly from the outside of the hull.

Mufflers, water separators, and siphon breaks are available as kits.

#### 4.4.1.1 Hose and Hose Fittings

No hose or hose fitting in the exhaust system may have a smaller inside diameter than the engine outlet. If the total run of exhaust hose is more than 6 meters (20 feet), measure exhaust back pressure and use larger diameter hose if back pressure exceeds specifications. See [Chapter 9 on page 51](#).

#### 4.4.1.2 Exhaust Hose

Use hose that has been approved for wet exhaust systems. Approved hose and stainless steel elbows are available from Cummins Onan. Horizontal runs of hose must slope down at least 42 mm per meter (1/2 inch per foot) and be supported such that there are no sags. The entire run of hose must be accessible for regular visual inspections and replacement.

#### 4.4.1.3 Hose Clamps

Use two stainless steel hose clamps at least 12.7 mm (1/2 inch) wide to clamp each end of each hose.

#### 4.4.1.4 Muffler

Install an approved muffler as close as practical to the engine. For optimum silencing, the length of hose between the engine and muffler should not exceed 2 meters (6 feet). The muffler inlet should be a minimum of 305 mm (1 foot) below the exhaust-water mixer and the outlet should be vertical to a water separator or elbow that turns down sharply.

When installing a water separator or fabricating a knee, the base of the muffler should not be more than 1.4 meter (54 inches) below the water separator or 1.2 meter (48 inches) below the knee in the piping (see [Section 4.4.2 on page 31](#)).

Mount the muffler such that air can circulate underneath to prevent condensation and mold. On unhoused generator sets provide at least 12 inches of free exhaust hose to absorb vibration.

### 4.4.1.5 Exhaust Water Separator

When an exhaust water separator is used the muffler outlet and water separator inlet diameters must be the same size. (See [Section 4.4.2 on page 31](#)). The water separator should be installed directly above the muffler to maintain a vertical lift. The through-hull fitting for the drain hose should be below the load water line, but not more than 152 mm (6 inches), and must have a sea cock. An Exhaust Water Separator Backflow Test (see [Section 4.4.1.7 on page 30](#)) must be conducted during the sea trials to determine that there is no backflow that could flood the engine.

### 4.4.1.6 Exhaust Through-Hull Fitting

The exhaust through-hull fitting must be above the load water line under all anticipated uses and speeds of the boat. To reduce wave wash-in when a water separator is used the top of the water separator must be at least 450 mm (18 inches) above the load water line. When an elbow is used at the top of the muffler outlet hose, the elbow must be at least 305 mm (12 inches) above the through-hull fitting. See [Section 4.4.2 on page 31](#).

#### CAUTION

*Backflow can cause major engine damage if the cylinders become flooded. The sea trials must verify that there is no backflow through either the exhaust hull fitting or the water separator drain hose fitting.*

### 4.4.1.7 Exhaust Water Separator Backflow Test

**Objective:** To determine that there is no backflow through the exhaust water separator under any operating conditions. See [Section 4.4.2 on page 31](#) for a sample drawing of the exhaust water separator system.

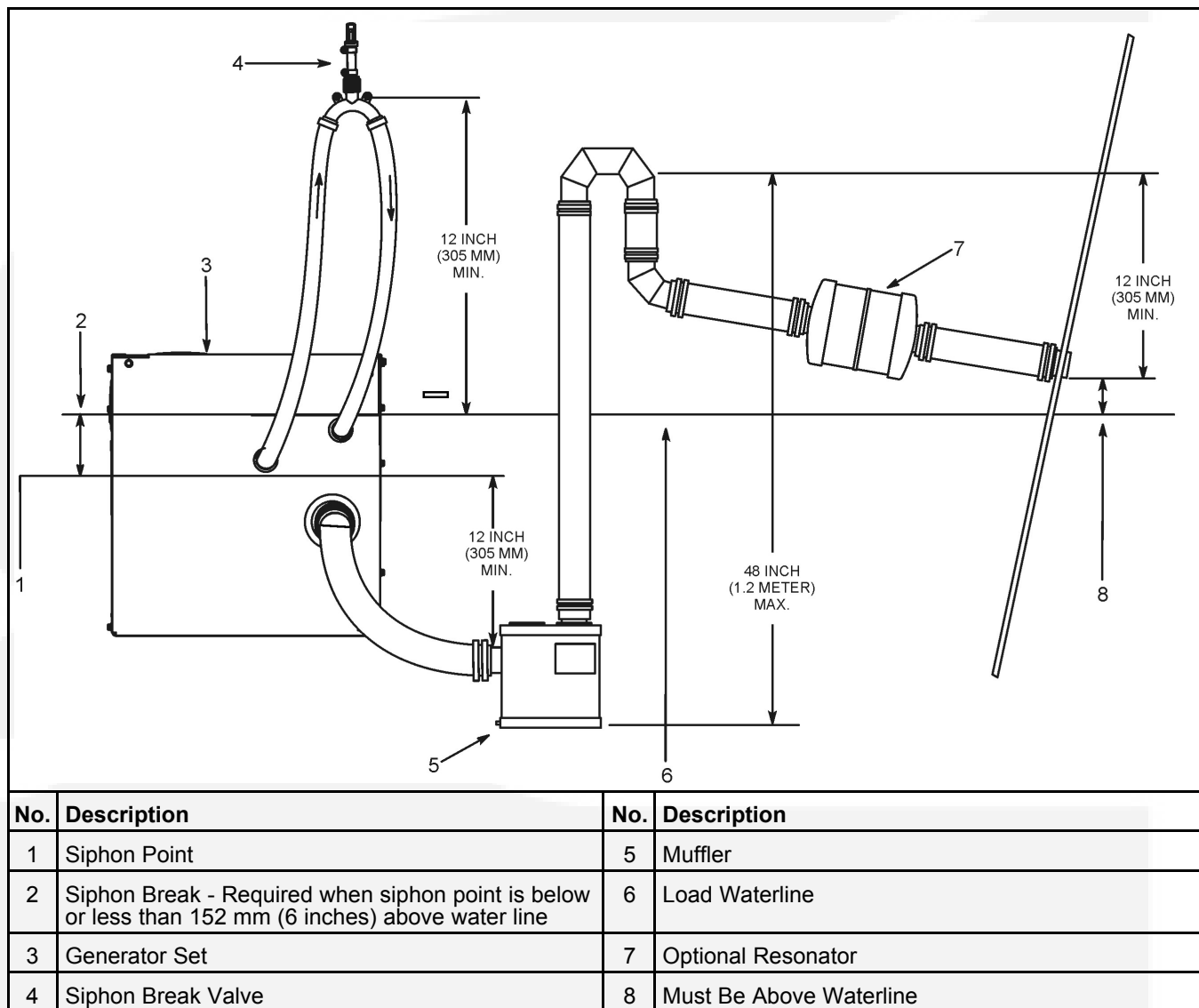
**Method:** Conduct this test during the sea trials in conjunction with the Raw Water Pickup Test found in the previous chapter. When the boat is ready for its sea trials and loaded to its maximum rated capacity:

1. Prepare by closing the drain hose sea cock and disconnecting the hose from the water separator.
2. Conduct the test by opening the sea cock while keeping the hose raised to its fitting on the water separator.

**Requirement:** There must not be any backflow while operating the boat throughout its speed range. If there is, relocate the through-hull fitting.

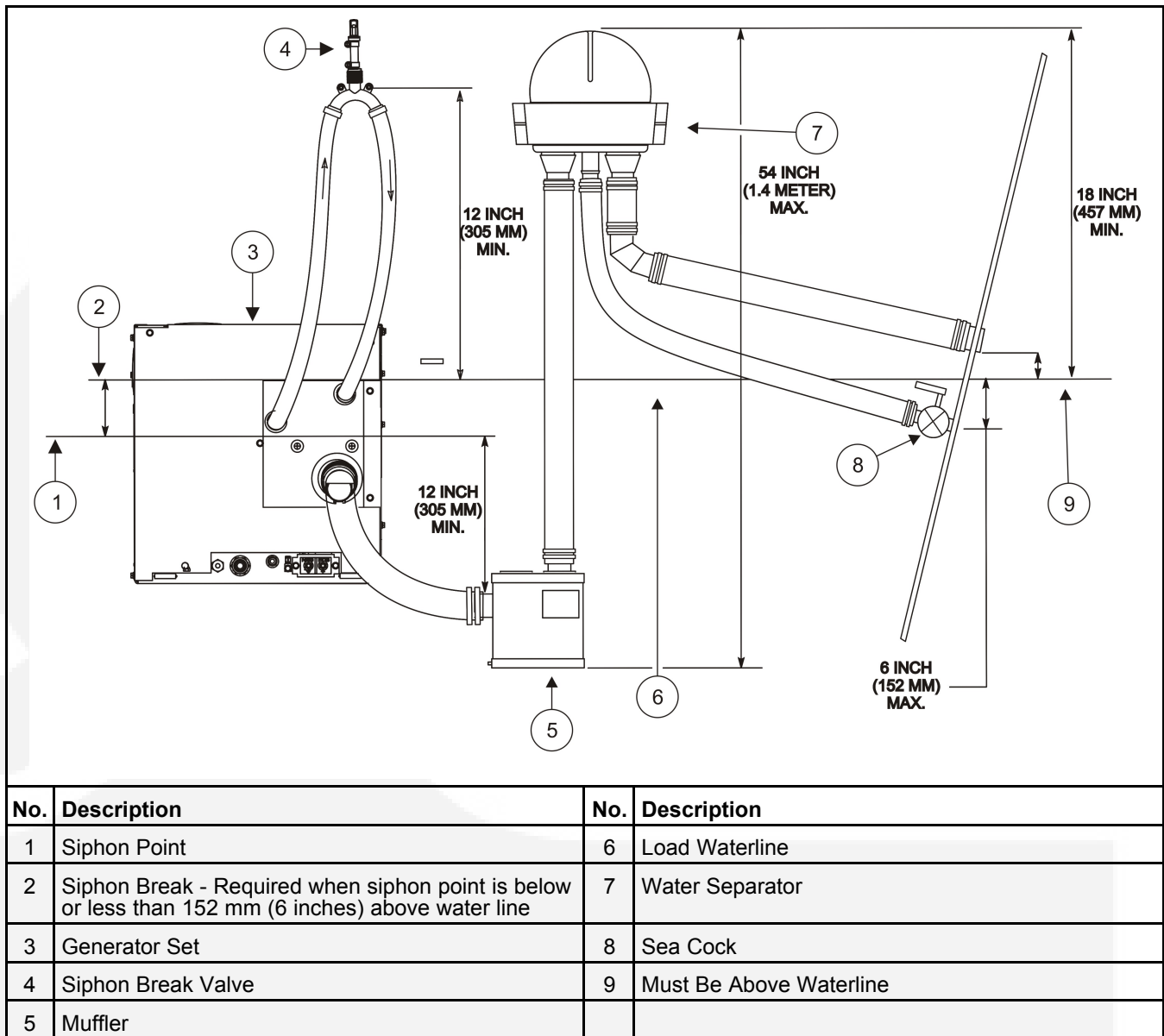
## 4.4.2 Exhaust System Illustration

### 4.4.2.1 Wet Exhaust System with Resonator



**FIGURE 4. TYPICAL WET EXHAUST SYSTEM WITH RESONATOR**

### 4.4.2.2 Wet Exhaust System with Water Separator



**FIGURE 5. TYPICAL WET EXHAUST SYSTEM WITH WATER SEPARATOR**

# 5 Electrical Connections

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## 5.1 AC Connections

### WARNING

***Hazardous Voltage! Touching uninsulated live parts inside the generator set and connected equipment can result in severe personal injury or death. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands, and use tools with insulated handles. Secure protective covers when completing installation.***

### WARNING

***Improper wiring can cause fire or electric shock resulting in severe personal injury or death. Only trained and experienced service personnel with knowledge of fuels, electricity, and machinery hazards should perform installation procedures. Review the Safety Precautions section of this manual.***

### WARNING

***Accidental or remote starting of the generator set can cause severe personal injury or death. To prevent unintended starting, do not connect the starting battery until it is time to start the generator set.***

### 5.1.1 Wiring Methods

All wiring methods, connections, wire current capacity, equipment grounding, and materials must be inspected and comply with applicable regulations. Use flexible conduit and stranded conductors for AC output connections to take up movement and vibration.

The AC output cables can be routed through holes in the sides and bottom of the base. Use the rubber grommets provided to protect the cables from chafing and seal noise inside when an enclosure is provided. Make sure all of the unused hose and cable entrance and exit holes around the base are capped or sealed. Wiring conduit must be sealed inside as well as outside.

### WARNING

***Carbon monoxide is deadly. All feed-through holes in decks and bulkheads for wiring must be sealed to prevent carbon monoxide (CO) and flammable vapors from entering the living spaces of the boat.***

### 5.1.2 Generator (Alternator) Connections

Make generator AC output connections or reconnections as required in the AC output box in accordance with the appropriate generator connection diagram [Appendix A on page 55](#). See [Appendix B on page 61](#) for connection locations, and knockout sizes and locations.

If voltage reconnections are made, the circuit breakers may need to be replaced to obtain the required protection or full generator set power. Voltage may need to be readjusted also. See [Chapter 7 on page 47](#).

### 5.1.3 Grounding

The generator set, power supply wiring, and all connected electrical equipment must be bonded to the common grounding system of the boat in accordance with applicable regulations.

#### NOTICE

Cummins Onan marine generator sets of 32 kW and below include an internal ground of the AC neutral as standard, with isolated AC neutral as an option. The AC neutral leads in the AC connection box are attached to either a bonded ground stud (grounded AC neutral) or an isolator (isolated AC neutral). All Cummins Onan marine generator sets above 32 kW are supplied with an isolated AC neutral. For generator sets above 32 kW, the installer must externally ground the AC neutral per applicable regulations and vessel installation wiring instructions.

#### ⚠ CAUTION

*Do not confuse DC electrical system isolation with AC neutral isolation. Some Cummins Onan marine generator sets are supplied with an isolated DC electrical system for use in steel and aluminum hull vessels (often referred to as "isolated ground" generator sets). When the Isolated DC ground option is specified, the DC negative (B-) battery connection is not connected directly to the engine block, but is on a separate isolated post. The wiring harness connects all accessories to B- at this isolated post. On some generator set models, there is a relay that momentarily connects B- to the engine block during starting to allow short term operation of glow plugs and the starter cranking motor via a ground path through the block. All generator sets, independent of AC and DC ground method, should be bonded to the vessel bond via the generator set bond stud, per applicable regulations.*

All generator sets, independent of AC and DC ground method, should be bonded to the vessel bond via the generator set bond stud, per applicable regulations.

#### ⚠ WARNING

*Faulty grounding of electrical equipment can lead to fire or electric shock resulting in severe personal injury or death. Grounding must be accomplished in accordance with applicable regulations.*

### 5.1.4 Transfer Switch

When the boat has provisions for connection to shore power, the generator set must be connected to the boat electrical system through an approved transfer switch to prevent backfeed.

#### ⚠ WARNING

*Interconnecting the generator set and shore power can lead to electrocution of utility line workers, equipment damage, and fire. Use an approved switching device to prevent interconnections.*

### 5.1.5 Load Balancing

The electrical loads on the generator set should be balanced as closely as possible between the AC output phases so that maximum power can be utilized. Redistribute the loads as necessary.



## 5.2 Battery Connections

The DC voltage rating for the generator set control and engine cranking is on the generator set nameplate. Depending on model, the generator set requires negative (-) ground 12 VDC or 24 VDC for its control and cranking systems. Some models are equipped for applications requiring an isolated ground. A kit is available for isolated DC ground systems.

### WARNING

***Accidental or remote starting of the generator set can cause severe personal injury or death. To prevent unintended starting, do not connect the starting battery until it is time to start the generator set.***

### 5.2.1 Batteries

See [Chapter 9 on page 51](#) for recommended battery capacity.

### 5.2.2 Battery Location and Mounting

Locate the battery where spills and leaks will not drip acid on fuel lines, wiring, or other equipment and where ventilation is adequate to prevent the accumulation of explosive gas. Secure the battery so that it cannot shift. Provide an insulating boot for the positive (+) terminal to protect against accidental contact.

### WARNING

***Arcing can ignite the explosive hydrogen gas given off by the battery, causing severe personal injury. The battery compartment must be ventilated and isolated from spark-producing equipment.***

### 5.2.3 Battery Cables

### WARNING

***Sparks can ignite fuel leading to severe personal injury or death. Do not run battery cables and fuel lines together. Separate cables and fuel lines with conduit or tubing if run through the same opening. Do not tie together.***

Size the battery cables according to the Battery Cable Gauges table below.

Total cable length is the sum of the lengths of the positive (+) and negative (-) cables. Total cable length will be approximately twice the distance between the battery and the generator set.

See the appropriate outline drawing in [Appendix B on page 61](#) for battery cable terminal locations. Provide an insulating boot for the positive (+) terminal to protect against accidental contact.

**TABLE 1. BATTERY CABLE GAUGES**

Total Cable Length, Feet (Meters)	Cable Gauge	
	AWG	Approximate Diameter (mm)*
10 (3)	4	5.88
14 (4.3)	3	6.61

18 (5.5)	2	7.42
22 (6.7)	1	9.43
30 (9.1)	1/0	9.46
* Minimum diameter when using metric gauge cables.		

### 5.2.4 Battery Recharging

See [Chapter 9 on page 51](#) for battery charging capacity of the engine-driven battery charging alternator.

## 5.3 Generator Set Ground (Vessel Bond)

The generator set must be bonded to the common grounding system of the boat in accordance with applicable regulations. See the appropriate drawing in [Appendix B on page 61](#) for connection location.

#### WARNING

***Faulty bonding of the generator set to the common grounding system of the boat can result in severe personal injury or death.***

## 5.4 Remote Control Connector

Connector J4 for remote control connections is stowed inside the control box. It mates with a Deutsch® 8-pin sealed connector plug.

Remove and discard the solid rubber slot plug (not the one with the round plastic insert). See the appropriate outline drawing in [Appendix B on page 61](#). Pull the connector out, fit the wire grommet into the slot and secure the access cover. Remove the protective cap over the connector pins and join the connector and its mate from the Cummins Onan Digital Display and (or) remote switch and meters.

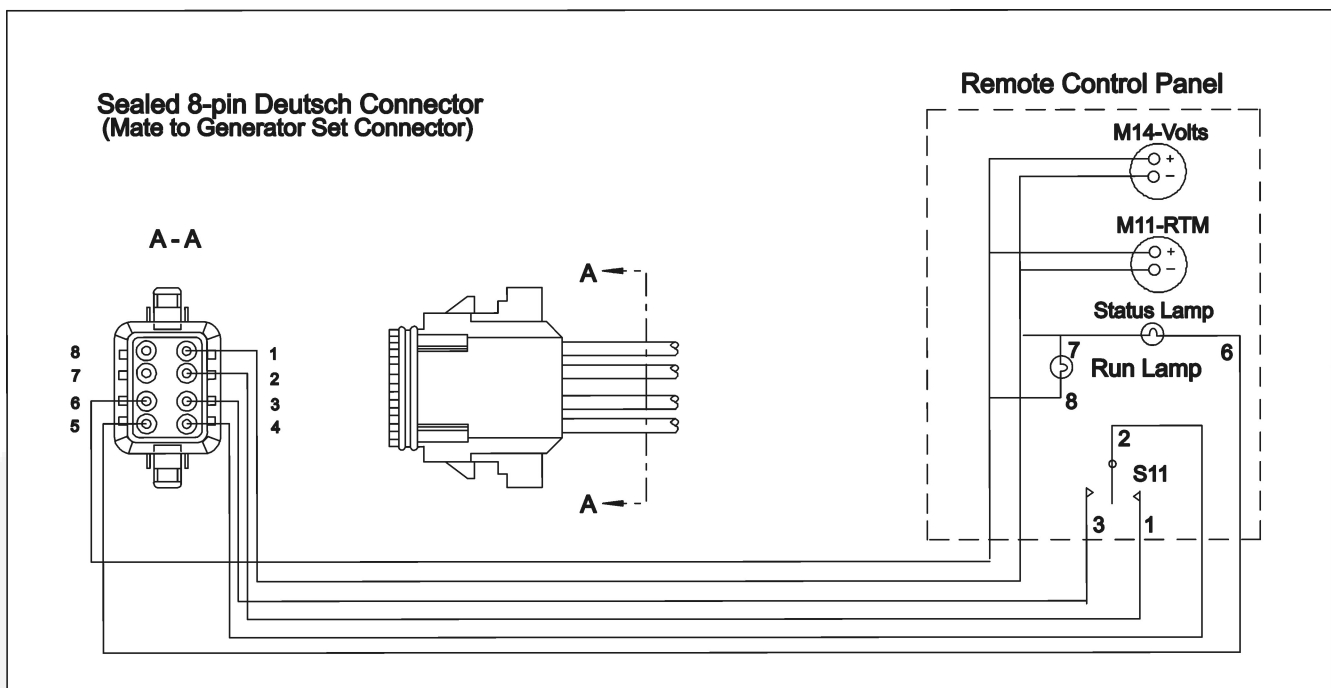


FIGURE 6. CONNECTIONS BETWEEN REMOTE PANEL AND ITS 8-PIN CONNECTOR

### 5.4.1 Connector Designations

The connector designated J4 is for remote connections when the optional Network Interface Module (NIM) is mounted inside the generator set control box. The connector designated J3 is for remote connections when the e-Series Digital Display is mounted on the generator set control box. See [Appendix A on page 55](#) for connection locations.

### 5.4.2 Cummins Onan Digital Displays

Up to 3 digital displays may be connected for remote control and monitoring of the generator set. Follow the installation instructions in the kit.

Kits may also be available to replace the generator set control switch panel with a digital display panel or to replace a digital display with a control switch panel.

### 5.4.3 Remote Control Switch and Meter

- Cummins Onan Remote Control Panel Kit: Remote control panels with a control switch or control switch and hour meter are available as kits. Follow the installation instructions in the kit.
- Non-Cummins Onan (Customer Supplied) Remote Control Panels: Refer to the wiring diagrams (schematics) in [Appendix A on page 55](#) to select and connect the remote control panel components. Use momentary-contact switches for start and stop.

### 5.4.4 Remote Control Wiring Harnesses

- Cummins Onan Harnesses: 8-conductor plug-in wiring harnesses of various lengths are available for connecting digital displays and (or) remote switch panels. "Y" harnesses are also available for applications requiring more than one remote control station.

- Non-Cummins Onan (Customer Supplied) Harnesses: Use 16 AWG wiring. For harnesses 14 to 46 meters (45 to 150 feet) long, use 14 AWG wiring at connector pins 2, 3, and 4.

**⚠ WARNING**

***Carbon monoxide is deadly. All feed-through holes in decks and bulkheads for wiring must be sealed to prevent carbon monoxide (CO) and flammable vapors from entering the living spaces of the boat.***

**⚠ CAUTION**

***Do not route remote control wiring near AC wiring. AC can induce false signals that can cause erratic operation of the generator set.***

## 5.5 External Shutdown Devices

The generator set control box has factory jumpered leads with quick-connect terminals labeled SWB+, ESTOP and CO for connecting external generator set shutdown devices. Connect ESTOP to an emergency shut down system, such as for fire suppression, and CO to a CO detector. The generator set will stop running if the circuit is opened between SWB+ and either of the other two connectors, ESTOP or CO. Therefore use normally-closed (NC) shutdown devices.

**NOTICE**

**The total load on SWB+ must not exceed 0.5 amps.**

### 5.5.1 Factory Jumpers

The generator set leaves the factory with SWB+ jumpered to the other two connectors, ESTOP and CO.

**NOTICE**

**The generator set will not run if the jumpers are not connected. Leave the jumpers connected when no external shutdown devices are to be connected.**

### 5.5.2 Wiring Grommet and Strain Relief

- Remove and discard the round plastic plug in the rubber grommet next to the access cover.
- Push the external wires and conduit through the grommet before making connections.
- Use wire ties to provide strain relief for the external leads.
- Secure the access cover when connections have been made.

### 5.5.3 Shutdown Indication

If shutdown occurs due to either device, the Cummins Onan Digital Displays will display, respectively, Code No. 5: Warning - Shutdown due to Vessel CO or Code No. 61: Emergency Shutdown.

See the Troubleshooting Chapter of the Operator Manual for more information.

#### NOTICE

**All of the status indicator lights in the control circuit will also blink the fault code.**

### 5.5.4 Option H647

Models with Option H647 have a relay and connector (J14/P14) for connection to the external customer circuits. Leave connector P14 connected if an external connection is not made, otherwise the generator set cannot run.

#### 5.5.4.1 Auxiliary Engine Shutdown

Pins 1 and 2 are provided to enable engine shutdown by means of an external shutdown device. The device must open the circuit to cause shutdown.

#### 5.5.4.2 CO Detector Shutdown

Remove the jumper across pins 1 and 3 and connect the remote CO detection and shutdown circuit. The device must have normally closed (NC) contacts. The combined maximum load of the CO and external stop devices must not exceed 0.5 amps.

Leave the jumper across pins 1 and 3 in place if a CO detector is not to be connected, otherwise the generator set will not run.

The digital display will show **Shutdown Due to Vessel CO (Code No. 5)** if the CO detector causes shutdown. See the Operator Manual.

## 5.6 Network Interface Module (NIM)

The optional NIM board has an open 12-pin connector socket for external network connections that mates with a Deutsch® 12-pin sealed connector plug, part number DT06-12S. See illustration below for NIM board mounting location.

See [Appendix A on page 55](#) for connection information.

#### NOTICE

**For more information on SAE 1939 applications see your Cummins Onan distributor. Cummins Onan publication D-3315, *Supported Messages on SAE J1939*, must be used in designing the interface for monitoring generator set status and diagnostics.**

#### NOTICE

**For more information on SmartCraft™ applications see your Cummins MerCruiser Distributor.**

# 5.6.1 NIM Mounting Location

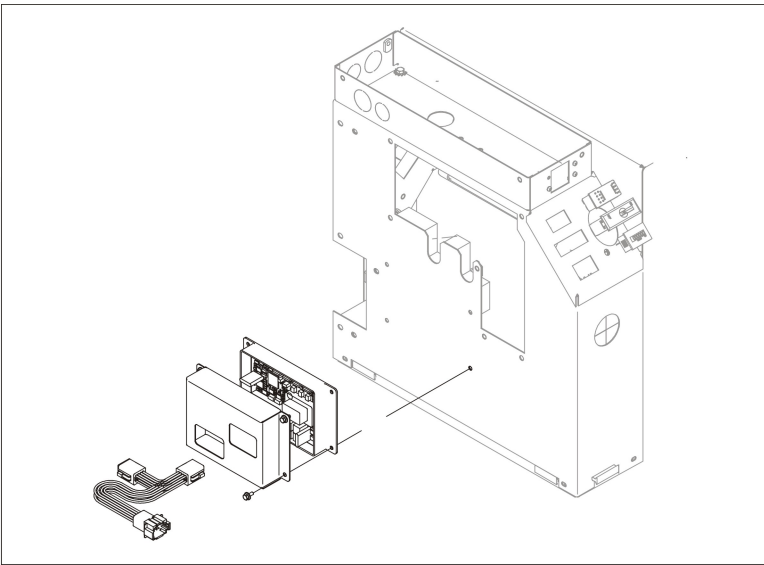


FIGURE 7. NIM MOUNTING LOCATION

# 5.6.2 NIM Configuration Jumpers

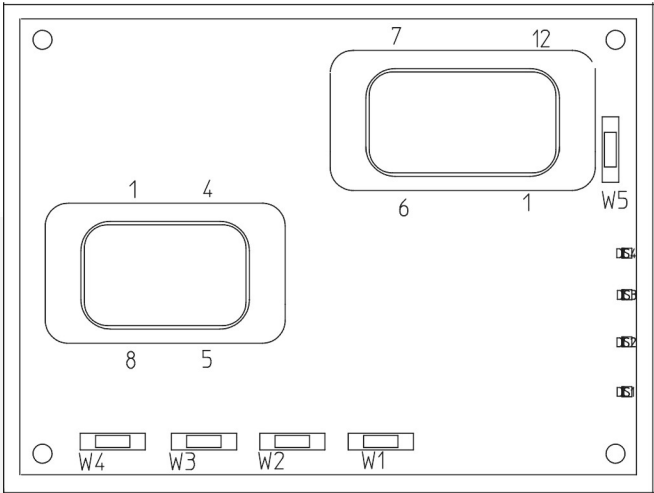
The NIM board has 5 jumpers to configure the board for the specific application, as shown below.

1. Jumper W1 has no function at this time.
2. Jumper W2 will be cut when the generator set is ordered for an SAE J1939 network application. The jumper must remain uncut when the generator set is ordered for a SmartCraft™ network application.
3. Jumpers W3 and W4 are used to assign the network addresses of the generator sets in a multiple-generator set installation. To assign an address, cut the jumpers as shown below.

TABLE 2. J1939 ADDRESSES

Jumper W3	Jumper W4	Address
Not Cut	Not Cut	234
Not Cut	Cut	158
Cut	Not Cut	179
Cut	Cut	203

4. Cut Jumper W5 if the bus termination resistor on this NIM board is not required to terminate the network bus. (The jumper is cut on a SmartCraft™ board.)



**FIGURE 8. NIM CONFIGURATION JUMPERS**

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# 6 Changing Generator Set Frequency

## 6.1 As Manufactured

The generator set was set up and adjusted at the factory for the frequency and voltage stated in the *As Manufactured* block on the nameplate (see figure below). If it is necessary to reconfigure voltage and (or) frequency for the application, follow the instructions in this section.

## 6.2 Reconnection Label

The generator set manuals were shipped with a sheet with peel-off reconnection labels ([Figure 10](#)) to apply over the *As Manufactured* block on the generator set nameplate ([Figure 9](#)) when reconfiguring the generator set for the application. Apply the appropriate label if different from the *As Manufactured* data block.

IMPORTANT ENGINE INFORMATION						
CUMMINS POWER GENERATION						
1400 73rd Ave. NE						
Minneapolis, MN 55432						
Model: <input type="text"/>	Spec: <input type="checkbox"/>	Made in U.S.A.				
S/N: <input type="text"/>	KVA: <input type="text"/>	Pf: <input type="text"/>	KW: <input type="text"/>	PH: <input type="text"/>	RPM: <input type="text"/>	
	50 Hz: <input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
	60 Hz: <input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
<b>As Manufactured:</b>						
Freq: <input type="text"/>	AC Volts: <input type="text"/>	Amps: <input type="text"/>				
Options: <input type="text"/>	Fuel: <input type="text"/>	Bat: <input type="text"/>		Wire Diagram: <input type="text"/>		
		Software Cfg: <input type="text"/>				
Insulation - NEMA Class <input type="text"/> Ambient 40 °C						
REFER TO OPERATOR'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS.						
99-2495 <input type="checkbox"/>						

FIGURE 9. "AS MANUFACTURED" BLOCK ON NAMEPLATE

<b><u>ALTERNATOR RECONNECTION LABEL</u></b>		
<p>THESE LABELS ARE TO BE USED WHEN GENSET IS REWIRED.            *TEAR-OFF LABEL SHOULD BE APPLIED OVER GENSET NAMEPLATE VOLTAGE.            REFER TO INSTALLATION MANUAL FOR DIRECTIONS.</p>		
<p><b>CAUTION:</b> CIRCUIT BREAKER MAY NEED TO BE CHANGED.  <b>FOR GENERATOR SET MODEL: 13.5/17 MDKBP</b></p>		
<p><b>THIS SET HAS BEEN RECONFIGURED TO:</b></p>		
Freq: 50HZ	AC Volts: 115/230V	Amps: 117.4/58.7
<p><b>THIS SET HAS BEEN RECONFIGURED TO:</b></p>		
Freq: 60HZ	AC Volts: 120/240V	Amps: 141.7/70.8
<p><b>THIS SET HAS BEEN RECONFIGURED TO:</b></p>		
Freq: 50HZ	AC Volts: 120/240V	Amps: 112.5/56.3
<p><b>FOR GENERATOR SET MODEL: 17.5/21.5 MDKBR</b></p>		
<p><b>THIS SET HAS BEEN RECONFIGURED TO:</b></p>		
Freq: 50HZ	AC Volts: 115/230V	Amps: 152.2/76.1
<p><b>THIS SET HAS BEEN RECONFIGURED TO:</b></p>		
Freq: 60HZ	AC Volts: 120/240V	Amps: 179/89.6
<p><b>THIS SET HAS BEEN RECONFIGURED TO:</b></p>		
Freq: 50HZ	AC Volts: 120/240V	Amps: 145.8/72.9

FIGURE 10. TYPICAL RECONNECTION LABELS

## 6.3 Changing Frequency

The DC side of the generator set control box has three frequency selection jumper leads terminated in connectors **J5**, **P6**, and **P7**. If application frequency is different from "As Manufactured" frequency follow the steps below.

1. Remove the control box cover.
2. Connect **J5** to **P6** for 60 Hz.
3. Disconnect **J5** from **P7** for 50 Hz.
4. Apply the appropriate reconfiguration label.
5. Replace the control box cover.

### NOTICE

When changing generator set operating frequency, make sure the line circuit breakers are suitable for the new output. Replace them, if necessary, with ones of appropriate rating.

### NOTICE

Check and adjust voltage as necessary after the frequency has been changed.

## 6.4 Reconnecting Generator

### WARNING

***Accidental or remote starting can cause severe personal injury or death. Before removing a panel or access door, or before working on the generator set, use an insulated wrench to disconnect the negative (-) cable from the battery to prevent accidental starting.***

If necessary:

1. Reconnect the generator for the application voltage in accordance with the appropriate generator connection schematic (see [Appendix A on page 55](#)).
2. Apply the appropriate reconfiguration label.
3. Adjust voltage, if necessary.

### NOTICE

**It may be necessary to change circuit breakers to provide required protection or full generator set power when reconnecting the generator.**

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# 7 Adjusting AC Output Voltage

---

## 7.1 Adjusting Voltage

Before adjusting voltage, make sure that proper fuel, exhaust, raw water, and battery connections have been made and that the engine has the proper levels of oil and coolant.

Disconnect all generator loads and connect accurate meters to measure AC voltage and frequency.

### NOTICE

**When reconnecting the generator for a different output voltage, make sure the line circuit breakers are suitable for the new output. Replace them if necessary with ones of appropriate rating.**

### ⚠ WARNING

***Hazardous Voltage! Touching uninsulated live parts inside the generator set and connected equipment can result in severe personal injury or death. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands, and use tools with insulated handles. Secure protective covers when completing installation.***

## 7.2 Adjusting Voltage Using Digital Display

1. Start the generator set and let voltage and frequency stabilize for 5 to 10 seconds. Make sure all loads have been disconnected.
2. Rapidly press **START** 6 times during the first minute after startup to put the generator set control into voltage adjust mode. The green status lamp will blink rapidly and the display will indicate a status change from **Running** to **Volt Adj** (see Voltage Adjustment Screen figure below).
3. To adjust voltage up, press and quickly release **START**. Voltage will increase approximately 0.6 volts with each press and release.
4. To adjust voltage down, press and hold **START** for about 1 second. Voltage will decrease approximately 0.6 volts with each press and release.
5. When satisfied with the adjustment, wait about 20 seconds for the display to indicate a status change from **Volt Adj** to **Running** and then press **STOP** to stop the generator set and save the adjustment.
6. Restart the generator set and check voltage.
7. Recalibrate AC voltage on the digital display as instructed in the Operator Manual.

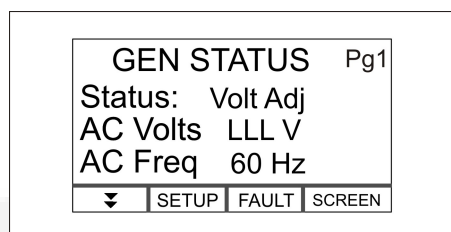


FIGURE 11. VOLTAGE ADJUSTMENT SCREEN

## 7.3 Adjusting Voltage Using Control Switch

1. Start the generator set and let voltage and frequency stabilize for 5 to 10 seconds. Make sure all loads have been disconnected.
2. Rapidly press **START** 6 times during the first minute after start up to put the generator set control into voltage adjust mode. The amber status lamp will begin blinking about once every second to indicate the change to voltage adjust mode. The green status lamp will remain on.
3. To adjust voltage up, press and quickly release **START**. Voltage will increase approximately 0.6 volts with each press and release.
4. To adjust voltage down, press and hold **START** for about 1 second. Voltage will decrease approximately 0.6 volts with each press and release.
5. When satisfied with the adjustment, wait about 20 seconds for the amber lamp to stop blinking and then press **STOP** to stop the generator set and save the adjustment.
6. Restart the generator set and check voltage.

## 8 Installation Checklist

**Before starting the generator set,** review the installation checklist below for those items that do not require the generator set to be actually running. Make necessary reconnections, modifications, and repairs. Then start and operate the generator set in accordance with the Operator's Manual, observing all of its instructions and precautions. Continue working through the installation checklist with the generator set running, making necessary reconnections, modifications, and repairs. Check off each item that is found to be true about the generator set. Do not place the generator set in service until each item has been checked off.

Check Box	Check List
	The generator set is protected from weather and splashing or dripping water.
	The Raw Water Pickup Test (See <a href="#">Section 4.3.8.1 on page 26</a> ) was conducted during the sea trials to establish the water line and a siphon break was installed, if found to be necessary.
	The sea trials established that at all boat speeds, enough raw water is picked up for generator set engine and exhaust cooling.
	The Exhaust Water Separator Backflow Test (See <a href="#">Section 4.4.1.7 on page 30</a> ) was conducted during the sea trials to establish that there is no backflow through the through-hull fitting or water separator under any operating conditions.
	All electrical devices used in spaces where gasoline vapors can accumulate are ignition protected.
	Generator set compartment ventilation meets regulations and the sea trials established that ventilation is sufficient to maintain acceptable generator set compartment temperatures, even during heat soaking after returning and docking.
	The living quarters are sealed against leaks from spaces where exhaust and fuel vapors can accumulate.
	The generator set is securely mounted.
	There is adequate clearance for conducting all maintenance specified in the Operator Manual.
	The coolant recovery tank is mounted properly and is accessible for inspection and filling.
	The entire exhaust system is accessible for inspection and replacement.
	Fuel tanks, piping, hoses, and filters comply with regulations and are accessible for inspection and replacement.
	The generator set is bonded to the boat grounding system in accordance with regulations.
	All grounded cranking motor circuits are connected by properly-sized common bonding conductors.
	If required, the kit for isolated DC ground was installed.
	An approved transfer switch prevents interconnections between shore power and generator set.
	AC wiring methods, materials, and bonding for grounding meet regulations.
	A properly sized battery has been installed, serviced, and charged. The battery is securely mounted in an adequately ventilated space and the positive (+) terminal is shielded from accidental contact.
	The remote control panel functions as intended and is not mounted where fuel vapors can accumulate.
	Emergency and (or) CO detection and shut-down devices have been connected and have been tested to determine that the generator set shuts down as intended.
	The generator set is properly sized for the application, the voltage and frequency are correct, and the loads across a multi-phase generator are balanced.
	Exhaust back pressure is acceptable.
	The exhaust system is leak-free and conveys all engine exhaust outside, away from windows, doors, and vents.

Check Box	Check List
	The fuel supply system is leak-free.
	The engine coolant and raw water systems are leak-free.
	The engine has the proper levels of oil and coolant.
	The raw water pump has been primed and the sea cock is open.
	All operators have been thoroughly briefed on the Operator Manual and its safety precautions - especially concerning the dangers of carbon monoxide and gasoline fuel vapors - and can demonstrate how to operate, maintain, and troubleshoot the generator set as explained therein.



# 9 Specifications

## 9.1 Specifications Table

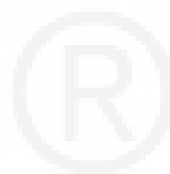
TABLE 3. GENERATOR SET SPECIFICATIONS

DESCRIPTION	MDKBH
<b>Alternator</b>	Single-Bearing, 2-Pole Rotating Field brush type
<b>Installation Drawing</b>	0500-4718
<b>Engine</b>	Kubota 4-Stroke Cycle, Indirect Injection, Water Cooled Diesel with Digital Electronic Governing
Model	Z482
<b>Rated RPM</b>	
60 Hz	2900
50 Hz	2400
Number of Cylinders	2
Bore	67 mm (2.64 in)
Stroke	68 mm (2.68 in)
Displacement	0.479 L (29.23 in <sup>3</sup> )
<b>FUEL:</b>	
Bio-Diesel Compantibility	N/A
<b>Consumption - 60 Hz</b>	
No Load	0.8 L/hr (0.2 gal/hr)
Half Load	1.3 L/hr (0.35 gal/hr)
Full Load	2.3 L/hr (0.6 gal/hr)
<b>Consumption - 50 Hz</b>	
No Load	0.6 L/hr (0.16 gal/hr)
Half Load	1.1 L/hr (0.29 gal/hr)
Full Load	1.9 L/hr (0.5 gal/hr)
Max Fuel Pump Lift	1.2 m (4 ft)
Minimum Fuel Inlet Pressure	- 1.7 psi
Minimum Fuel Inlet Pressure with Auxiliary Pump	N/A
<b>LUBRICATION:</b>	
Engine Oil Capacity	2.1 L (2.2 qt)
<b>Maximum Angularity any Direction</b>	
Continuous	20°
Intermittent	30°
<b>COOLING:</b>	

DESCRIPTION	MDKBH
Coolant Capacity	2.1 L (2.2 qt)
<b>Coolant Flow Rate</b>	
60 Hz	13 L/min (3.5 gal/min)
50 Hz	11 L/min (3 gal/min)
<b>Raw Water Flow Rate</b>	
60 Hz	19 L/min (5 gal/min)
50 Hz	15 L/min (4 gal/min)
Minimum Raw Water Inlet Pressure	- 1.7 psi
Maximum Pressure Drop across Keel Cooler Outlet and Inlet Connection	N/A
<b>Heat Rejection to Coolant</b>	
60 Hz	N/A
50 Hz	N/A
Thermostat Opening Temperature	N/A
Thermostat Fully Open Temperature	N/A
Recommended Pressure Cap	N/A
<b>GENERATOR SET AIR FLOW:</b>	
Combustion Air Flow	0.5 m <sup>3</sup> /min (18 ft <sup>3</sup> /min)
<b>Heat Rejection to Ambient</b>	
60 Hz	33 Kcal/min (132 Btu/min)
50 Hz	28 Kcal/min (112 Btu/min)
<b>EXHAUST:</b>	
Maximum Exhaust Back Pressure	3 in Hg
Dry Exhaust Gas Flow	N/A
Dry Exhaust Temperature	N/A
<b>BATTERIES:</b>	
Nominal Battery Voltage	12 VDC
Minimum CCA Rating - SAE @ 0 °C (32 °F) 12 VDC	300 Amps
Minimum CCA Rating - SAE @ 0 °C (32 °F) 24 VDC	N/A
<b>12 Volt Net Battery Charging Output</b>	
Negative Ground (60 Hz)	3 Amps
Isolated Ground (60 Hz)	3 Amps
Negative Ground (50 Hz)	3 Amps
Isolated Ground (50 Hz)	3 Amps
<b>24 Volt Net Battery Charging Output</b>	
Negative Ground (60 Hz)	N/A
Isolated Ground (60 Hz)	N/A
Negative Ground (50 Hz)	N/A

DESCRIPTION	MDKBH
Isolated Ground (50 Hz)	N/A
<b>Starter Rolling Current</b>	
12V	N/A
24V	N/A
<b>Maximum Starting Current Resistance</b>	
12V	N/A
24V	N/A
<b>SIZE, WEIGHT, NOISE:</b>	
<b>Weight without Sound Shield:</b>	
Dry Weight	N/A
<b>Weight with Sound Shield:</b>	
Dry Weight	159 kg (350 lb)
<b>Sound Level with Sound Shield @ 1 meter</b>	71/68 dB(A) @ 60/50 Hz

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# Appendix A. Wiring Diagrams

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.



A.1 MDKBH Wiring Diagram

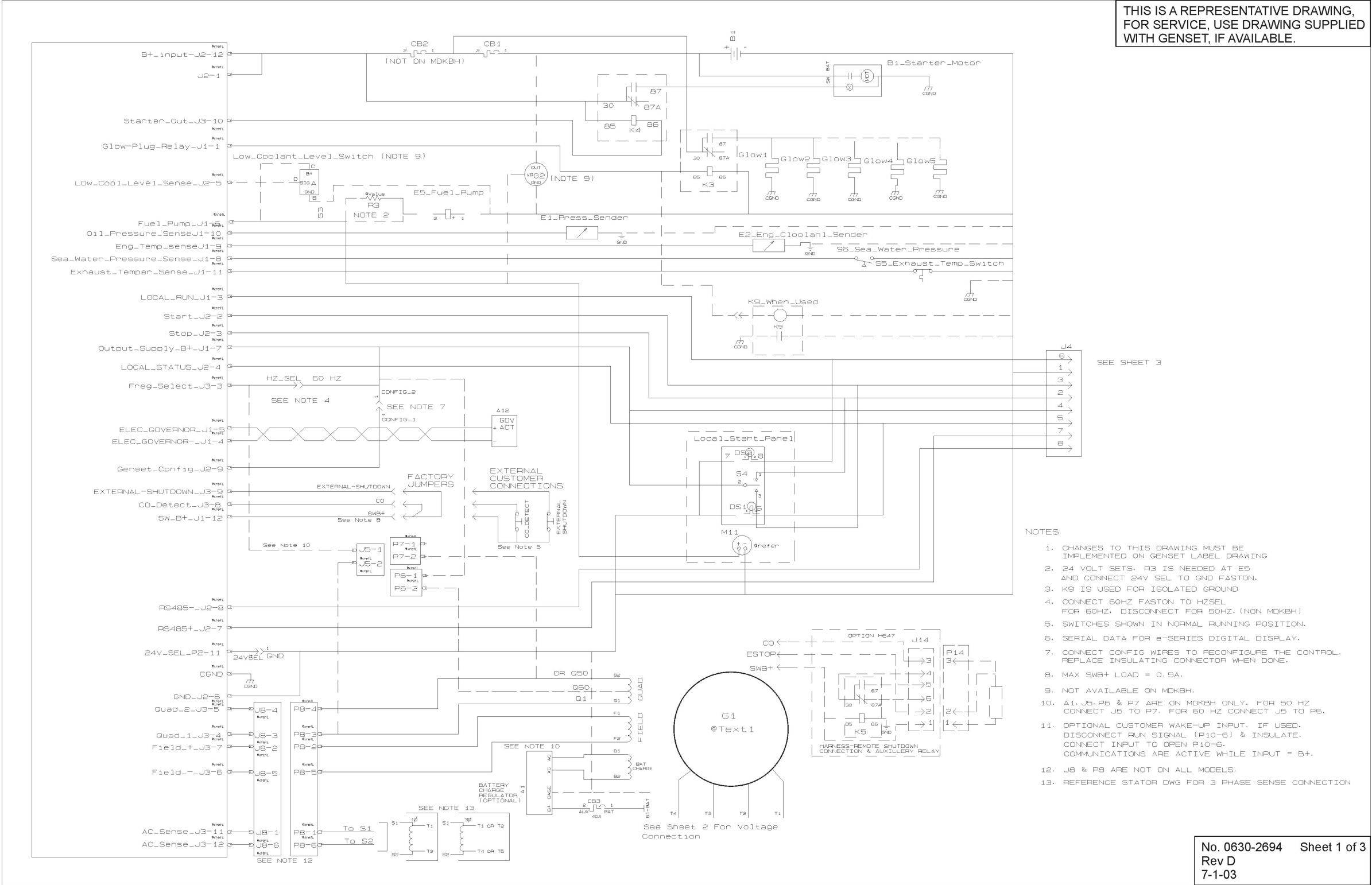


FIGURE 12. 0630-2694 REVISION D SHEET 1

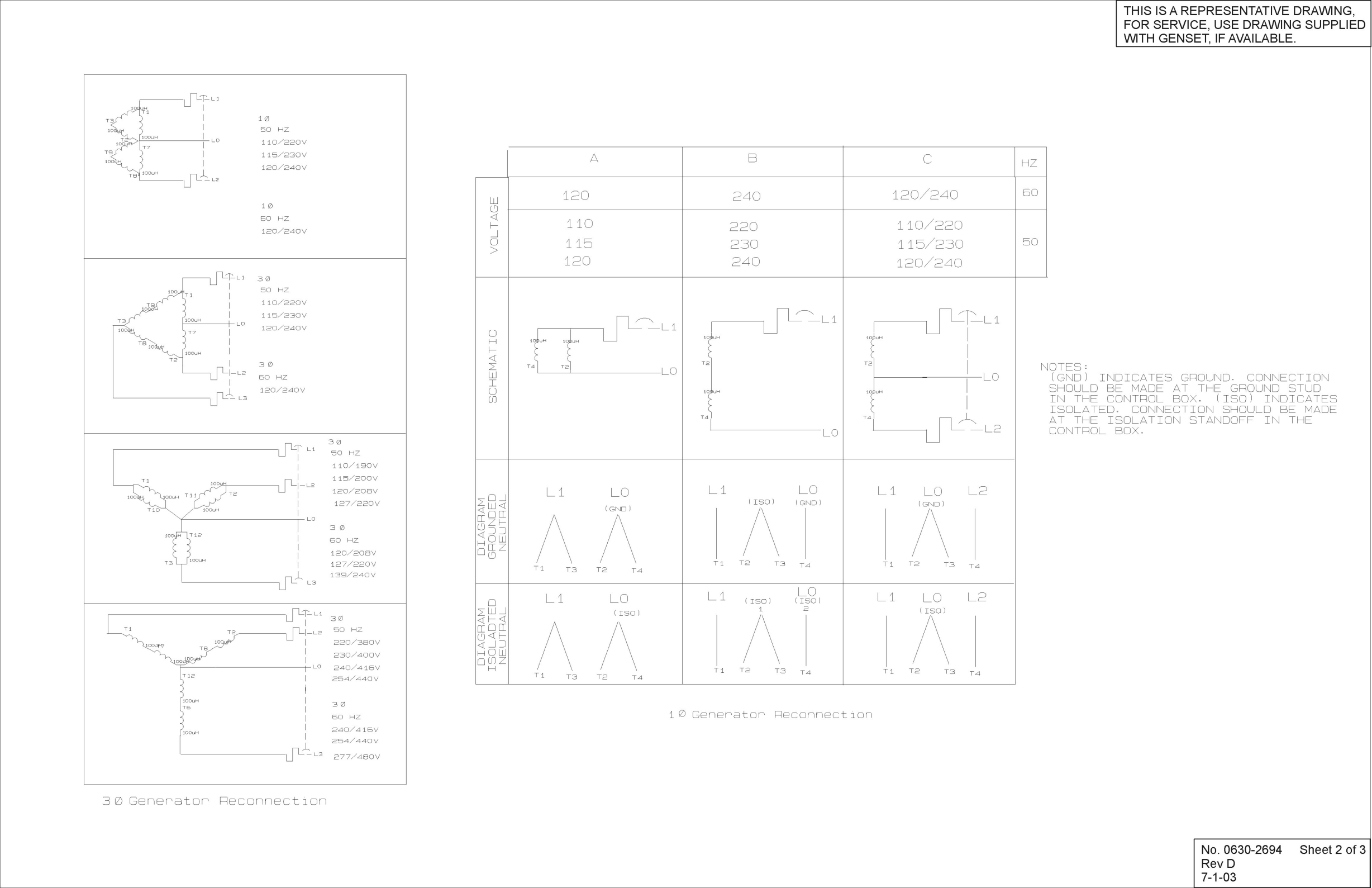


FIGURE 13. 0630-2694 REVISION D SHEET 2



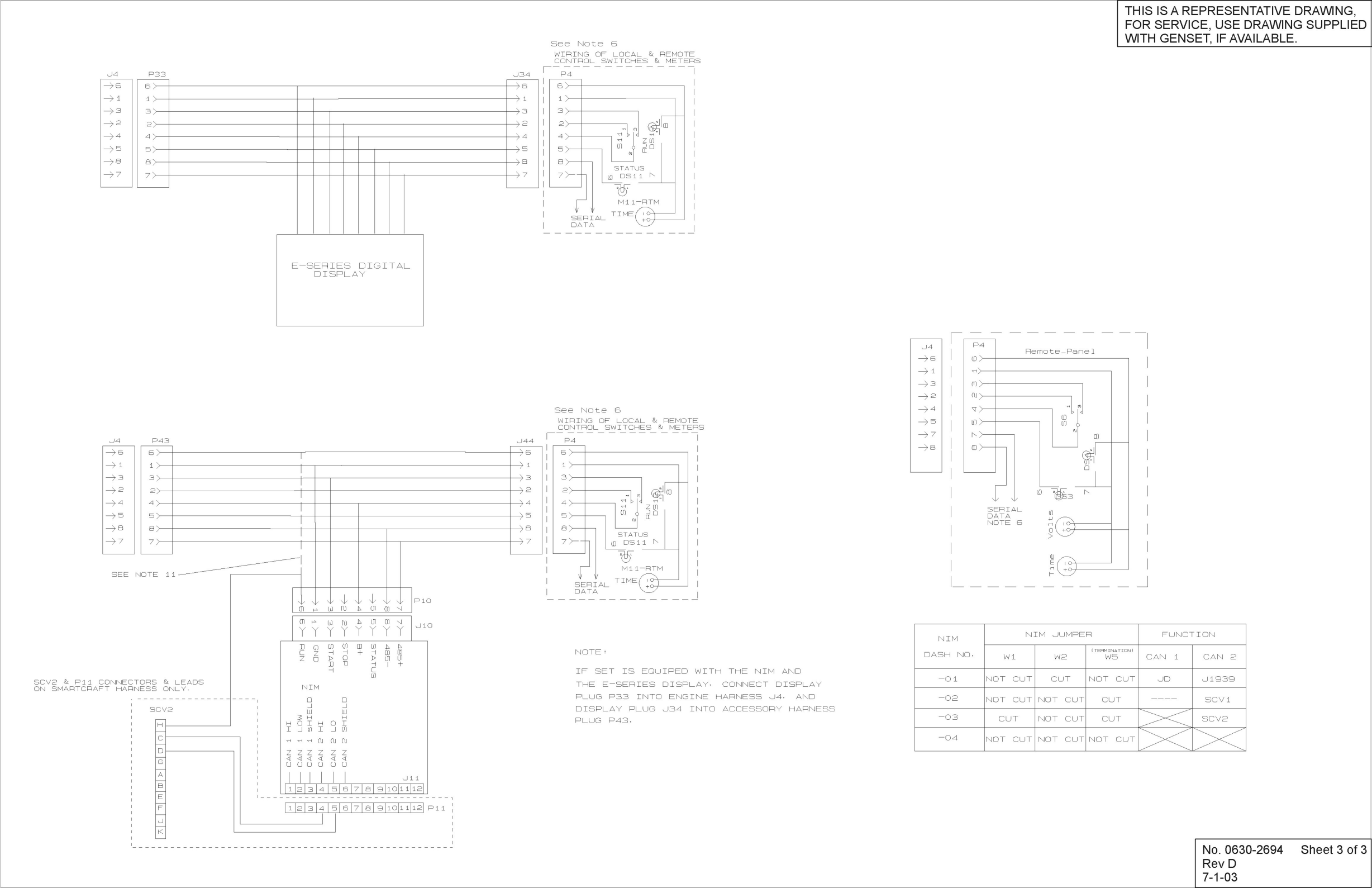


FIGURE 14. 0630-2694 REVISION D SHEET 3

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# Appendix B. Outline Drawings

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The drawings included in this section are representative. For current complete information, refer to the drawing package that was shipped with the unit.



# B.1 MDKBH Outline Drawing

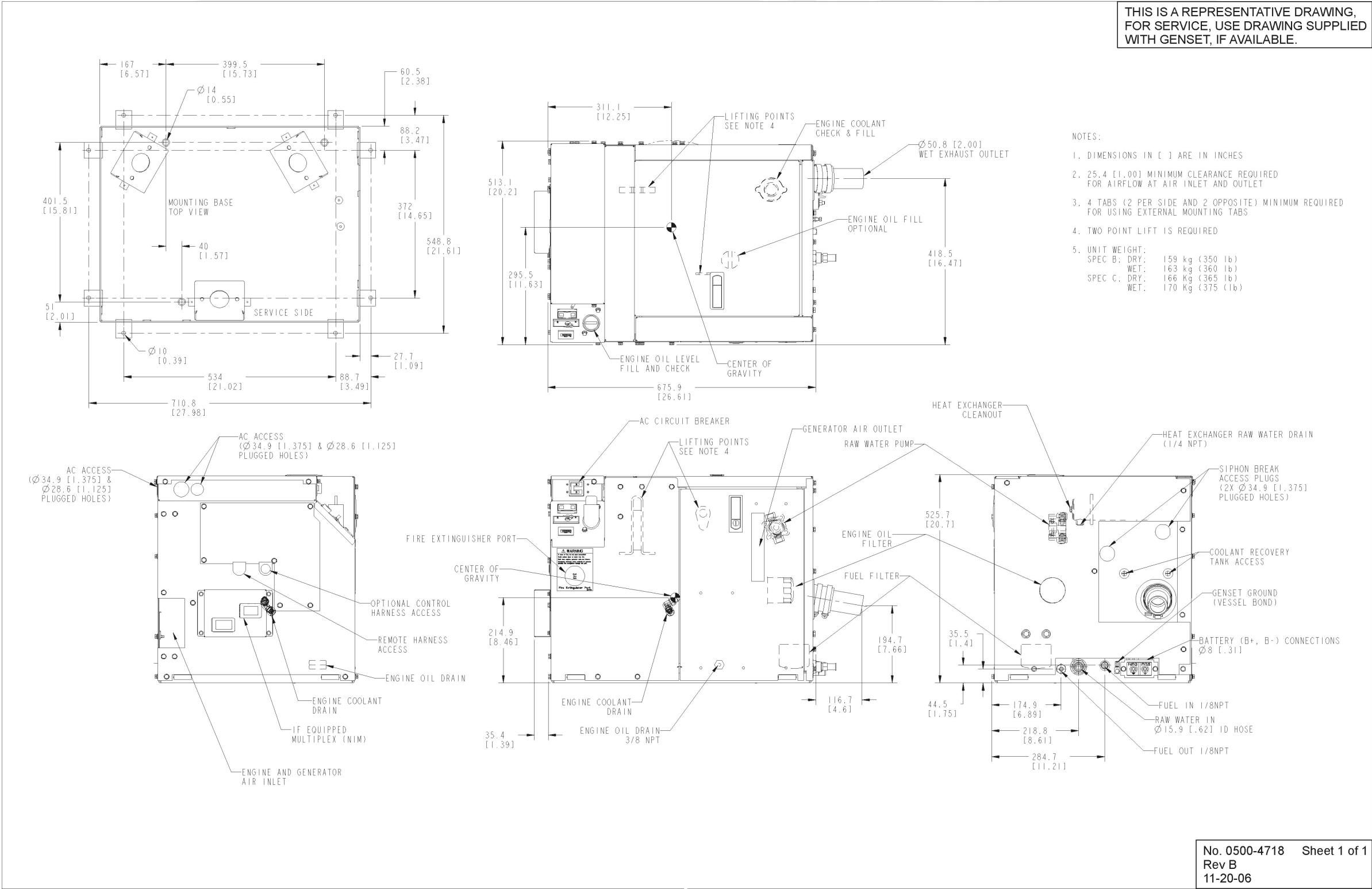


FIGURE 15. MDKBH OUTLINE DRAWING

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