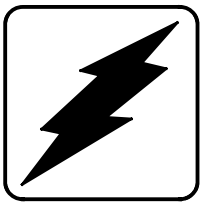
Installation

Commercial Generator Sets



Models:

15/30RYG

ISO 9001 KOHLER POWER SYSTEMS NATIONALLY REGISTERED

KOHLER® POWER SYSTEMS

TP-6329 8/07c

California Proposition 65

⚠ WARNING

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

Product Identification Information

Product identification numbers determine service parts. Record the product identification numbers in the spaces below immediately after unpacking the products so that the numbers are readily available for future reference. Record field-installed kit numbers after installing the kits.

Generator Set Identification Numbers

Record the product identification numbers from the generator set nameplate(s).

Model Designation _____

Specification Number _____

Serial Number _____

Accessory Number	Accessory Description

Controller Identification

Record the controller description from the generator set operation manual, spec sheet, or sales invoice.

Controller Description ADC 2100

Engine Identification

Record the product identification information from the engine nameplate.

Manufacturer _____

Model Designation _____

Serial Number _____

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IMPORTANT SAFETY INSTRUCTIONS. Electromechanical equipment, including generator sets, transfer switches, switchgear, and accessories, can cause bodily harm and pose life-threatening danger when improperly installed, operated, or maintained. To prevent accidents be aware of potential dangers and act safely. Read and follow all safety precautions and instructions. SAVE THESE INSTRUCTIONS.

This manual has several types of safety precautions and instructions: Danger, Warning, Caution, and Notice.

DANGER

Danger indicates the presence of a hazard that ***will cause severe personal injury, death***, or ***substantial property damage***.

WARNING

Warning indicates the presence of a hazard that ***can cause severe personal injury, death,*** or ***substantial property damage***.

CAUTION

Caution indicates the presence of a hazard that ***will*** or ***can cause minor personal injury*** or ***property damage***.

NOTE

Notice communicates installation, operation, or maintenance information that is safety related but not hazard related.

Safety decals affixed to the equipment in prominent places alert the operator or service technician to potential hazards and explain how to act safely. The decals are shown throughout this publication to improve operator recognition. Replace missing or damaged decals.

Accidental Starting

WARNING

Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

Battery

WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Wear protective goggles and clothing. Battery acid may cause blindness and burn skin.

WARNING

Explosion.
Can cause severe injury or death.
Relays in the battery charger cause arcs or sparks.

Locate the battery in a well-ventilated area. Isolate the battery charger from explosive fumes.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. Do not dispose of a battery in a fire. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove all jewelry before servicing the equipment. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface away from the battery. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Ventilate the compartments containing batteries to prevent accumulation of explosive gases.

Battery electrolyte is a diluted sulfuric acid. Battery acid can cause severe injury or death. Battery acid can cause blindness and burn skin. Always wear splashproof safety goggles, rubber gloves, and boots when servicing the battery. Do not open a sealed battery or mutilate the battery case. If battery acid splashes in the eyes or on the skin, immediately flush the affected area for 15 minutes with large quantities of clean water. Seek immediate medical aid in the case of eye contact. Never add acid to a battery after placing the battery in service, as this may result in hazardous spattering of battery acid.

Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery. Never connect the negative (-) battery cable to the positive (+) connection terminal of the starter solenoid. Do not test the battery condition by shorting the terminals together.

Battery acid cleanup. Battery acid can cause severe injury or death. Battery acid is electrically conductive and corrosive. Add 500 g (1 lb.) of bicarbonate of soda (baking soda) to a container with 4 L (1 gal.) of water and mix the neutralizing solution. Pour the neutralizing solution on the spilled battery acid and continue to add the neutralizing solution to the spilled battery acid until all evidence of a chemical reaction (foaming) has ceased. Flush the resulting liquid with water and dry the area.

Engine Backfire/Flash Fire

⚠ WARNING

Fire.
Can cause severe injury or death.

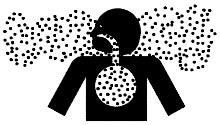
Do not smoke or permit flames or sparks near fuels or the fuel system.

Servicing the fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuels or fuel vapors. Catch fuels in an approved container when removing the fuel line or carburetor.

Servicing the air cleaner. A sudden backfire can cause severe injury or death. Do not operate the generator set with the air cleaner removed.

Exhaust System

⚠ WARNING



Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

Generator set operation. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Avoid breathing exhaust fumes when working on or near the generator set. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate the generator set where exhaust gas could accumulate and seep back inside a potentially occupied building.

Carbon monoxide detectors. Carbon monoxide can cause severe nausea, fainting, or death. Install carbon monoxide detectors on each level of the building. Locate the detectors to adequately warn the building's occupants of the presence of carbon monoxide. Keep the detectors operational at all times. Periodically test and replace the carbon monoxide detectors according to the manufacturer's instructions.

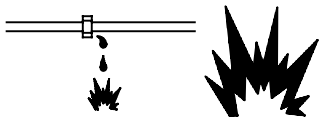
Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas present in exhaust gases. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Carbon monoxide poisoning symptoms include but are not limited to the following:

- Light-headedness, dizziness
- Physical fatigue, weakness in joints and muscles
- Sleepiness, mental fatigue, inability to concentrate or speak clearly, blurred vision
- Stomachache, vomiting, nausea

If experiencing any of these symptoms and carbon monoxide poisoning is possible, seek fresh air immediately and remain active. Do not sit, lie down, or fall asleep. Alert others to the possibility of carbon monoxide poisoning. Seek medical attention if the condition of affected persons does not improve within minutes of breathing fresh air.

Fuel System

⚠ WARNING



Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

The fuel system. Explosive fuel vapors can cause severe injury or death. Vaporized fuels are highly explosive. Use extreme care when handling and storing fuels. Store fuels in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running because spilled fuel may ignite on contact with hot parts or from sparks. Do not smoke or permit flames or sparks to occur near sources of spilled fuel or fuel vapors. Keep the fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid fuel line breakage caused by vibration. Do not operate the generator set in the presence of fuel leaks, fuel accumulation, or sparks. Repair fuel systems before resuming generator set operation.

Explosive fuel vapors can cause severe injury or death. Take additional precautions when using the following fuels:

Propane (LP)—Adequate ventilation is mandatory. Because propane is heavier than air, install propane gas detectors low in a room. Inspect the detectors per the manufacturer's instructions.

Natural Gas—Adequate ventilation is mandatory. Because natural gas rises, install natural gas detectors high in a room. Inspect the detectors per the manufacturer's instructions.

Gas fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check the LP vapor gas or natural gas fuel system for leakage by using a soap and water solution with the fuel system test pressurized to 6–8 ounces per square inch (10–14 inches water column). Do not use a soap solution containing either ammonia or chlorine because both prevent bubble formation. A successful test depends on the ability of the solution to bubble.

Hazardous Noise

⚠ CAUTION

Hazardous noise.
Can cause hearing loss.

Never operate the generator set without a muffler or with a faulty exhaust system.

Hazardous Voltage/ Moving Parts

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ WARNING

Hazardous voltage. Moving parts.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

⚠ WARNING

Hazardous voltage.
Backfeed to the utility system can cause property damage, severe injury, or death.

If the generator set is used for standby power, install an automatic transfer switch to prevent inadvertent interconnection of standby and normal sources of supply.

⚠ CAUTION

Welding the generator set.
Can cause severe electrical equipment damage.

Never weld components of the generator set without first disconnecting the battery, controller wiring harness, and engine electronic control module (ECM).

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, transfer switch, and related equipment and electrical circuits. Turn off the main circuit breakers of all power sources before servicing the equipment. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

Welding on the generator set. Can cause severe electrical equipment damage. Before welding on the generator set perform the following steps: (1) Remove the battery cables, negative (-) lead first. (2) Disconnect all engine electronic control module (ECM) connectors. (3) Disconnect all generator set controller and voltage regulator circuit board connectors. (4) Disconnect the engine battery-charging alternator connections. (5) Attach the weld ground connection close to the weld location.

Installing the battery charger. Hazardous voltage can cause severe injury or death. An ungrounded battery charger may cause electrical shock. Connect the battery charger enclosure to the ground of a permanent wiring system. As an alternative, install an equipment grounding conductor with circuit conductors and connect it to the equipment grounding terminal or the lead on the battery charger. Install the battery charger as prescribed in the equipment manual. Install the battery charger in compliance with local codes and ordinances.

Connecting the battery and the battery charger. Hazardous voltage can cause severe injury or death. Reconnect the battery correctly, positive to positive and negative to negative, to avoid electrical shock and damage to the battery charger and battery(ies). Have a qualified electrician install the battery(ies).

Short circuits. Hazardous voltage/current can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

Engine block heater. Hazardous voltage can cause severe injury or death. The engine block heater can cause electrical shock. Remove the engine block heater plug from the electrical outlet before working on the block heater electrical connections.

Electrical backfeed to the utility. Hazardous backfeed voltage can cause severe injury or death. Install a transfer switch in standby power installations to prevent the connection of standby and other sources of power. Electrical backfeed into a utility electrical system can cause severe injury or death to utility personnel working on power lines.

⚠ WARNING

Airborne particles.
Can cause severe injury or blindness.

Wear protective goggles and clothing when using power tools, hand tools, or compressed air.

Servicing the generator set when it is operating. Exposed moving parts can cause severe injury or death. Keep hands, feet, hair, clothing, and test leads away from the belts and pulleys when the generator set is running. Replace guards, screens, and covers before operating the generator set.

Heavy Equipment

⚠ WARNING

Unbalanced weight.
Improper lifting can cause severe injury or death and equipment damage.

Do not use lifting eyes.
Lift the generator set using lifting bars inserted through the lifting holes on the skid.

Hot Parts

⚠ WARNING

Hot coolant and steam.
Can cause severe injury or death.

Before removing the pressure cap, stop the generator set and allow it to cool. Then loosen the pressure cap to relieve pressure.

⚠ WARNING

Hot engine and exhaust system.
Can cause severe injury or death.

Do not work on the generator set until it cools.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

Notice

NOTICE

This generator set has been rewired from its nameplate voltage to

246242

NOTICE

Voltage reconnection. Affix a notice to the generator set after reconnecting the set to a voltage different from the voltage on the nameplate. Order voltage reconnection decal 246242 from an authorized service distributor/dealer.

NOTICE

Canadian installations only. For standby service connect the output of the generator set to a suitably rated transfer switch in accordance with Canadian Electrical Code, Part 1.

This manual provides installation instructions for Model 15/30RYG commercial generator sets equipped with ADC 2100 controls. Operation manuals are available separately.

Information in this publication represents data available at the time of print. Kohler Co. reserves the right to change this publication and the products represented without notice and without any obligation or liability whatsoever.

Read this manual and carefully follow all procedures and safety precautions to ensure proper equipment operation and to avoid bodily injury. Read and follow the Safety Precautions and Instructions section at the beginning of this manual. Keep this manual with the equipment for future reference.

List of Related Materials

Figure 1 identifies related literature available for the generator sets covered in this manual. Only trained and qualified personnel should install or service the generator set.

Literature Type	Part Number
Installation Manual 15/30RYG	TP-6329
Operation Manual 15/30RYG	TP-6197
Operation Manual Supplement (Engine)	TP-6101
Parts Catalog*	TP-6319
Service Manual (Engine)	TP-6327
Service Manual (Generator Set)	TP-6198
Wiring Diagram Manual (Generator Set)	TP-6437
* One Parts Catalog combines generator and engine information.	

Figure 1 Related Literature

Warranty Registration

Complete the startup and installation checklists supplied with the startup notification form. Complete and sign the startup notification form and return copies to Kohler Co. and the distributor/dealer as instructed on the form.

Service Assistance

For professional advice on generator power requirements and conscientious service, please contact your nearest Kohler distributor or dealer.

- Consult the Yellow Pages under the heading Generators—Electric.
- Visit the Kohler Power Systems website at KohlerPower.com.
- Look at the labels and stickers on your Kohler product or review the appropriate literature or documents included with the product.
- Call toll free in the US and Canada 1-800-544-2444.
- Outside the US and Canada, call the nearest regional office.

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Fax: (65) 6264-6455

China
North China Regional Office, Beijing
Phone: (86) 10 6518 7950
(86) 10 6518 7951
(86) 10 6518 7952
Fax: (86) 10 6518 7955

East China Regional Office, Shanghai
Phone: (86) 21 6288 0500
Fax: (86) 21 6288 0550

India, Bangladesh, Sri Lanka
India Regional Office
Bangalore, India
Phone: (91) 80 3366208
(91) 80 3366231
Fax: (91) 80 3315972

Japan, Korea
North Asia Regional Office
Tokyo, Japan
Phone: (813) 3440-4515
Fax: (813) 3440-2727

Latin America
Latin America Regional Office
Lakeland, Florida, USA
Phone: (863) 619-7568
Fax: (863) 701-7131

1.1 Introduction

The information in this section applies to all installations. Review this section and the safety precautions before starting the installation procedure. The generator set specification sheet also contains data that may be required during the installation process.

The generator set and accessories must be installed by a trained, authorized Kohler distributor, dealer, or authorized representative. The installation must comply with all applicable national and local codes.

1.2 Enclosed and Open Generator Sets

Enclosed generator sets include a factory-supplied weather or sound housing. The exhaust systems of enclosed units are complete for outdoor installations. Review Section 1 and then refer to Section 3 for the outdoor installation of enclosed units.

Note: Do not install enclosed units inside a building.

Open generator sets do not include a factory-supplied weather or sound enclosure. Install open generator sets inside a building with the exhaust gas piped safely outside. Adequate cooling and combustion air are required. Review Sections 1 and 2 for the installation of open units before proceeding to the installation procedure in Section 3.

Note: Do not install open commercial generator sets in residential applications.

1.3 Location Factors

Ideally, the generator set should be mounted on concrete at ground level. For above-ground installations, including roof installations, weight considerations are especially important. The building engineer must determine whether the structure can support the weight of the generator set.

The location of the generator set must:

- Support the weight of the generator set and related equipment such as batteries, radiators, and mounting pad(s). Keep in mind that the mounting pad weight may exceed the weight of the generator set.
- Meet applicable fire rating codes and standards.
- Position the generator set over a noncombustible surface. Do not allow accumulation of combustible materials under the generator set.
- Permit vibration isolation to reduce noise and prevent damage.
- Be clean, dry (open units), and not subject to flooding.
- Allow ventilation with a minimum amount of ductwork. (open units)
- Provide clearance for cooling air flow and access for service. See Section 3.2 for required clearances around the generator set.
- Allow safe expulsion of exhaust.
- Minimize the risk of public or unauthorized access.

1.4 Mounting Surface

The manufacturer recommends a single, level concrete mounting pad. This method provides maximum stability for the generator set. The recommended mounting pad dimensions for open and enclosed units are shown in the dimension drawings in Section 7.

Refer to the generator set dimension drawings for conduit and fuel-line placement. The drawings give dimensions for electrical and fuel connection roughins and stubups.

1.5 Vibration Isolation

The generator set is equipped with neoprene vibration isolators. Connections between the generator set or its mounting base and any conduits, fuel lines, or exhaust piping must include flexible sections to prevent breakage and to isolate vibration.

1.6 Unit-Mounted Radiator Cooling

The generator set is equipped with a unit-mounted radiator common cooling system.

1.6.1 System Features

The system's major components include an engine-driven fan and circulating water pump, a radiator, and a thermostat. The pump circulates water through the engine until it reaches operating temperature. Then the engine thermostat opens, allowing water circulation through the radiator. The thermostat restricts water flow as necessary to prevent overcooling. The fan blows air from the engine side of the radiator across the cooling surface.

1.6.2 Recommended Coolant

Add antifreeze before starting the generator set or energizing the block heater.

The generator set manufacturer recommends a solution of 50% ethylene glycol and 50% clean, softened water to provide freezing protection to –37°C (–34°F) and boiling protection to 129°C (256°F). A 50/50 solution also inhibits corrosion. Consult the engine manufacturer's operation manual for engine coolant specifications.

1.7 Fuel Supply

Gas fuel systems operate on either LP (liquefied petroleum) or natural gas. Refer to the the instructions in Section 3.8 for more detailed information on fuel requirements.

Note: Design and install gas fuel systems in accordance with NFPA-54, National Fuel Gas Code, and applicable local codes.

Gas lines. Never use fuel piping to ground electrical equipment. The gas supplier is responsible for installation, repair, and alteration to gas piping.

Use Schedule 40 black-iron pipe for gas piping. Copper tubing may be used if the fuel does not contain hydrogen sulfide or other ingredients that react chemically with copper.

Line size. Size piping according to the requirements of the equipment. Refer to the the instructions in Section 3.8. In addition to the actual fuel consumption, consider the following pressure loss factors:

- Pipe length
- Other appliances on the same fuel supply
- Number of fittings

Flexible connections. Rigid-mount the piping but protect it from vibration. Use flexible connections spanning a minimum of 152 mm (6 in.) between the stationary piping and the engine fuel inlet connection.

1.8 Electrical System

Before installing the generator set, provide for electrical connections through conduit to the transfer switch and other accessories for the generator set. Route DC leads in separate conduit from AC conductors. Carefully install the selected generator set accessories. Route wiring to the generator set through flexible connections. Comply with all applicable codes when installing a wiring system.

1.8.1 Line Circuit Breakers

AC circuit protection. All AC circuits must include circuit breaker or fuse protection. If the generator set is not equipped with a factory-installed circuit breaker, select a circuit breaker for up to 125% of the rated generator set output current. The circuit breaker must open all ungrounded connectors. The circuit breaker or fuse must be mounted within 7.6 m (25 ft.) of the alternator output terminals.

1.8.2 Electrical Connections

Several electrical connections must be made between the generator set and other components of the system for proper operation. Most field-installed accessory kits include installation instructions. Comply with applicable national and local codes when installing a wiring system.

Size the wire according to the length of run and 115% of the circuit current (amperage) as directed by the National Electrical Code® (NEC) in ANSI/NFPA 70.

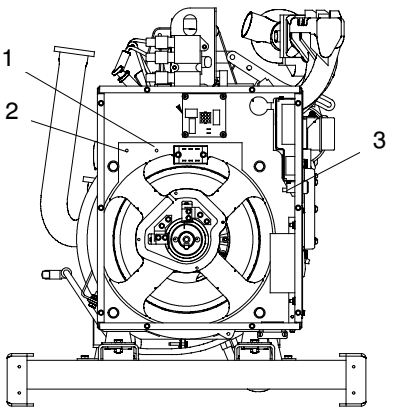
The National Electrical Code® is a registered trademark of the National Fire Protection Association, Inc.

1.8.3 Ground and Neutral Connections

Ground the generator set. The grounding method must comply with NEC and local codes. Connect the grounding strap to the generator set ground lug, terminal GND inside the junction box.

Various regulations and site configurations including the National Electrical Code (NEC), local codes, and the type of transfer switch used in the application determine the grounding of the neutral at the generator. NEC 2002 Section 250.20 is one example that has a very good explanation of the neutral grounding requirements for generators.

Kohler generator sets are shipped with the generator neutral attached to the generator in the junction box. At installation, the neutral can be grounded at the generator set or lifted from the ground stud and isolated if the installation requires an ungrounded neutral connection at the generator. The generator set will operate properly with the neutral either bonded to ground or isolated from ground at the generator.

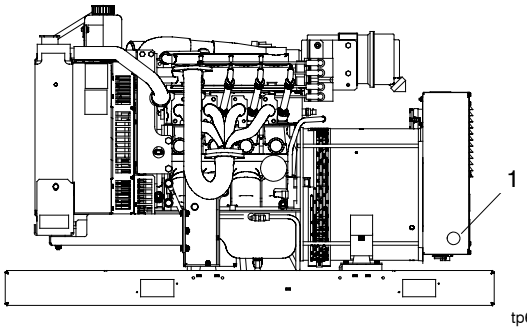


1. Ground GND connection
2. L0 connection
3. Line circuit breaker

Figure 1-1 Generator Set Equipment Ground Connection (inside junction box)

1.8.4 Load Lead Connections

Feed load leads to the generator set junction box through the back of the box. See Figure 1-2. Route DC leads in separate conduit from AC conductors.



1. Bring leads in through the back of the junction box at this location.

Figure 1-2 Load Lead Connection

1.8.5 Terminal Connector Torque

Use the torque values shown in Figure 1-3 or Figure 1-4 for terminal connectors. Refer to UL-486A, UL-486B, and UL-486E for information on terminal connectors for aluminum and/or copper conductors. Comply with applicable national and local codes when installing a wiring system.

Wire Size for Unit Connection	Tightening Torque, Nm (in. lb.)			
	Slot Head 4.7 mm (No. 10) or Larger*		Hexagonal Head—External Drive Socket Wrench	
AWG, kcmil (mm^2)	Slot Width <1.2 mm (0.047 in.) Slot Length <6.4 mm (0.25 in.)	Slot Width >1.2 mm (0.047 in.) Slot Length >6.4 mm (0.25 in.)	Split-Bolt Connectors	Other Connections
18–10 (0.82–5.3)	2.3 (20)	4.0 (35)	9.0 (80)	8.5 (75)
8 (8.4)	2.8 (25)	4.5 (40)	9.0 (80)	8.5 (75)
6–4 (13.3–21.2)	4.0 (35)	5.1 (45)	18.6 (165)	12.4 (110)
3 (26.7)	4.0 (35)	5.6 (50)	31.1 (275)	16.9 (150)
2 (33.6)	4.5 (40)	5.6 (50)	31.1 (275)	16.9 (150)
1 (42.4)	—	5.6 (50)	31.1 (275)	16.9 (150)
1/0–2/0 (53.5–67.4)	—	5.6 (50)	43.5 (385)	20.3 (180)
3/0–4/0 (85.0–107.2)	—	5.6 (50)	56.5 (500)	28.2 (250)
250–350 (127–177)	—	5.6 (50)	73.4 (650)	36.7 (325)
400 (203)	—	5.6 (50)	93.2 (825)	36.7 (325)
500 (253)	—	5.6 (50)	93.2 (825)	42.4 (375)
600–750 (304–380)	—	5.6 (50)	113.0 (1000)	42.4 (375)
800–1000 (406–508)	—	5.6 (50)	124.3 (1100)	56.5 (500)
1250–2000 (635–1016)	—	—	124.3 (1100)	67.8 (600)

* For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length is to be measured at the bottom of the slot.

Note: If a connector has a clamp screw such as a slotted, hexagonal head screw with more than one means of tightening, test the connector using both applicable torque values.

Figure 1-3 Tightening Torque for Screw-Type Pressure Wire Connectors

Note: If a connector has a clamp screw such as a slotted, hexagonal head screw with more than one means of tightening, test the connector using both applicable torque values provided in Figure 1-3.

Socket Size Across Flats, mm (in.)	Tightening Torque, Nm (in. lb.)
3.2 (1/8)	5.1 (45)
4.0 (5/32)	11.4 (100)
4.8 (3/16)	13.8 (120)
5.6 (7/32)	17.0 (150)
6.4 (1/4)	22.6 (200)
7.9 (5/16)	31.1 (275)
9.5 (3/8)	42.4 (375)
12.7 (1/2)	56.5 (500)
14.3 (9/16)	67.8 (600)

Note: For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length is to be measured at the bottom of the slot.

Figure 1-4 Tightening Torque for Pressure Wire Connectors with Internal-Drive Socket-Head Screws

1.8.6 Batteries

Battery location. Refer to generator set dimension drawing ADV-6916 for the battery location.

Battery type. Starting batteries are usually the lead-acid type and are sized according to the engine manufacturer's recommendation for a particular ambient temperature and required cranking time. The ADC 2100 uses three 15-second crank cycles separated by 15-second rests for larger models. Refer to the generator set specification sheet for the required battery cold-cranking ampere (CCA) rating.

1.8.7 Battery Chargers

An engine-driven, battery-charging alternator charges the battery whenever the generator set operates. Engine-driven systems can quickly restore the charge used in a normal cranking cycle.

When the engine is not operating, a very low charge rate from an AC-powered battery charger is usually sufficient to maintain a full charge on the batteries. Select an automatic float/equalize battery charger with a 3 amp or greater rating.

Use separate, self-contained battery chargers or units built into the automatic transfer switch. Run leads from a transfer switch-mounted battery charger in conduit separate from the conduit that holds the generator load cables or remote engine-start circuits.

1.8.8 Remote Start Connection (optional)

Connect leads 3 and 4 from the ADC 2100 controller to the automatic transfer switch's engine start terminals or to an optional remote start/stop switch.

1.8.9 Automatic Transfer Switches

A typical standby system has at least one automatic transfer switch connected to the generator set output to automatically transfer the electrical load to the generator set if the normal source fails. When normal power returns, the switch transfers the load back to the normal power source and then signals the generator set to stop.

The transfer switch uses a set of contacts to signal the engine/generator to start. When the normal source fails and the generator set master switch is in the AUTO position, the transfer switch contacts close to start the generator set.

The engine start terminals are usually located near the transfer switch contactor with an engine start decal identifying the terminals. Use the transfer switch wiring diagrams to identify the engine start terminals prior to making connections.

Use 14-gauge wire run through conduit to connect the transfer switch engine-start contacts or a remote manual engine-start switch to the engine start connectors on the generator set. Connect to leads 3 and 4 from the ADC 2100 generator set controller. Use separate conduits for engine-start leads, generator set load cables, and battery charger leads.

2.1 Introduction

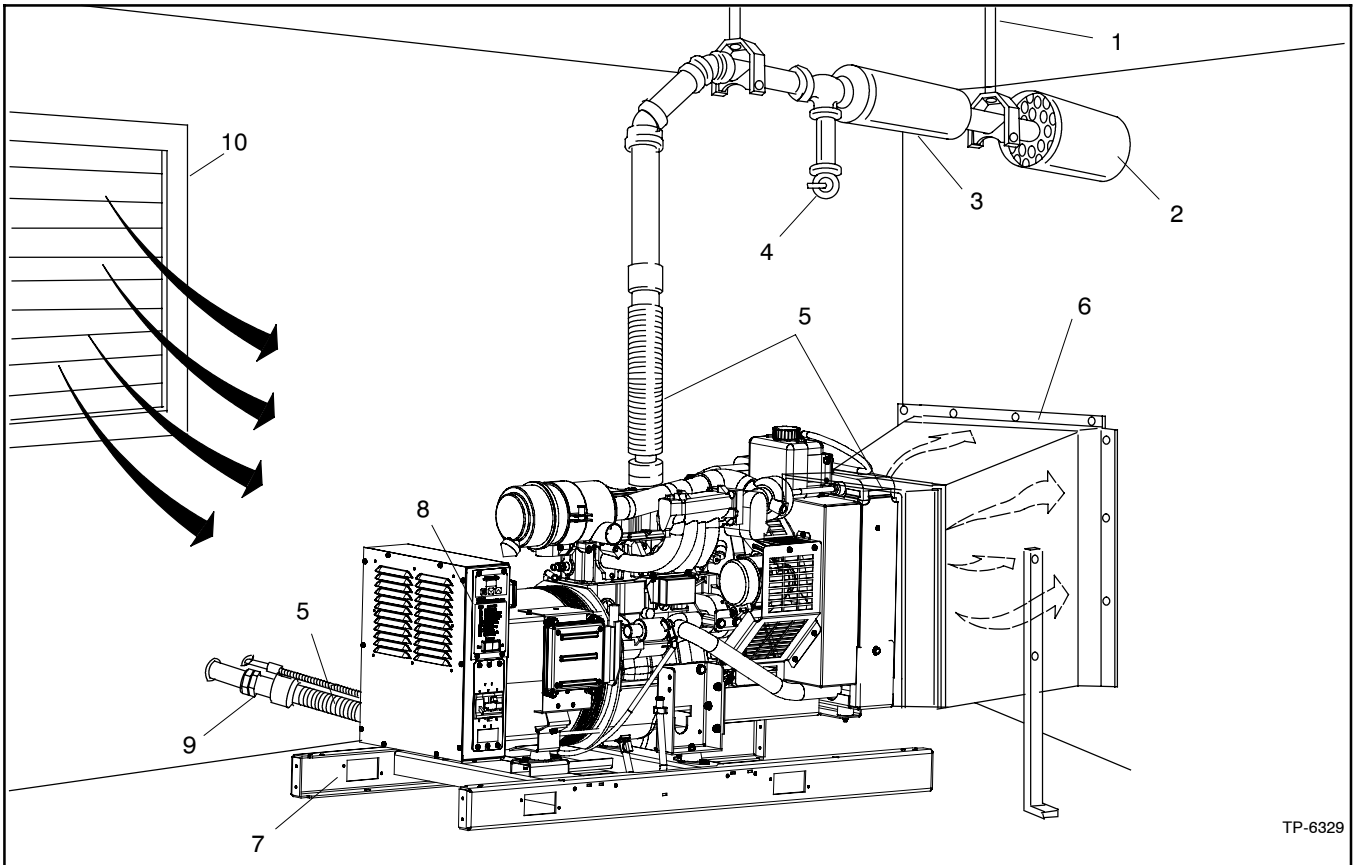
This section contains installation information specific to open (unhoused) commercial generator sets. Review the precautions in the Safety Precautions section and the information in Section 1, General.

Open (unhoused) commercial generator sets may be installed inside an unoccupied building if the exhaust gas is piped safely outside and adequate air flow is provided for cooling and combustion. The generator set location must be safe, secure (locked), and well-ventilated. Figure 2-1 illustrates a typical open-unit installation.

For the protection of the building's occupants, install carbon monoxide (CO) detectors on each level of the building. Locate the detectors to adequately warn the building's occupants of the presence of carbon monoxide.

Note: Do not install open (unenclosed) commercial generator sets in residential applications.

Note: Do not install enclosed units inside a building.



Note: Do not install open commercial generator sets in residential applications.

1. Supports
2. Exhaust thimble (for wall or ceiling)
3. Silencer
4. Water trap with drain
5. Flexible sections
6. Duct work for cooling air outlet
7. Mounting base
8. Controller
9. Electrical conduit
10. Fresh air intake

Figure 2-1 Typical Open Commercial Generator Set Installation

2.2 Air and Cooling

Combustion and heat dissipation require an ample flow of clean, cool air.

To prevent accumulation of explosive gases, ventilate compartments containing batteries.

2.2.1 Installation Considerations

Intake and outlet openings. Provide air intake and air outlet openings for generator sets located in a building or enclosure. Keep air inlets and outlets clean and unobstructed. Position the air inlet into the prevailing wind and the air outlet in the opposite direction.

Ventilating fans. Use ventilating fans and/or ductwork to increase airflow if the generator set's cooling fan does not provide adequate cooling to prevent overheating. See Figure 2-2. When using ductwork and ventilating fans, check the exhaust fan capacity in m^3/min. (cfm). If using exhaust fans, install fan-operated louvers with exhaust fans to regulate airflow. See Figure 2-5. Follow the fan manufacturer's recommendations to determine the size of the inlet and outlet openings.

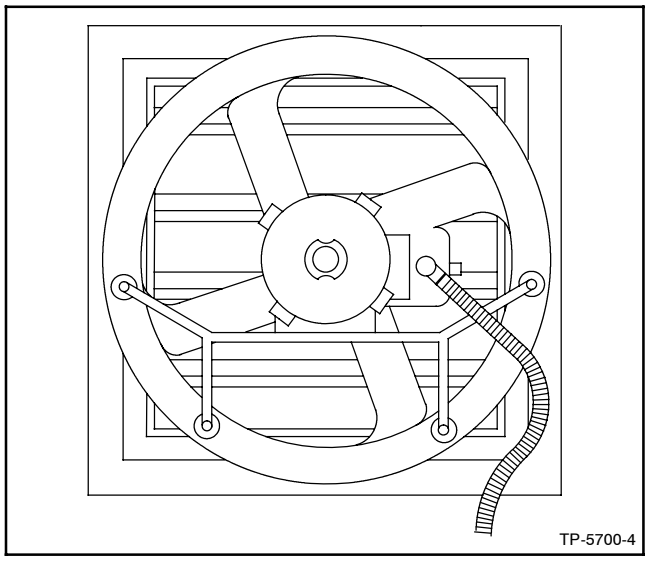


Figure 2-2 Ventilating Fans

Thermostatically-controlled louvers. The ventilation system must provide a temperature differential sufficient to prevent high engine temperature shutdown on even the hottest days.

In areas of great temperature variation, install movable louvers to thermostatically regulate airflow and room temperature. See Figure 2-3 and Figure 2-4. Refer to 2.2.2, Cooling Air Requirements, Louvers, for further information.

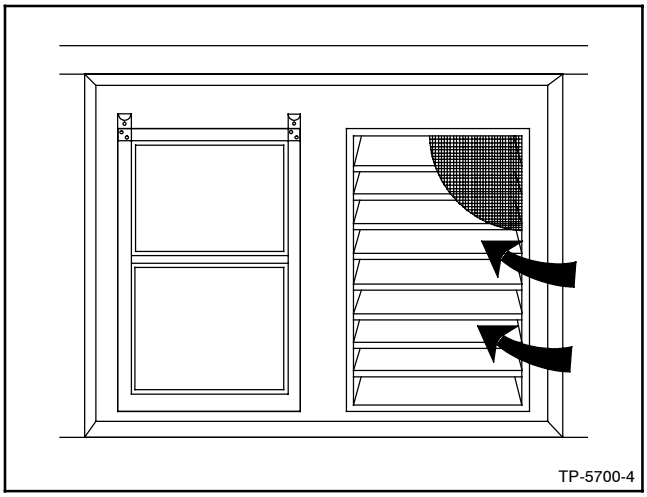


Figure 2-3 Stationary Air Inlet Louvers

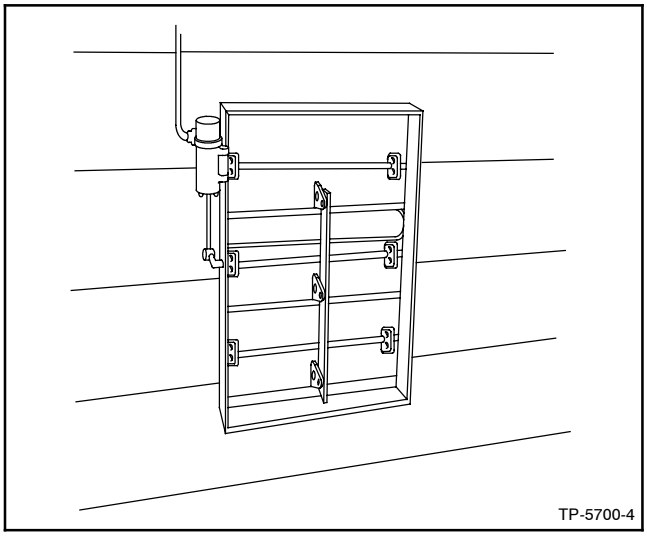


Figure 2-4 Moveable Air Inlet Louvers

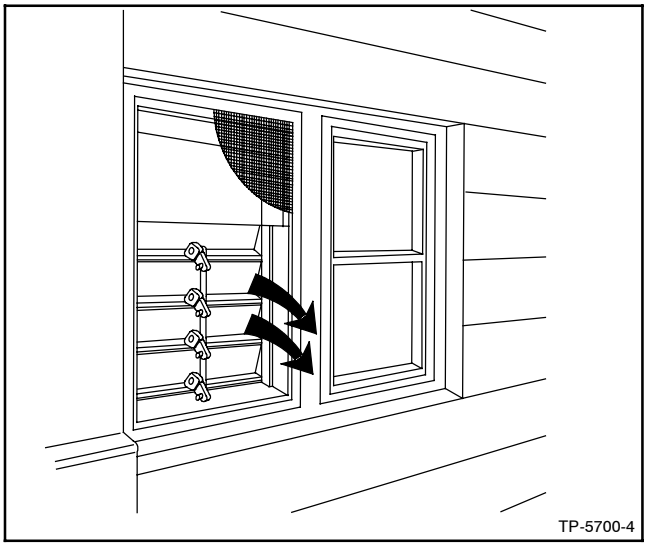


Figure 2-5 Exhaust Fan-Operated Louvers

In cold climate interior installations using controlled recirculation to recover heat, install thermostatically activated louvers and fans to prevent the generator set and engine room from overheating.

Electric louvers are usually connected to the optional generator set run relay. Typically, the louvers are energized to open when the generator set is operating. However, some louvers are energized to close and when deenergized are spring-actuated to open when the generator set is operating.

Filters. Install a furnace-type or similar filter in the inlet opening if the generator set operates in an atmosphere highly contaminated with impurities such as dust and chaff.

Air restrictions. When using a filter, screen, or other air restriction, increase the inlet opening size by the following amounts to compensate for diminished airflow:

- Louvers**:** Enlarge the opening 50%.
- Window screening: Enlarge the opening 80%.
- Furnace-type filters: Enlarge the opening 120%.

2.2.2 Cooling Air Requirements

The generator set is equipped with a unit-mounted radiator common cooling system. Figure 2-1 shows a typical unit-mounted radiator installation. Note the direction of airflow and refer to the figure as needed during installation.

Use ductwork to direct airflow. Direct the radiator air outside the room or enclosure using sheet metal ductwork with structural supports. Keep ductwork as short, straight, and unobstructed as possible. Combined static pressure restrictions greater than 0.12 kPa or 13 mm (0.5 in.) water column on the radiator inlet and outlet openings cause reduced airflow and contribute to overheating especially in high ambient air temperatures. Use heavy canvas, silicone rubber, or similar flexible material for the connection between the radiator duct flange and the ductwork to prevent noise and vibration transmission.

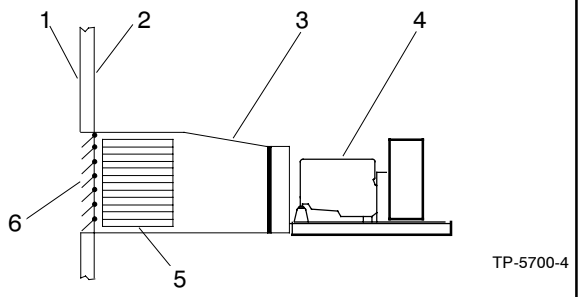
Outlet and inlet location and sizing. Size the outlet duct area 150% larger than the radiator duct flange area. Size the inlet air opening at least as large but preferably 50% larger than the outlet.

If screens, louvers, or filters are used on either the inlet or outlet, increase the inlet or outlet size according to the recommendations given in Section 2.2.1, Installation Considerations.

Since the exhaust air of larger units is both high volume and high velocity, direct the exhaust flow away from areas occupied by people or animals.

Louvers. Design temperature-controlling louvers to prevent air inlet restrictions and air pressure reductions inside the building. Low building pressure can extinguish pilot lights on gas-fired appliances or cause problems with the building ventilation system.

Additionally, bringing large quantities of winter air into a building wastes building heat and risks frozen water pipes in normally heated spaces. Use dampers and controlled air outlet louvers as shown in Figure 2-6 to eliminate these problems and allow recovery of engine heat to reduce building heat loss. Close the louvers to the exterior and open the interior louvers when the outdoor temperature is below 18–21°C (65–70°F). Reverse the louver settings when the outdoor temperature is above 21–24°C (70–75°F).

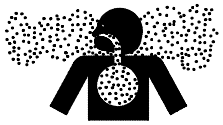


1. Exterior
2. Interior
3. Air outlet duct
4. Generator set
5. Dampers
6. Controlled air outlet louvers

Figure 2-6 Air Control Louvers

2.3 Exhaust System

⚠ WARNING



Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

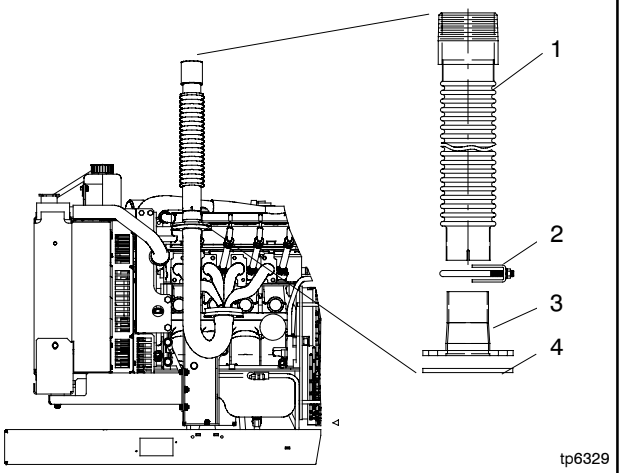
Generator set operation. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Avoid breathing exhaust fumes when working on or near the generator set. Never operate the generator set inside a building unless the exhaust gas is piped safely outside. Never operate the generator set where exhaust gas could accumulate and seep back inside a potentially occupied building.

Satisfactory generator set performance requires proper exhaust system installation. The following sections detail exhaust system components.

2.3.1 Flexible Exhaust Line

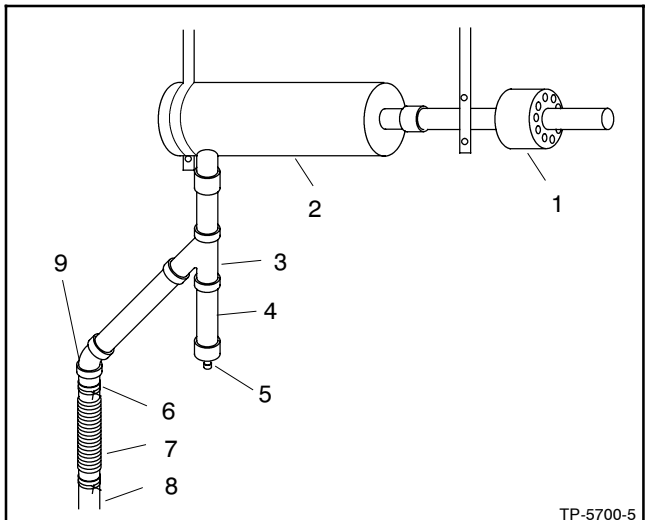
For units without enclosures or with separately mounted exhaust systems, install the flexible exhaust kit onto the engine exhaust outlet. See Figure 2-7 and Figure 2-8. The flexible line limits stress on the engine exhaust manifold or turbocharger. Never allow the engine manifold or turbocharger to support the silencer or exhausting piping.

Note: Do not bend the flexible section or use it to compensate for misalignment between the engine exhaust and the exhaust piping.



1. Flexible exhaust line
2. Clamp
3. Exhaust pipe
4. Gasket

Figure 2-7 Flexible Exhaust Kit

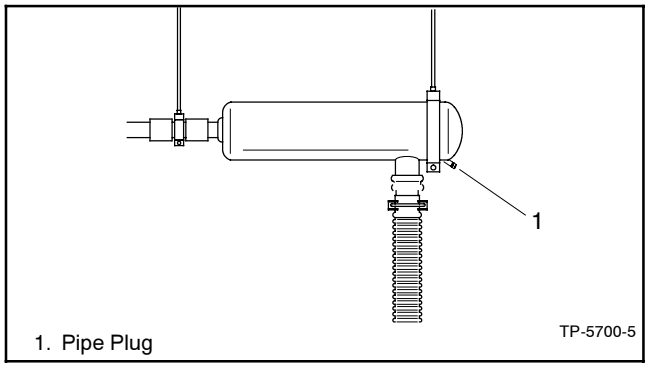


1. Exhaust wall thimble
2. Muffler
3. 45° Y fitting
4. Water trap
5. Drain petcock
6. Outer diameter adapter and clamp
7. Flexible section
8. Manifold
9. 45° elbow

Figure 2-8 Exhaust System, Side-Inlet Silencer

2.3.2 Condensation Trap

Some silencers are equipped with a drain pipe plug for draining condensation, see Figure 2-9. Otherwise, install a wye- or tee-type condensation trap with a drain plug or petcock between the engine and the exhaust silencer as shown in Figure 2-10. The trap prevents condensed moisture in the engine exhaust from draining into the engine after shutdown. Periodically drain collected moisture from the trap.



1. Pipe Plug

Figure 2-9 Silencer Condensation Drain Plug

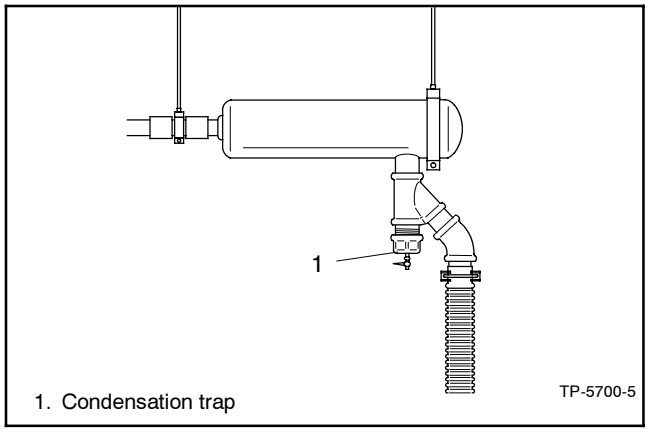


Figure 2-10 Condensation Trap

2.3.3 Piping

Note: Select piping with a diameter that is the same size as or larger than the manifold outlet's inside diameter.

- Keep exhaust lines as short and straight as possible.
- Use schedule 40 black-iron pipe.
- Use sweep elbows with a radius of at least three times the pipe diameter.
- Use exhaust piping that conforms to applicable codes.
- Support the exhaust piping securely, allowing for thermal expansion.
- Insulate the exhaust piping with high-temperature insulation to reduce the heat rejected by exhaust piping and consequently the amount of ventilating air required.

Exhaust temperatures measured at the engine's exhaust outlet are listed on the generator set specification sheets.

Route the exhaust piping a minimum of 914 mm (36 in.). from combustible material, including building materials and natural surroundings.

When planning exhaust silencer and piping placement, consider the location of combustible materials. If the proximity of the exhaust system to the combustible materials cannot be avoided, follow a regular maintenance schedule to ensure that combustible materials are kept away from the exhaust pipes after installation. Combustible materials include building materials as well as natural surroundings. Keep dry field grass, foliage, and combustible landscaping material a safe distance from the exhaust system.

2.3.4 Double-Sleeved Thimbles

If the exhaust pipe passes through a wall or roof, use a double-sleeved exhaust thimble to prevent the transmission of exhaust pipe heat to the combustible material. Figure 2-11 shows construction details of a typical double-sleeved thimble in which exhaust piping passes through a combustible structure. Sheet metal shops usually fabricate thimbles using installation engineer's specifications and drawings.

Construct the thimble so it extends at least 254 mm (10 in.) both inside and outside the structure's surface. Openings at both ends of the thimble allow cooling air to circulate through the thimble. If screening is used on the outer end to keep birds and animals from entering the thimble, use a mesh large enough to allow unrestricted air circulation through the thimble. See Section 2.3.5 for additional exhaust outlet location and protection considerations.

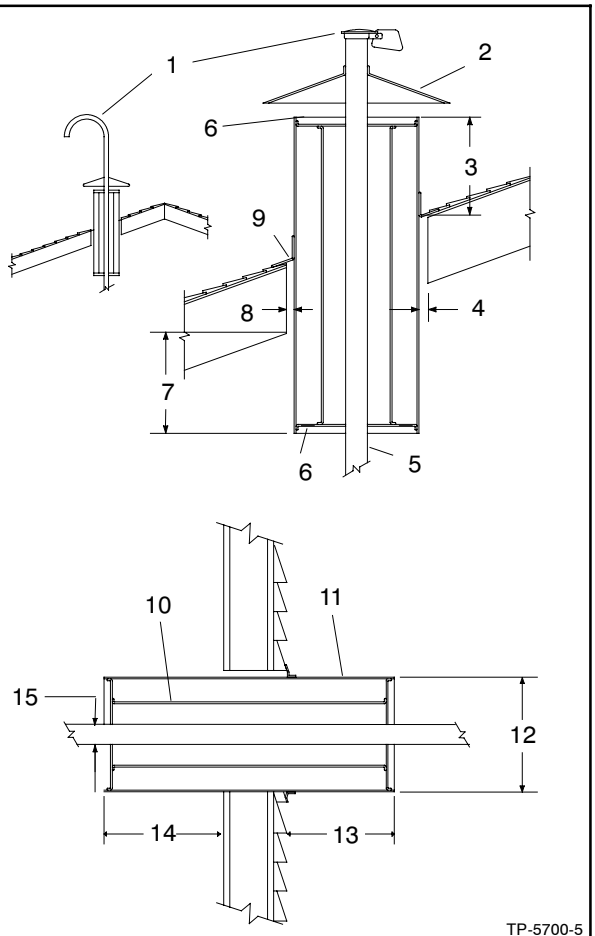
2.3.5 Exhaust Outlet

Outlet location. Engine performance and efficiency depend on the location of the exhaust outlet. Direct the exhaust outlet away from the air inlet to prevent exhaust gases from entering the air inlet and clogging the dry-type air filter elements. Hot exhaust drawn through the radiator adversely affects engine cooling. Locate the exhaust outlet to prevent exhaust fumes from entering a building or enclosure.

Noise reduction. The exhaust outlet configuration affects the apparent noise level for people or animals in the vicinity. An upward-directed outlet seems quieter than one directed downward or horizontally. Additionally, a 30- to 45-degree angled cut at the end of a horizontal exhaust outlet pipe reduces turbulence at the outlet, thereby reducing the noise level.

Rain cap. To prevent precipitation from entering the exhaust pipe, install a rain cap on vertical outlets. See Figure 2-11. In a climate where freezing is common, do not use a rain cap. Instead, extend the exhaust piping at least 610 mm (24 in.) beyond the roof line and create a gradual U bend at the end to direct the exhaust outlet downward. Keep the pipe outlet at least 457 mm (18 in.) from the roof to prevent hot exhaust from igniting the roof material.

Note: Avoid using a rain cap in areas subject to freezing temperatures.



1. Rain cap (or gradual U bend)
2. Rain shield
3. 254 mm (10 in.) minimum
4. 25 mm (1 in.) minimum
5. Exhaust pipe
6. Ventilation holes at both ends
7. 254 mm (10 in.) minimum
8. 25 mm (1 in.) minimum
9. Flashing
10. Inner sleeve
11. Outer sleeve
12. Thimble outer diameter
13. 254 mm (10 in.) minimum outside
14. 254 mm (10 in.) minimum inside
15. Exhaust pipe diameter

Figure 2-11 Double-Sleeved Thimbles and Rain Cap

2.3.6 Exhaust System Backpressure

Exhaust backpressure limits engine power and excessive backpressure causes serious engine damage. Excessive backpressure usually results from one or more of the following reasons:

- The exhaust pipe diameter is too small.
- The exhaust pipe is too long.
- The exhaust system has too many sharp bends.
- The exhaust silencer is too small.
- The exhaust silencer is not the correct design for the application.

The engine's maximum exhaust backpressure limit is 10.2 kPa (3.0 in. Hg). Use the following procedure to verify that the installed exhaust system does not exceed the maximum exhaust backpressure limit.

Exhaust System Backpressure Calculation Procedure

Determine the total backpressure by calculating the effects of the individual exhaust system components and adding the results. Make calculations using either English or metric units. Exhaust pipe references are nominal pipe NPT (in.) sizes. The procedure shows an example with *italic* text.

1. Identify the type of silencer used in the application and refer to Figure 2-12 for the silencer back pressure.

   Example: Determine the silencer backpressure for the recommended critical silencer on a model 30RYG generator set.
   Silencer backpressure = 5.5 kPa (1.6 in. Hg)

2. Refer to Figure 2-12 for the backpressure from the J-shaped engine-mounted exhaust pipe.

   Example: Determine the exhaust pipe backpressure for a model 30RYG generator set.
   Exhaust pipe backpressure = 1.7 kPa (0.5 in. Hg)

Silencer Type	Backpressure, kPa (in. Hg.)	
	15RYG	30RYG
Residential, SIEO, 2 in. NPT	1.5 (0.47)	4.7 (1.4)
Critical, SIEO, 2 in. NPT	1.7 (0.51)	5.5 (1.6)
Exhaust J-tube	0.3 (0.1)	1.7 (0.5)

Figure 2-12 Silencer and Engine Exhaust Pipe Back Pressures

3. Refer to the generator set specification sheet for:

   a. Engine exhaust flow at rated kW in m^3/min. (cfm)

      Example: 8.35 m^3/min. (295 cfm)

   b. Maximum allowable backpressure in kPa (in. of Hg)

      Example: 10.2 kPa (3.0 in. Hg)

4. Refer to the submittal catalog for:

   a. The flexible exhaust adapter part number
      Example: 324089

   b. Flexible exhaust adapter, flexible section length
      Example: 432 mm (17 in.)

5. Count the number of elbows and flexible sections in the exhaust system between the engine and the exhaust system outlet. Compare the radius of the bend (R) to the pipe diameter (D). Diameter is the nominal pipe diameter in inches. Determine the equivalent length in m (ft.) of straight pipe for the elbows and flexible sections from the following:

Bend Angle	Elbow Type	Bend Radius	Equivalent Length, ft.
90 °	Close	R = D	32 x D* / 12
90 °	Medium	R = 2D	10 x D* / 12
90 °	Sweep	R = 4D	8 x D* / 12
45 °	Close	R = D	15 x D* / 12
45 °	Sweep	R = 4D	9 x D* / 12
Flex Sections		—	2 x Length† / 12

* Use the diameter of the silencer inlet in *inches* from step 4 for the initial calculation. If the results from step 8 indicate excessive backpressure drop, then recalculate using the larger-diameter pipe size selected.

† Use the flexible exhaust adapter length from step 4 and add any additional flex sections in the exhaust system expressed in *inches*.

   Convert the equivalent pipe length calculated in feet to meters using ft. x 0.305 = m, as needed.

   Examples:

   For two 45 ° sweep elbows:
   9 x 2.0 in. / 12 = 1.5 equiv. ft. or 0.46 equiv. m
   Multiply by 2 for 2 elbows:

   2 x 1.5 ft. = 3.0 equivalent ft. or
   2 x 0.46 m = 0.92 equiv. m

   Flexible sections:
   2 x 17 in. / 12 = 2.8 equiv. ft. or 0.86 equiv. m

   Equivalent of straight pipe:
   3.0 + 2.8 = 5.8 equiv. straight ft.
   0.9 + 0.86 = 1.76 equiv. straight m

6. Determine the total length of straight pipe used in the exhaust system. Add this calculation to the equivalent length for elbows and flexible sections obtained in step 5.

   Example:

   Straight pipe = 3.0 m (10 ft.).
   Equivalent straight pipe from step 5: 1.76 m (5.8 ft.)

   3.0 m + 1.76 m =4 .76 m or
   10 ft. + 5.8 ft. = 15.8 ft. total

7. Refer to Figure 2-13. Place a straight edge across the chart with the edge in line with the pipe size in inches (D) on the right column from step 4 and the engine exhaust flow (Q) from step 2 on the left column.

   Read backpressure kPa/m or in. of Hg/ft. (ΔP) from the center column. Calculate the total piping system backpressure by multiplying the total equivalent straight pipe in m (ft.) from step 6 by the kPa/m or in. of Hg/ft. of pipe from this step.

   Example:

   4.76 equiv. m x 0.5 kPa/m =
   2.4 total system backpressure in kPa

   15.8 equiv. ft. x 0.048 in. Hg/ft. =
   0.76 total system backpressure in inches of Hg.

8. Add the backpressure of the piping determined in step 7 to the backpressure of the silencer and exhaust pipe determined in steps 1 and 2. The total should not exceed the engine manufacturer's maximum allowable system backpressure determined in step 2 or on the generator set's specification sheet. If the total exceeds the maximum, use a larger pipe size or silencer or both. Repeat the calculation if new components are selected to verify that the system backpressure would not exceed the limit using the larger component(s).

   Example:

   2.4+ 1.7 + 5.45 kPa = 9.55 kPa
   Maximum allowable backpressure = 10.2 kPa
   9.55 <10.2; backpressure drop is acceptable

   0.76 +0.5 + 1.6 in. Hg. = 2.86 in. Hg.
   Maximum allowable backpressure = 2.88 in. of Hg.
   2.86 < 3 in Hg; backpressure drop is acceptable

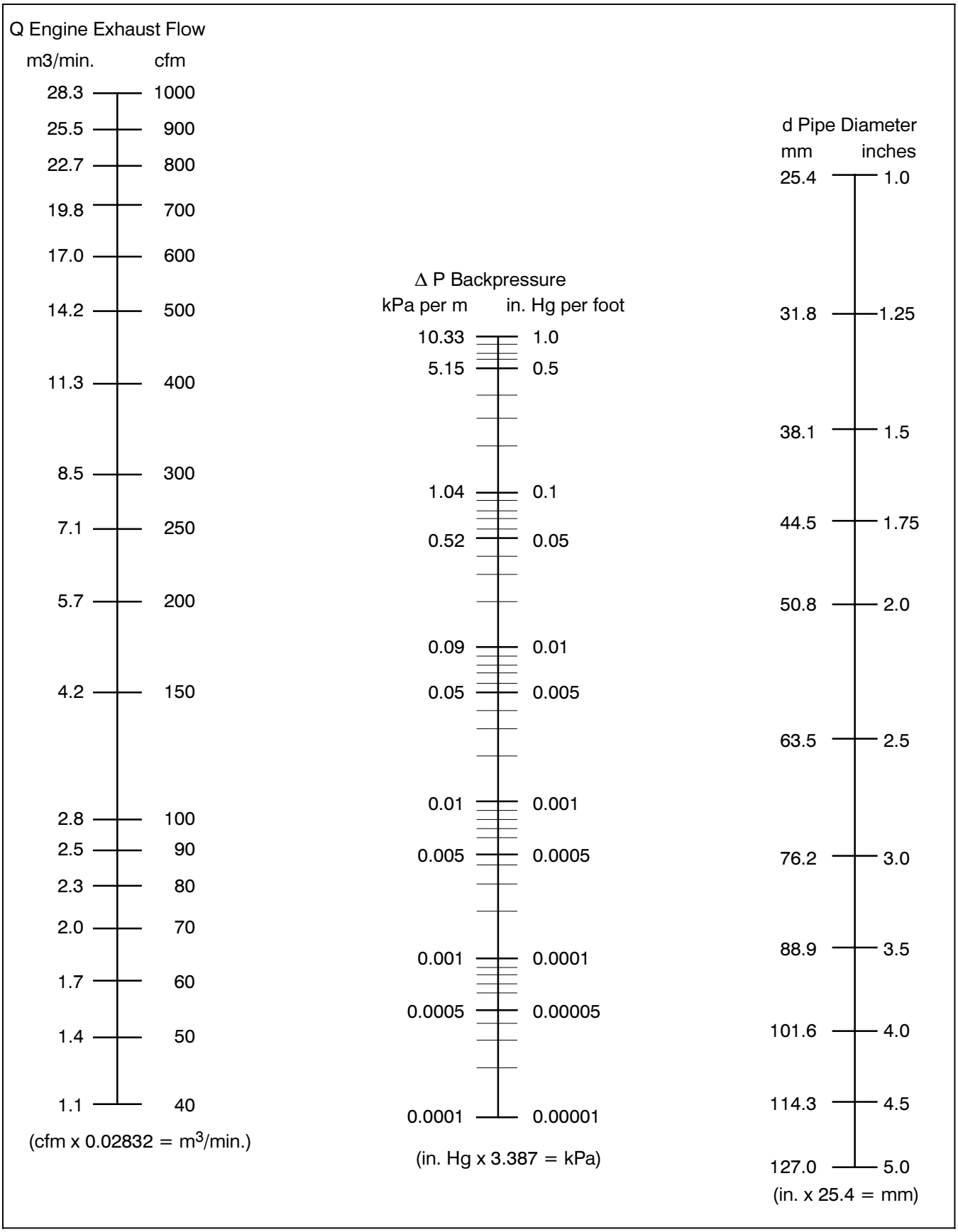


Figure 2-13 Backpressure using Pipe Size 4 in., 152 m or Less

3.1 Introduction

Have the generator set installed by a trained, authorized Kohler distributor, dealer, or authorized representative.

Note: These instructions outline one procedure for installing the generator set. Local codes may require different procedures. Install the equipment in compliance with the National Electrical Code (NEC) and local codes.

Enclosed units must be installed outside. The exhaust systems on enclosed units are designed for outdoor installations. Review the information in Section 1, General, before beginning the installation procedure.

Note: Do not install enclosed units inside a building.

Note: Outdoor Installations: Install carbon monoxide (CO) detector(s) on each level of any building adjacent to a generator set. Locate the detectors to adequately warn the building's occupants of the presence of carbon monoxide.

Open units may be installed inside a building. The exhaust must be piped safely outside, and adequate air for combustion and cooling must be provided. Review the information in Sections 1 and 2 before beginning the installation procedure. See Figure 2-1 for a typical open-unit installation.

Note: Indoor Installations: For the protection of generator set service technicians and any other people that may enter the building, install carbon monoxide (CO) detector(s) on each level of the building. Locate the detectors to adequately warn the building's occupants of the presence of carbon monoxide.

Read and follow the safety precautions in this manual and observe the decals on the equipment. Refer to the diagrams and drawings in Section 7 for dimensions and electrical connections during the installation procedure. Read the entire installation procedure and obtain the accessories and tools needed before beginning installation. Perform the steps in the order shown.

To install optional accessories, follow the instructions provided with each kit.

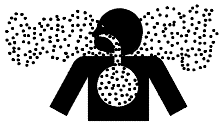
⚠ WARNING

Hazardous voltage.
Backfeed to the utility system can cause property damage, severe injury, or death.

If the generator set is used for standby power, install an automatic transfer switch to prevent inadvertent interconnection of standby and normal sources of supply.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, transfer switch, and related equipment and electrical circuits. Turn off the main circuit breakers of all power sources before servicing the equipment. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

⚠ WARNING



Carbon monoxide.
Can cause severe nausea, fainting, or death.

The exhaust system must be leakproof and routinely inspected.

Carbon monoxide detectors. Carbon monoxide can cause severe nausea, fainting, or death. Install carbon monoxide detectors on each level of the building. Locate the detectors to adequately warn the building's occupants of the presence of carbon monoxide. Keep the detectors operational at all times. Periodically test and replace the carbon monoxide detectors according to the manufacturer's instructions.

Tools Required:

- Multimeter (for measuring voltage and current)
- Frequency meter (may be part of multimeter)
- Torque wrench
- Wrenches
- Screwdrivers
- Socket wrenches or nut drivers
- Pliers
- Safety glasses or goggles
- Drill with bits and hole saw (outdoor installations)

Installer/Customer-Supplied Items:

- One 12-volt battery with a minimum rating of 600 cold cranking amps (CCA) at 0°F. Battery kit PA-324553 is recommended.
- Gravel or crushed stone (outdoor installations)
- Concrete mounting pad
- Cables and conduit
- Fuel supply line with shutoff valve and pipe sealant (provided by fuel supplier)
- Carbon monoxide (CO) detector(s)
- Exhaust piping (open units)

Required Accessories for Open Units:

- Silencer: Critical SIEO or engine-mounted
- Flex exhaust
- Radiator duct flange

Available Accessories:

- Air cleaner restriction indicator
- Battery charger
- Battery heater
- Block heater
- Flexible fuel lines
- Rain cap
- Relay kit, includes common fault and auxiliary run relays
- Remote digital gauge
- Rodent guards
- Skid end caps

3.2 Prepare Site

See Section 1.3 for important factors to consider in choosing the generator set location.

3.2.1 Indoor Installations, Open Units

Maintain a minimum of 457 mm (18 in.) between the generator set and any adjacent walls or obstructions to allow access for maintenance and service. See Figure 2-1 for a typical open-unit installation. Prepare an area for mounting the generator set.

1. Clear all combustible materials from the generator set location.

2. Refer to the applicable dimension drawing in Section 7 to find the minimum mounting pad dimensions. Lay a concrete pad, including mounting bolts and stub-ups for the fuel supply and electrical conduit as shown.

3. Provide air intake and outlet openings as described in Section 2.2.

3.2.2 Outdoor Installations, Enclosed Units

Choose a location that is at least 0.9 m (3 ft.) from any building or structure and near the incoming gas service. Allow a minimum of 2.4 m (8 ft.) clearance beyond the exhaust end of the generator set. Plan the installation so that the exhaust end of the generator set is not directed toward the building or any openings where exhaust gas could be drawn into the building.

1. Obtain a building permit and contact your local utility companies to mark the locations of underground pipes and cables.

2. Prepare an area for mounting the generator set.

   a. Clear all combustible materials, including plants and shrubs, building materials, and lawn furniture, from an area at least 2.4 m (8 ft.) beyond the exhaust end of the generator set.

   b. Spread a 76-mm (3-in.) thick layer of gravel to support the concrete mounting pad. For the mounting pad dimensions, see Figure 7-2 for weather enclosures or Figure 7-6 for sound enclosures.

   c. Lay a 100 mm (4 in.) thick concrete pad on the gravel layer. Include mounting bolts and stub-ups for the fuel supply and electrical conduit. See Figure 7-2 or Figure 7-6 for the mounting pad dimensions, mounting bolts, and stub-up locations.

3.3 Lifting Generator Set

⚠ WARNING

Unbalanced weight.
Improper lifting can cause severe injury or death and equipment damage.

Do not use lifting eyes.
Lift the generator set using lifting bars inserted through the lifting holes on the skid.

Open generator sets weigh approximately 325 kg (720 lb.). Enclosed units weigh approximately 500 kg (1100 lb.). Use equipment that is rated for the generator set's weight to lift the unit into place.

Follow these general precautions when lifting all generator sets. When lifting housed units, lift the weather enclosure and generator set together as one unit.

- Do not lift the generator set using the lifting eyes attached to the engine and/or alternator. These eyes cannot support the generator set's weight. Instead, insert lifting hooks or lifting bars through the four holes in the mounting skid. The placement of the holes prevents the lifting cables from damaging the generator set components and maintains balance during lifting.
- If the lifting cables contact the air cleaner, guards, or other protruding components, use spreader bars on the cables. If the cables still do not clear the protruding component(s), temporarily remove the component(s).

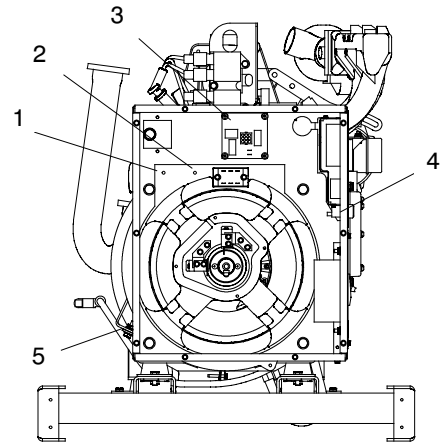
3.4 Mount and Ground Generator Set

1. Place the generator set on the concrete mounting pad. Secure the generator set with mounting bolts anchored in the concrete pad.

2. Ground the generator set. The grounding method must comply with NEC and local codes. Connect the grounding strap to the generator set ground lug, terminal GRD inside the controller compartment. See Figure 3-1.

Kohler generator sets are shipped with the generator neutral attached to the generator in the junction box. At installation, the neutral can be grounded at the generator set or lifted from the ground stud and isolated if the installation requires an ungrounded neutral connection at the generator. The generator set will operate properly with the neutral either bonded to ground or isolated from ground at the generator.

Various regulations and site configurations including the National Electrical Code (NEC), local codes, and the type of transfer switch used in the application determine the grounding of the neutral at the generator. NEC 2002 Section 250.20 is one example that has a very good explanation of the neutral grounding requirements for generators.



1. Neutral (L0) connection
2. Ground (GRD) connection
3. Relay interface board (RIB; standard 3-relay board shown)
4. Line circuit breaker
5. Load lead access opening

Figure 3-1 Generator Set Electrical Connections

3.5 Generator Set Electrical Connections

Note: Have a licensed electrician make the following electrical connections. All connections must comply with state and local codes.

Size the wire according to the length of run and 115% of the circuit current (amperage) as directed by the National Electrical Code® (NEC) in ANSI/NFPA 70. See Figure 3-1 and refer to the wiring diagrams in Section 7, Diagrams and Drawings.

Load Lead and Engine Start Connections

1. Install a 120 VAC receptacle for the generator set battery charger and block heater, if equipped. Supply power to the receptacle through a circuit that is powered at all times, by the utility and by the generator set during utility power outages.

2. Some codes require the use of a disconnect switch. Check the code requirements for your location and install a disconnect switch, if required.

3. Use separate conduit for the power cables and the low voltage engine start leads. Local codes and the length of run as well as the transfer switch wire size requirements will determine the wire size needed for the AC leads. Route the load leads into the junction box through the access opening in the back of the box.

4. Connect the load leads from the line circuit breaker in the generator set junction box to the transfer switch emergency power connection points. See Figure 3-1 and refer to the transfer switch Installation Manual for ATS connection instructions.

5. Use a minimum of 16 gauge wire for the engine start connections. Connect the engine start leads to leads 3 and 4 at the customer interface connector and to the engine start terminals on the transfer switch. Refer to the transfer switch Installation Manual for ATS connection instructions.

6. If an auxiliary fault switch is used, connect it to leads 30 and N at the customer interface connector.

Optional Five-Relay Interface Board (RIB)

The optional relay interface board (RIB) has 5 relays and a customer connection harness. The standard RIB has 3 relays with no customer connections required. See Figure 3-1 for the RIB location.

The common fault relay is energized on a fault. The auxiliary run relay is energized when the generator set is running. When a relay is energized, the normally open contacts close and the normally closed contacts open.

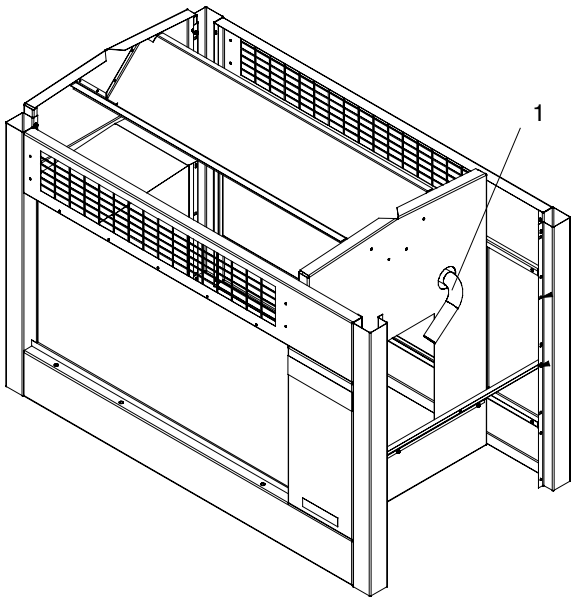
Connect customer equipment to connector P24 on the optional relay board harness. Use 16 gauge or larger leads for the relay connections. Connect to each relay's normally open or normally closed contacts depending on the requirements for the connected equipment. See Figure 3-2 and the manufacturer's instructions for the connected equipment.

Lead Number	P24 Pin Number	Connection
88	6	Common fault relay normally open
89	2	Common fault relay common
90	3	Common fault relay normally closed
91	4	Run relay normally open
92	1	Run relay common
93	5	Run relay normally closed

Figure 3-2 Optional Relay Connections

3.6 Exhaust Pipe Orientation (Dropover Sound Enclosures)

Generator sets equipped with dropover style sound enclosures are shipped with the exhaust pipe disconnected from the silencer. Connect the exhaust pipe after installing the enclosure. Install the exhaust pipe with the opening pointed down and angled toward the center of the generator set at a 45 degree angle. See Figure 3-3 and the decal in the exhaust compartment of the enclosure.



1. Exhaust pipe. Orient at 45 degree angle as shown.

Figure 3-3 Exhaust Pipe Orientation

3.7 Install Engine Starting Battery

⚠ WARNING

Explosion.
Can cause severe injury or death.
Relays in the battery charger cause arcs or sparks.

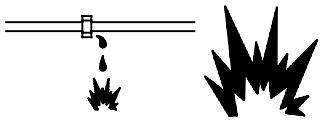
Locate the battery in a well-ventilated area. Isolate the battery charger from explosive fumes.

Battery gases. Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flames or sparks to occur near a battery at any time, particularly when it is charging. Do not dispose of a battery in a fire. To prevent burns and sparks that could cause an explosion, avoid touching the battery terminals with tools or other metal objects. Remove all jewelry before servicing the equipment. Discharge static electricity from your body before touching batteries by first touching a grounded metal surface away from the battery. To avoid sparks, do not disturb the battery charger connections while the battery is charging. Always turn the battery charger off before disconnecting the battery connections. Ventilate the compartments containing batteries to prevent accumulation of explosive gases.

1. Verify that the generator set master switch is in the OFF/RESET position.
2. Ensure that the starting battery is fully charged before placing the battery in service.
3. Clean the battery posts and/or adapters if necessary.
4. Install battery post adapters, if needed.
5. Place the battery on the battery rack on the skid. See dimension drawing ADV-6916A in Section 7 for the battery location.
6. Connect the red battery cable to the positive (+) battery terminal.
7. Connect the black battery cable to the negative (-) battery terminal.
8. Place the boots over the battery terminals.
9. Plug the battery heater and battery charger, if equipped, into the 120 VAC power supply.

3.8 Install and Connect Fuel Supply

⚠ WARNING



Explosive fuel vapors.
Can cause severe injury or death.

Use extreme care when handling, storing, and using fuels.

The fuel system. Explosive fuel vapors can cause severe injury or death. Vaporized fuels are highly explosive. Use extreme care when handling and storing fuels. Store fuels in a well-ventilated area away from spark-producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running because spilled fuel may ignite on contact with hot parts or from sparks. Do not smoke or permit flames or sparks to occur near sources of spilled fuel or fuel vapors. Keep the fuel lines and connections tight and in good condition. Do not replace flexible fuel lines with rigid lines. Use flexible sections to avoid fuel line breakage caused by vibration. Do not operate the generator set in the presence of fuel leaks, fuel accumulation, or sparks. Repair fuel systems before resuming generator set operation.

Note: Have the fuel piping and regulator installed by the fuel supplier. The fuel supply installation must comply with NFPA and local codes.

1. See Figure 3-4, Figure 3-5, and Figure 3-6 for the fuel supply requirements. Add up the fuel requirements for the generator set plus all other gas-fired equipment fueled by the same supply. Check that the primary regulator and gas meter have sufficient capacity for the fuel requirements for the generator set plus all other gas-fired equipment. Have the fuel supplier install a larger gas meter, if necessary.

Model	Gas Flow Rate, Btu/hr.	
	Natural Gas	LP
15RYG	205,000	212,500
30RYG	548,000	547,500

Figure 3-4 Natural Gas Flow Rate

Fuel Supply Specifications	
Fuel type	LP Gas or Natural Gas
Fuel supply inlet	3/4-14 NPT
Fuel supply pressure oz./in.^{2} (in. H_2O)	4-6 (7-11)
Nominal Fuel Rating, Btu/ft^3:	
Natural gas	1000
LP vapor	2500

Figure 3-5 Fuel Requirements

Fuel Consumption	15RYG	30RYG
Natural Gas, m^3/hr. (cfh) at % load		
100%	5.7 (200)	12.7 (450)
75%	4.5 (160)	10.6 (375)
50%	3.5 (125)	8.5 (300)
25%	2.5 (90)	6.4 (225)
LP Gas, m^3/hr. (cfh) at % load		
100%	2.4 (85)	5.1 (180)
75%	1.8 (65)	4.2 (150)
50%	1.4 (51)	3.4 (120)
25%	1.0 (37)	2.5 (90)

Figure 3-6 Generator Set Fuel Consumption

2. Measure the pipe length from the primary gas pressure regulator to the pipe connection on the generator set fuel inlet. Add 2.4 m (8 ft.) to the measured length for each 90 degree elbow. Use the pipe size indicated in Figure 3-7 for the total length of pipe.

   Have your fuel supplier install a manual fuel shut-off valve and rigid gas piping. Bring the pipe to within 10 inches of the generator set fuel inlet location. See Figure 3-8.

Maximum Pipe Length m (ft.)	Pipe Size	
	15RYG	30RYG
6.1 (20)	3/4 in. NPT	1 1/4 in. NPT
9.1 (30)	1 in. NPT	1 1/4 in. NPT
18.3 (60)	1 in. NPT	1 1/2 in. NPT
30.5 (100)	1 1/4 in. NPT	1 1/2 in. NPT
45.7 (150)	1 1/4 in. NPT	2 in. NPT
61.0 (200)	1 1/4 in. NPT	2 in. NPT

Figure 3-7 Fuel Pipe Sizes

Figure 3-8 Manual Fuel Shut-Off Valve (outdoor installation shown)

3. Connect the fuel supply.

   a. Apply pipe sealant that is approved for fuel connections to the threaded fuel connections.

   b. Use a section of flexible fuel line to connect the fuel supply to the fuel inlet connection on the generator set. See Figure 3-9 and Figure 3-10 for the fuel inlet connection location.

   c. Open the manual fuel valves and leak test all fuel connections using soapy water. If a leak is detected, close the fuel valves, disconnect the lines at the location of the leak, clean the fittings, and apply fresh pipe sealant. Reconnect the lines and recheck for leaks.

   Note: After the system installation is complete, check for fuel leaks with the generator set running. See Section 3.9, Operation Tests.

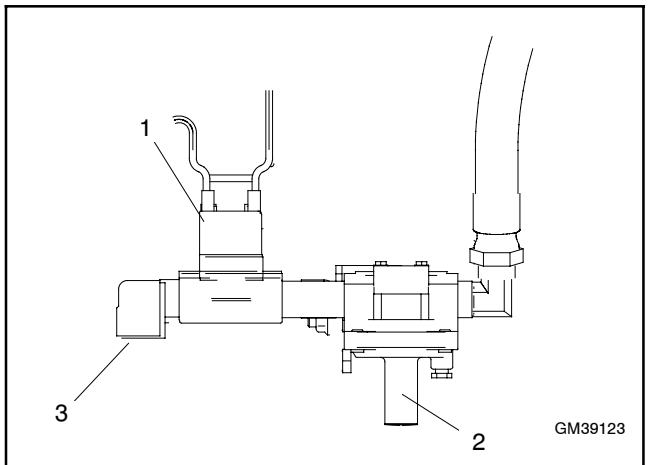
4. Check that the fuel system is set up for the fuel being used (natural gas or LP).

   a. Check the orientation of the fuel regulator and check the hang tag attached to the regulator. The fuel regulator is installed pointing up for natural gas and down for LP gas. See Figure 3-10.

   b. Use the following procedure to convert the fuel system, if necessary.

1. Fuel system

Figure 3-9 Generator Set Fuel System Location (enclosed unit shown)



1. Solenoid valve
2. Secondary regulator (shown pointing down for LP)
3. Fuel supply connection

Note: UL 2200 listed units include a second fuel valve.

Figure 3-10 Fuel System (LP gas setup shown)

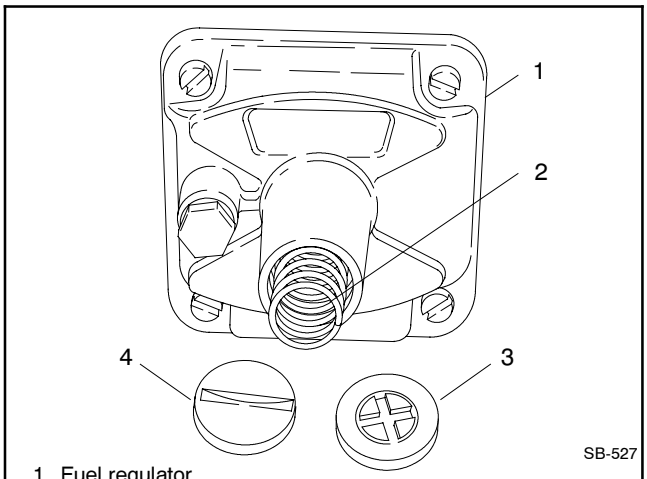
3.8.1 Fuel Conversion Procedures

When converting the generator set to operate with LP gas, remove the internal spring from the secondary regulator and rotate the regulator to point down. To operate the generator set on natural gas, install the spring and rotate the regulator to point up.

LP Fuel Conversion Procedure

Use the following steps to set the fuel system for LP gas:

1. Remove the fuel regulator cover plug. See Figure 3-11.



1. Fuel regulator
2. Spring
3. Adjustment screw
4. Cover plug

Figure 3-11 Fuel Regulator, Typical

2. Remove the adjustment screw and spring from the fuel regulator. Save the adjustment screw and spring for possible conversion back to natural gas.

3. Reinstall the cover plug.

4. Rotate the regulator to point down as shown in Figure 3-10.

5. Disconnect leads 65 and 70A at the quick connects in the wiring harness.

6. Connect a manometer to check the fuel supply pressure on the carburetor side of the regulator.

7. Adjust the fuel supply pressure with the generator set running at full load. Rotate the adjustment screw on the primary fuel regulator until the manometer indicates a fuel pressure of 7–11 inches water column. Pressures below 7 inches water column may result in poor response to load changes or lack of power.

8. Reinstall the cover plug.

9. Check the fuel connections for leaks with the generator set running.

10. With the generator set running at rated load, use a UEGO oxygen sensor to check and adjust the fuel mixture. Use Oxygen Sensor Service Kit GM29385 and follow the instructions in Section 3.8.2.

Natural Gas Fuel Conversion Procedure

Use the following steps to convert the generator set to natural gas:

1. Rotate the regulator so that it is pointing up.

2. Remove the fuel regulator cover plug. See Figure 3-11.

3. Install the spring and adjustment screw.

4. Set the adjustment screw to 11 mm (7/16 in.) below the top of the regulator.

5. Connect leads 65 and 70A at the quick-connects in the wiring harness.

6. Connect a manometer to check the fuel supply pressure on the carburetor side of the regulator.

7. Adjust the fuel pressure with the generator set running at full load. Rotate the adjustment screw on the secondary fuel regulator until the manometer indicates a fuel pressure of 4–6 inches water column.

8. Reinstall the cover plug.

9. With the generator set running at rated load, use a UEGO oxygen sensor to check and adjust the fuel mixture. Follow the instructions in Section 3.8.2.

3.8.2 Fuel System Adjustment Procedures

⚠ WARNING

Hot engine and exhaust system. Can cause severe injury or death.

Do not work on the generator set until it cools.

Servicing the exhaust system. Hot parts can cause severe injury or death. Do not touch hot engine parts. The engine and exhaust system components become extremely hot during operation.

Use a UEGO oxygen sensor to check the fuel system adjustment. Use Oxygen Sensor Service Kit GM29385 or GM58035.

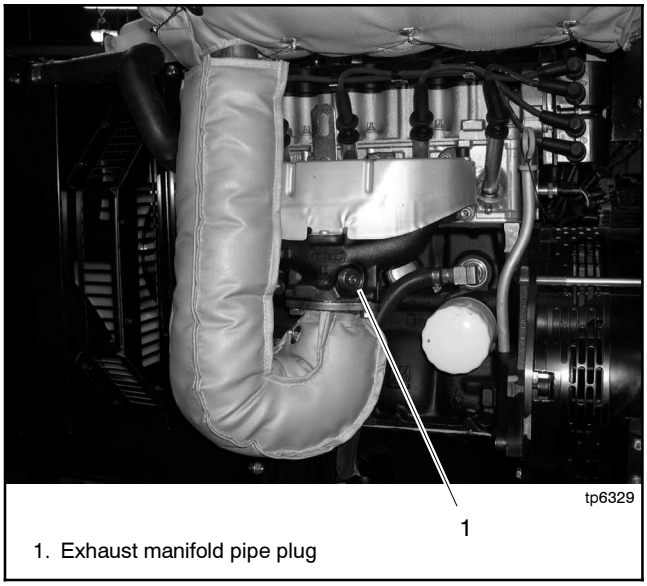
1. Place the generator set master switch in the OFF position.

2. Disconnect power to the battery charger, if equipped.

3. Disconnect the generator set engine starting battery, negative (–) lead first.

4. Allow the generator set to cool.

5. Install the oxygen sensor in the exhaust manifold at the location shown in Figure 3-12.



1. Exhaust manifold pipe plug

Figure 3-12 Oxygen Sensor Mounting Location

6. Connect the oxygen sensor harness as directed in the instructions provided with the oxygen sensor kit.

7. Check that the generator set master switch is in the OFF position.

8. Reconnect the generator set engine starting battery, negative (–) lead last.

9. Place the controller master switch in the RUN position to start generator set.

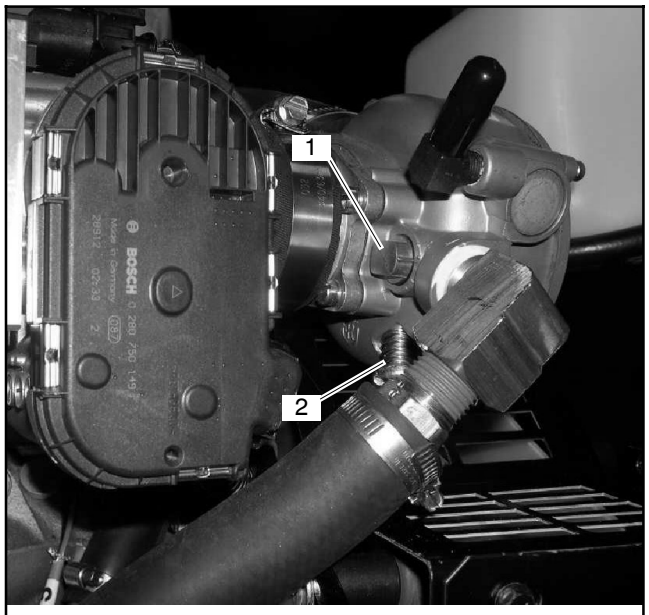
10. Allow the generator set to run until the generator set reaches normal operating temperature. The time required to reach normal operating temperature depends primarily on the ambient temperature and the size of the engine.

11. With the generator set at normal operating temperature, apply 90%–100% of rated load. If a load bank is not available, apply a load at least comparable to what is generally connected to the generator set.

12. Adjust the fuel mixture adjustment screw (on the mixer, see Figure 3-13) to obtain a full load oxygen sensor voltage reading of 2.5 × ±0.10 VDC (or a lambda (λ) value of approximately 1.0 as indicated in the instructions provided with oxygen sensor kit GM58035).

    If the oxygen sensor voltage reading is too low with the fuel mixture adjustment in the richest position (turned in clockwise), turn the fuel regulator adjustment screw clockwise and readjust the fuel mixture adjustment screw.

    If the oxygen sensor voltage reading is too high with the fuel mixture adjustment in the leanest position (turned out counterclockwise), turn the fuel regulator adjustment screw counterclockwise and readjust the fuel mixture adjustment screw.



1. Fuel mixture adjustment screw (full load)
2. Idle adjustment screw

tp6329

Figure 3-13 Fuel Mixture Adjustment Screw Location

13. Disconnect the load.

14. Adjust the idle screw (see Figure 3-13) to obtain a no-load oxygen sensor voltage reading of 2.5 ±0.10 VDC.

15. Repeat steps 11 through 14 to verify the settings.

16. Place the generator set master switch in the OFF position to stop generator set.

17. Disconnect the generator set engine starting battery(ies), negative (–) lead first.

18. Allow the generator set exhaust system to cool. Disconnect and remove the oxygen sensor as instructed in SB-634.

19. Reconnect the generator set engine starting battery, negative (–) lead last.

20. Reconnect power to battery charger, if equipped.

3.9 Operation Tests

⚠ WARNING

Hazardous voltage. Moving parts. Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

1. Check the items in the Prestart Checklist in the generator set Operation Manual, TP-6197.

2. Move the generator set master switch to the RUN position to start the generator set.

3. Use a digital voltmeter (DVM) to check the output voltage from the generator set. If voltage adjustments are required, refer to Section 5.4 for instructions to use the ADC 2100 voltage adjustment menu.

4. Perform voltage checks as described in the ATS Operation and Installation manual. Close the main circuit breaker on the main distribution panel when instructed to connect power in the test procedure.

5. Test the system operation as described in the ATS Operation and Installation manual.

6. Set the exerciser on the transfer switch. Refer to the instructions in the ATS Operation and Installation manual.

7. Verify that the generator set master switch is in the AUTO position.

8. Verify that all guards and enclosures are in place.

Notes

4.1 Introduction

Accessories are available factory-installed and/or shipped loose. Obtain the most current list of accessories from the generator set specification sheet or by contacting your local authorized service distributor/dealer.

Have accessories installed by a trained, authorized Kohler distributor, dealer, or authorized representative. Follow the installation instructions provided with each kit. Use separate conduit for AC and DC leads to reduce the possibility of electrical interference. Use shielded cable for all analog inputs. Verify that the leads and conduit do not interfere with the operation of the generator set or obstruct the service areas.

Verify that the accessory installation complies with the National Electrical Code (NEC) and all applicable local and state codes.

Accessory Wiring. To determine the appropriate size for the customer-supplied wiring of engine battery-powered accessories, use the guidelines in Figure 4-1. Use 18–20 gauge wire for signal wires up to 305 m (1000 ft.).

Length, m (ft.)	Wire Gauge
30.5 (100)	18–20
152.4 (500)	14
304.8 (1000)	10

Figure 4-1 Wire Length and Size, Lead N and 42B

See Section 7, Diagrams and Drawings, for more information regarding generator set electrical connections.

The following sections detail a few common accessories and their functions. The instructions provided with the accessory kit supersede these instructions, if different.

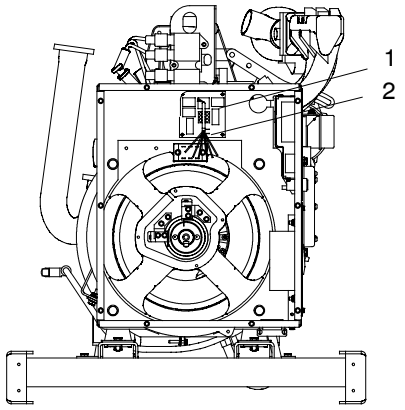
4.2 Common Fault and Run Relay Board

The optional relay board replaces the standard relay interface board (RIB) and provides two additional relays to control customer-provided equipment:

- Common fault relay
- Auxiliary run relay

The relay board location is shown in Figure 4-2. Connect customer equipment to the relay board harness. Figure 4-3 lists the customer connections.

The common fault relay is energized on a fault. The auxiliary run relay is energized when the generator set is running. Connect to each relay's normally open or normally closed contacts depending on the application.



1. Relay board location
2. Relay board harness

Figure 4-2 Common Fault and Run Relay Board

Harness Lead Number	Connector Pin Number	Connection
88	6	Common fault normally open
89	2	Common fault common
90	3	Common fault normally closed
91	4	Run relay normally open
92	1	Run relay common
93	5	Run relay normally closed

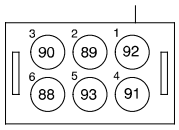


Figure 4-3 Common Fault and Run Relay Board Harness Connections

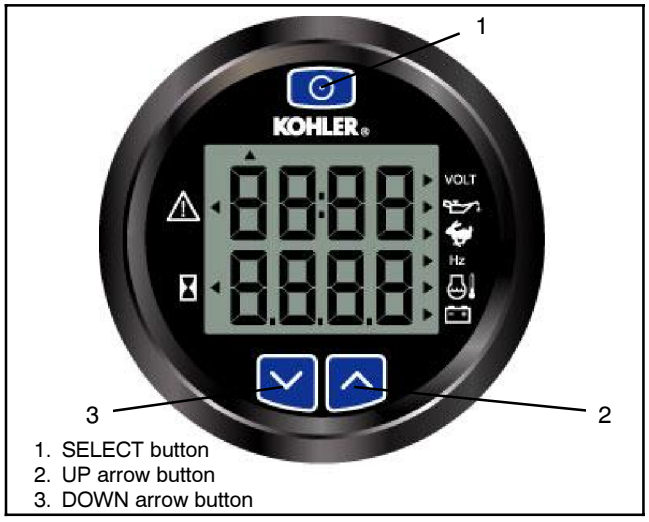
4.3 Remote Digital Gauge

The digital gauge allows for remote starting/stopping and monitoring of certain generator set functions. See Figure 4-4. (The remote digital gauge does not display oil pressure for model 15/30RYG generator sets.) The generator set has a 12-pin customer-interface connector for connection to the remote digital gauge. Refer to TT-1379 for instructions to install, connect, and operate the remote digital gauge.

The ADC 2100 communications parameter Cn must be set to Cn01 to communicate with the gauge. See Section 5.3.

If the ADC 2100 is configured for a CAN gauge (communications parameter setting Cn01 or Cn02), the controller remains powered continuously to maintain communication with the gauge. If the ADC 2100 is not configured for a CAN gauge (communications parameter setting Cn00), the controller will power down after 48 hours of no activity.

ADC 2100 application program version 1.14 or higher is required for the remote digital gauge. Refer to TT-1285, Program Loader Instructions, for instructions to load the latest version of the controller application code, if necessary.



1. SELECT button
2. UP arrow button
3. DOWN arrow button

Figure 4-4 Remote Digital Gauge

Use one or more remote extension harness kits to connect the gauge to the generator set. Do not use more than 3 remote harness kits and do not exceed 22.86 m (75 ft.) in harness length. See Figure 4-5 for kit selection.

Remote Extension Harness Kit Number	Length m (ft.)
GM32333-KP1	4.6 (15)
GM32333-KP2	7.6 (25)

Figure 4-5 Remote Extension Harness Kits (For Gauge to Generator Set)

4.4 Block Heaters

Block heaters are available as installed accessories on all generator sets. Use block heaters on all standby applications where the generator set is subject to temperatures below 16°C (60°F). Connect the block heater to a power source that is energized when the generator set is not running.

Note: Block heater damage. The block heater will fail if the energized heater element is not immersed in coolant. Fill the cooling system before turning on the block heater. Run the engine until it is warm and refill the radiator to purge the air from the system before energizing the block heater.

5.1 Advanced Digital Control (ADC 2100)

The Model 15/30RYG generator sets use the Advanced Digital Control (ADC 2100). The ADC 2100 uses password-protected menus for generator output adjustments and controller configuration.

This section contains instructions for using the controller's password-protected menus to check and adjust the generator output and controller configuration. The controller configuration and generator set output are factory-set and should not require field adjustment under normal circumstances. Check and adjust the configuration and/or output in the following cases:

- Check and adjust the controller configuration and generator output after generator set reconnection to a different voltage.
- Check the controller configuration when troubleshooting generator set problems.
- Check and adjust the generator set output after installation if the voltage requires adjustment for a particular application.

5.2 Controller Automatic Power Down

If the ADC 2100 is not configured for a CAN gauge (communications parameter setting Cn00, see Section 5.3), the controller will power down after 48 hours of no activity. If the generator set has been started, the controller will power down 48 hours after the generator stops. A remote start signal from a transfer switch or remote switch connected to engine start leads 3 and 4 will signal the controller to power up and the generator set to start.

If the ADC 2100 is configured for a CAN gauge (communications parameter setting Cn01 or Cn02), the controller will not power down. The ADC 2100 remains powered at all times to allow remote start commands from the remote CAN gauge.

5.3 Controller Configuration

The controller configuration for each generator model is set at the factory and should not normally require changes. The controller's configuration mode allows adjustment of the system parameters listed in this section. If necessary, use the instructions in this section to check the configuration after installation and change the parameters to match the settings shown in Figure 5-1.

The controller will automatically exit the configuration mode without saving any changes after about 1 minute if no buttons are pressed. Start the configuration procedure over again from the beginning if the controller exits the configuration mode before the settings have been saved.

Follow the instructions in Figure 5-2 to enter the configuration mode while the engine is **not** running and then step through the following parameters. Use the up (∧) and down (∨) arrow buttons to select the appropriate setting for the application.

Note: Be sure to save your settings before exiting the configuration mode. The controller reverts to the last saved settings when the master switch is moved to the OFF/RESET position.

Voltage/frequency setting (Uu). Select the system voltage and frequency from the table in Figure 5-1.

Note: This parameter sets the nominal system voltage and frequency. To adjust the output (measured) voltage, see Section 5.1.

Unit configuration (Uc). This parameter sets the generator set type. Select Uc01, standby.

Engine configuration (Ec). The engine configuration must match the generator set engine type.

Advanced configuration mode (Adnc). The data input types, battery voltage, and communications setting can be changed in the advanced configuration mode. Press the up arrow button when *Adnc* is displayed to enter the advanced configuration mode.

Engine data input types (Ed). This setting defines the type of senders used on the generator set engine.

Battery voltage (Bt). This setting toggles between 12 and 24 VDC for the engine starting battery voltage. The 15/30RYG uses a 12-volt battery, Bt12.

Communications setting (Cn). This setting allows the user to set the controller for communication with optional meters. The 15/30RYG is factory-set for no CAN communications, Cn00. Change this setting if the optional Remote Digital Gauge is used.

Parameter	Setting	Description			
		Voltage, VAC	Frequency, Hz	Phases, Wires	Connection
Unit's system voltage and frequency, 15RYG	Uu01	120/240	60	Single phase, 3 Wire	1 PH
	Uu04	277/480	60	Three phase, 4 Wire	Wye
	Uu10 *	120/240	60	Three phase, 4 Wire	Delta
	Uu10 *	139/240	60	Three phase, 4 Wire	Wye
	Uu11 *	120/208	60	Three phase, 4 Wire	Wye
	Uu16 *	127/220	60	Three phase, 4 Wire	Wye
Unit's system voltage and frequency, 30RYG	Uu01	120/240	60	Single phase, 3 Wire,	1 PH
	Uu03	230/400	50	Three phase, 4 Wire	Wye
	Uu04	277/480	60	Three phase, 4 Wire	Wye
	Uu07 *	110/220	50	Single phase, 3 Wire	1 PH
	Uu10 *	120/240	60	Three phase, 4 Wire	Delta
	Uu10 *	139/240	60	Three phase, 4 Wire	Wye
	Uu11 *	120/208	60	Three phase, 4 Wire	Wye
	Uu16 *	127/220	60	Three phase, 4 Wire	Wye
	Uu17 *	110/190	50	Three phase, 4 Wire	Wye
	Uu17 *	110/220	50	Three phase, 4 Wire	Delta
	Uu18 *	120/208	50	Three phase, 4 Wire	Wye
	Uu21 *	220/380	50	Three phase, 4 Wire	Wye
	Uu22 *	240/416	50	Three phase, 4 Wire	Wye
	Uu23 *	115/200	50	Three phase, 4 Wire	Wye
Unit configuration	Uc01	Standby			
Engine type	Ec03	15RYG			
	Ec06	30RYG			
Engine data input types	Ed01	15/30RYG factory setup			
Battery voltage	Bt12	12 VDC			
Communications	Cn00	No CAN communications			
	Cn01	J1939 (use for Remote Digital Gauge)			
	Cn06 †	Enables J1939 communications and 1-hour ADC power down after engine stop for either: a. Remote start/stop switch b. Automatic transfer switch c. Remote Digital Gauge with remote start/stop switch and replacement harness			

* ADC application program version 1.20 or higher

† ADC application program version 1.21 or higher

Figure 5-1 Configuration Parameters

Controller Configuration Mode:

Hold the Select button:

Display:

Move the generator set master switch to the RUN position. (The generator set engine will not start.)

Display: . 0

Wait about 5 seconds until the display shows the program version number. (The number may be different than the one shown here.)

Display: 104

Press the down arrow key and then the up arrow key 3 times to enter the configuration mode. (This is the controller "password.")

Display: Uu01

Now release the Select button.

Press:

or

To set the voltage/frequency setting. See Figure 5-1.

Display: Uu*XX*

To step to the next parameter, unit configuration Uc.

or

To set the unit configuration setting to Uc01, if necessary.

Display: Uc01

To step to the next parameter, engine type Ec.

or

To set the engine type to Ec03 OR Ec06, if necessary. See Figure 5-1.

Display: Ec0*X*

To step to the next parameter, advanced configuration mode or save mode selection.

Display: Adnc

Now either save your settings or enter the Advanced Configuration Mode to set the engine data inputs, battery voltage, and communications.

Press:

To enter advanced configuration mode. **Go to Figure 5-3.**

Display: Ed00

or

or

To proceed to the save mode without entering the advanced configuration mode. **Go to Figure 5-4.**

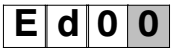
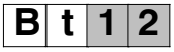
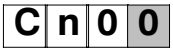
Display: SAVE

Note: Shaded boxes show which number in the controller display changes when the up or down arrow key is pressed.

Figure 5-2 Configuration Mode (system voltage/frequency, unit configuration, and engine type parameters)

Pressing the up arrow key at the Adnc display (See Figure 5-2) puts you into the Advanced Configuration Mode.

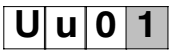
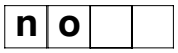
Press:

 or 	To set the engine data input type to Ed00.	
	To enter battery voltage selection mode.	
 or 	To toggle between 12 and 24 VDC. Set this parameter to 12 VDC.	
	To enter communications selection mode.	
 or 	To set the communications parameter to Cn00 or Cn01. See Figure 5-1.	
	To enter SAVE mode. Go to Figure 5-4.	

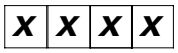
Note: Be sure to save your settings before exiting the configuration mode. The controller reverts to the last *saved* settings when the master switch is moved to the OFF/RESET position.

Figure 5-3 Advanced Configuration Mode (engine data input types, battery voltage, and engine communications)

There are 3 options when the display says SAVE:
Press:

 **or**	To return to the first parameter, system voltage/frequency Uu, to check or change settings before saving. See Figure 5-2.	
 **or**	To save changes.	
	To discard changes without saving.	

"Yes"or "no" flashes when the up or down arrow is pressed and then the controller exits the configuration mode. The display returns to the runtime hours.



Now move the master switch to OFF/RESET.

* *X* in the runtime hours display above denotes any number from 0 to 9.

Figure 5-4 Save Mode (after configuring generator set parameters)

5.4 Voltage Adjustments

⚠ WARNING

Hazardous voltage. Moving parts. Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Short circuits. Hazardous voltage/current can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

The controller's adjustment mode allows adjustment of the output voltage, if necessary. Have adjustments performed by an authorized distributor/dealer or service technician.

Note: A digital voltmeter is required for these adjustments.

Use a voltmeter to check the output voltage. If the output voltage is not within specifications, use the ADC controller to adjust the output voltage while the generator set is running. The flowcharts in Figure 5-6 and Figure 5-7 outline the adjustment procedures.

Note: Be sure to save your settings before exiting the configuration mode.

Voltage changes are lost if they are not saved before the generator set shuts down. If the changes are not saved, the generator set continues to run with the new settings until it shuts down but then reverts to the previous settings at the next startup.

Pressing the Select button when SAVE is displayed returns to the first parameter, voltage adjust (1P).

Voltage Adjustment Procedure

Note: Refer to the flowcharts in Figure 5-6 and Figure 5-7 during the voltage adjustment procedure.

1. With the generator set off, connect a digital multimeter to the output leads or an electrical outlet on the load side of the generator set. Set the meter to measure AC voltage.
2. Start the generator set by moving the generator set master switch to the RUN position.
3. Use the ADC controller to adjust the voltage (parameter 1P) until the output voltage reaches the desired value. See Figure 5-5 for the approximate change in voltage per step in parameter 1P.

Measured Voltage, VAC	Voltage Change per Step, VAC	
	Coarse Adjust	Fine Adjust
85–132	5	0.5
180–251	7	0.7

Figure 5-5 Voltage Adjustment (approximate)

4. Adjust the voltage stability (gain, parameter 2P) to minimize light flicker.
5. Readjust the voltage, if necessary.
6. Stop the generator set.

Output Voltage Adjustment Mode:

Display :*

Move the generator set master switch to the RUN position. The generator set engine starts and the controller display shows the engine runtime hours.

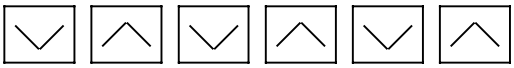
Display: *X X X X*

Hold:

Wait about 5 seconds until the display changes from runtime hours to the program version number.

Display: *X. X X*

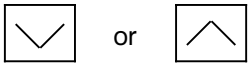
Press the down arrow key and then the up arrow key 3 times to enter the adjustment mode. (This is the controller "password.")



Display: 1 P *X X*

The controller is now in the voltage coarse adjustment mode.

Press:



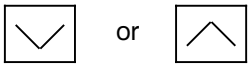
or

To raise or lower the voltage in large increments (approximately 5–7 volts per step).

Display: 1 P *X X*

To enter fine voltage adjustment mode.

Display: 1 P *X X*



or

To raise or lower the voltage in smaller increments (approximately 0.5–0.7 volts per step).

Continued on Figure 5-7.

* Shaded boxes show which character in the controller display changes for each adjustment. *X* in the examples above denotes any number from 0 to 9. The actual values may vary from model-to-model.

TP6196

Figure 5-6 Output Voltage Adjustments

Continued from Figure 5-6:

Display : *

To enter coarse voltage stability (gain) adjustment mode.

2	P	*x*	*x*

 or 

To raise or lower the voltage stability (gain) in large increments.

To enter fine voltage stability (gain) adjustment mode.

2	P	*x*	*x*

 or 

To raise or lower the voltage stability (gain) in smaller increments.

To enter volts/Hz adjustment mode.

3	P	0	*x*

 or 

To raise or lower the volts/Hz: 00=low; 09= high

To enter SAVE mode.

S	A	V	E

Note: Be sure to save your settings before exiting the configuration mode. The controller reverts to the last *saved* settings when the master switch is moved to the OFF/RESET position.

There are 3 options when the display says SAVE:

S	A	V	E

Press:

To return to the first parameter, coarse voltage adjustment, to check or change settings before saving. See Figure 5-6.

1	P	*x*	*x*

or

To save changes.

Y	E	S	

or

To discard changes without saving.

n	o		

"Yes"or "no" flashes when the up or down arrow is pressed and then the controller exits the configuration mode. The display returns to the runtime hours.

x	*x*	*x*	*x*

Now move the master switch to OFF/RESET.

* *X* in the examples above denotes any number from 0 to 9. The actual values may vary from model-to-model.

Figure 5-7 Output Voltage Adjustments, Continued

Notes

6.1 Voltage Reconnection

The reconnection procedure explains voltage reconnections only. Some 30kW models are now available factory-configured for 50 Hz. Do not attempt to change the frequency from 60 Hz to 50 Hz (or vice-versa) in the field.

The following instructions explain the reconnection of 12-lead generator sets. In all cases, follow the National Electrical Code (NEC) guidelines.

Reconnect the stator leads of the generator set if a different output phase or voltage is desired. Refer to the following procedure and the connection schematics. Refer to Section 5 for instructions to make adjustments though the ADC 2100 menus when instructed in the procedure. Follow all safety precautions at the front of this manual and in the text while performing this procedure.

Note: Order voltage reconnection decal 246242 from an authorized service distributor/dealer and affix decal to generator set after reconnecting to a voltage different than the nameplate.

⚠ WARNING

Accidental starting.
Can cause severe injury or death.

Disconnect the battery cables before working on the generator set. Remove the negative (-) lead first when disconnecting the battery. Reconnect the negative (-) lead last when reconnecting the battery.

Disabling the generator set. Accidental starting can cause severe injury or death. Before working on the generator set or connected equipment, disable the generator set as follows: (1) Move the generator set master switch to the OFF position. (2) Disconnect the power to the battery charger. (3) Remove the battery cables, negative (-) lead first. Reconnect the negative (-) lead last when reconnecting the battery. Follow these precautions to prevent starting of the generator set by an automatic transfer switch, remote start/stop switch, or engine start command from a remote computer.

⚠ WARNING

Hazardous voltage. Moving parts.
Can cause severe injury or death.

Operate the generator set only when all guards and electrical enclosures are in place.

Grounding electrical equipment. Hazardous voltage can cause severe injury or death. Electrocution is possible whenever electricity is present. Ensure you comply with all applicable codes and standards. Electrically ground the generator set, transfer switch, and related equipment and electrical circuits. Turn off the main circuit breakers of all power sources before servicing the equipment. Never contact electrical leads or appliances when standing in water or on wet ground because these conditions increase the risk of electrocution.

Short circuits. Hazardous voltage/current can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while making adjustments or repairs. Remove all jewelry before servicing the equipment.

6.2 Four-Lead (Single-Phase) Generator Sets

Figure 6-1 shows the factory connection for the single-phase 120/240 V 60 Hz generator set. Single-phase models are not reconnectable.

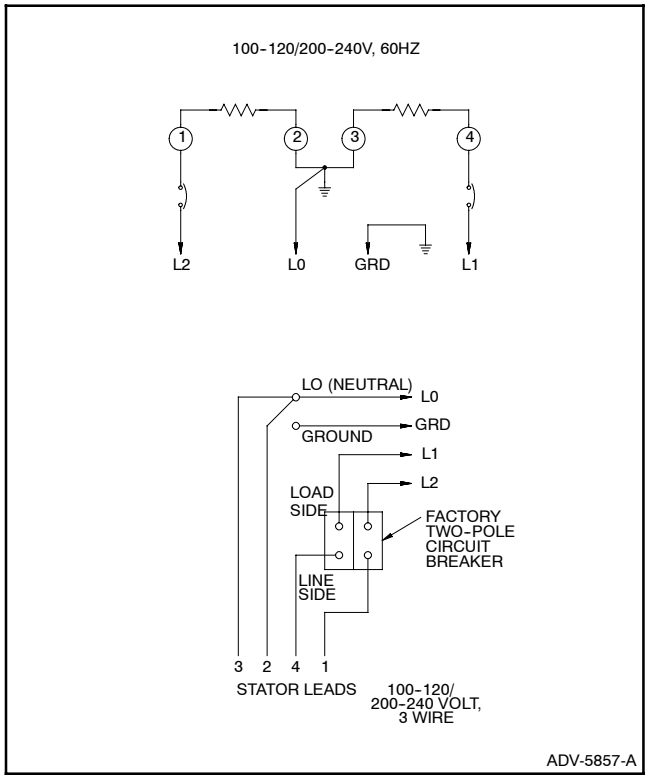


Figure 6-1 Single-Phase Factory Connection, 120/240 V 60 Hz

6.3 12-Lead (Three-Phase) Generator Sets

Note: The current transformers (CTs) shown on the following diagrams are not used on generator sets equipped with the Advanced Digital Control (ADC 2100).

Three-phase, 12-lead generator sets are reconnectable to the voltages and phases shown in Figure 6-2. Use the following procedure to reconnect the generator to the desired voltage configuration, change the system voltage setting, and adjust the output voltage.

Note: Equipment damage. Verify that the voltage ratings of the transfer switch, line circuit breakers, and other accessories match the selected line voltage.

Reconnection Procedure

1. Place the generator set master switch in the OFF/RESET position.
2. Disconnect engine starting battery, negative (-) lead first. Disconnect power to battery charger, if equipped.
3. Select desired voltage connection from Figure 6-2. Connect the leads according to the diagram for desired phase and voltage.
4. Reconnect generator set engine starting battery, negative (-) lead last.
5. Follow the instructions in Section 5.3 to enter the ADC 2100 configuration menu and check the system configuration. Verify that the system voltage and frequency parameter (Uu) is correct for single-phase or three-phase configurations.
6. Connect a digital multimeter (DVM) to the generator set output.
7. Follow the instructions in Section 5.4 to start the generator set and enter the ADC 2100 voltage adjustment menu.
8. Check the voltmeter for the correct voltage. Adjust output voltage, if necessary, using the ADC 2100 voltage adjustment menu.
9. Stop the generator set after the adjustment procedure.

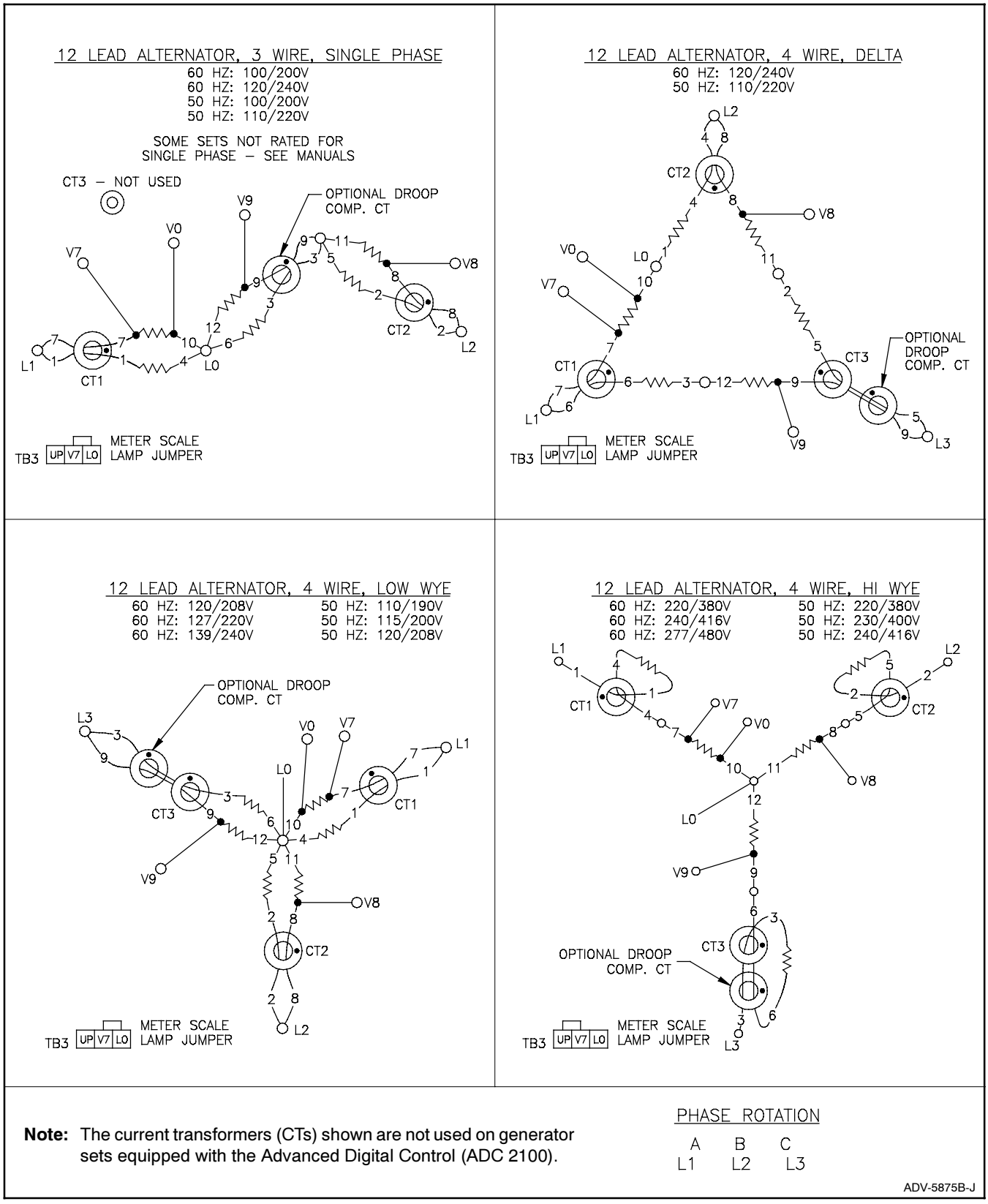


Figure 6-2 12-Lead Generator Reconnection

Notes

Section 7 Dimension Drawings

This section contains the dimension drawings listed in Figure 7-1.

Note: For wiring diagrams, refer to TP-6347, Wiring Diagram Manual.

Dimension Drawing Description	Drawing Number	Page
Generator Set	ADV-6916A-E	48
Exhaust and Duct Flange	ADV-6916B-E	49
Weather Housing	ADV-6916C-E	50
Sound Upfit	ADV-6916D-E	51
Sound Housing	ADV-6916E-E	52
Drop-Over Sound Housing	ADV-6916F-E	53
High-Wind Mounting Details	ADV-6916G-E	54

Figure 7-1 Dimension Drawings

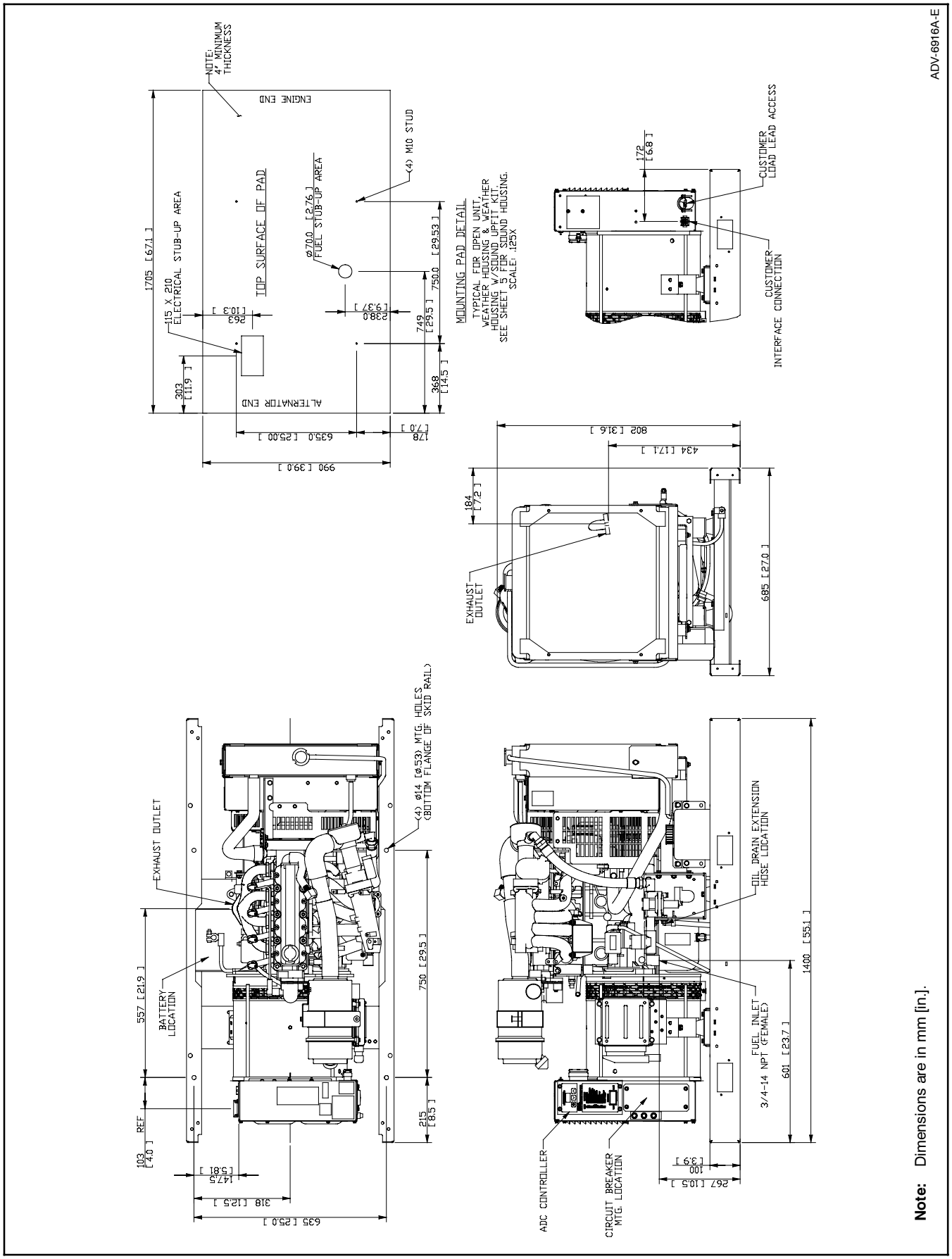


Figure 7-2 Dimension Drawing, ADV-6916A-E, Sheet 1, Generator Set

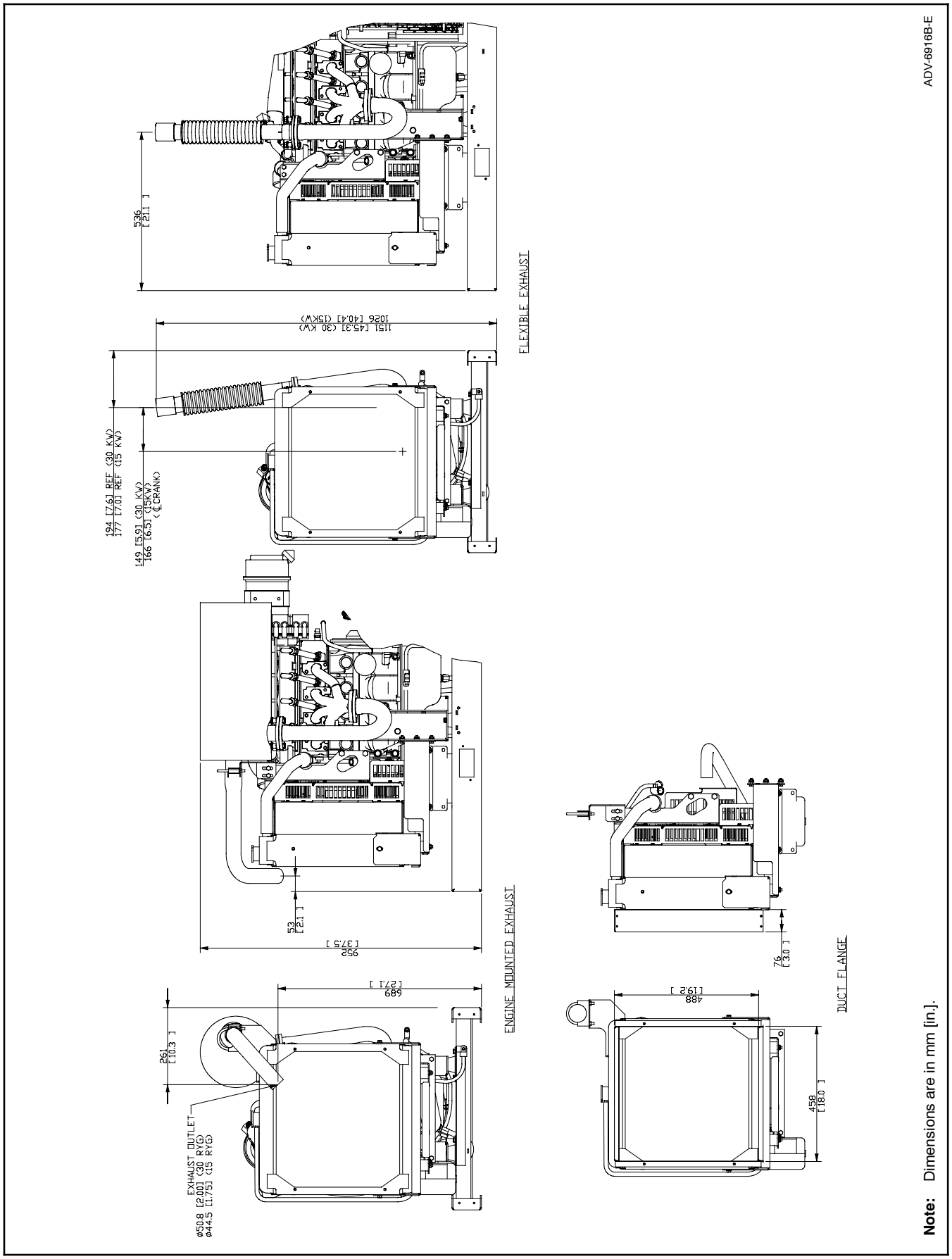


Figure 7-3 Dimension Drawing, ADV-6916B-E, Sheet 2, Exhaust Options and Duct Flange

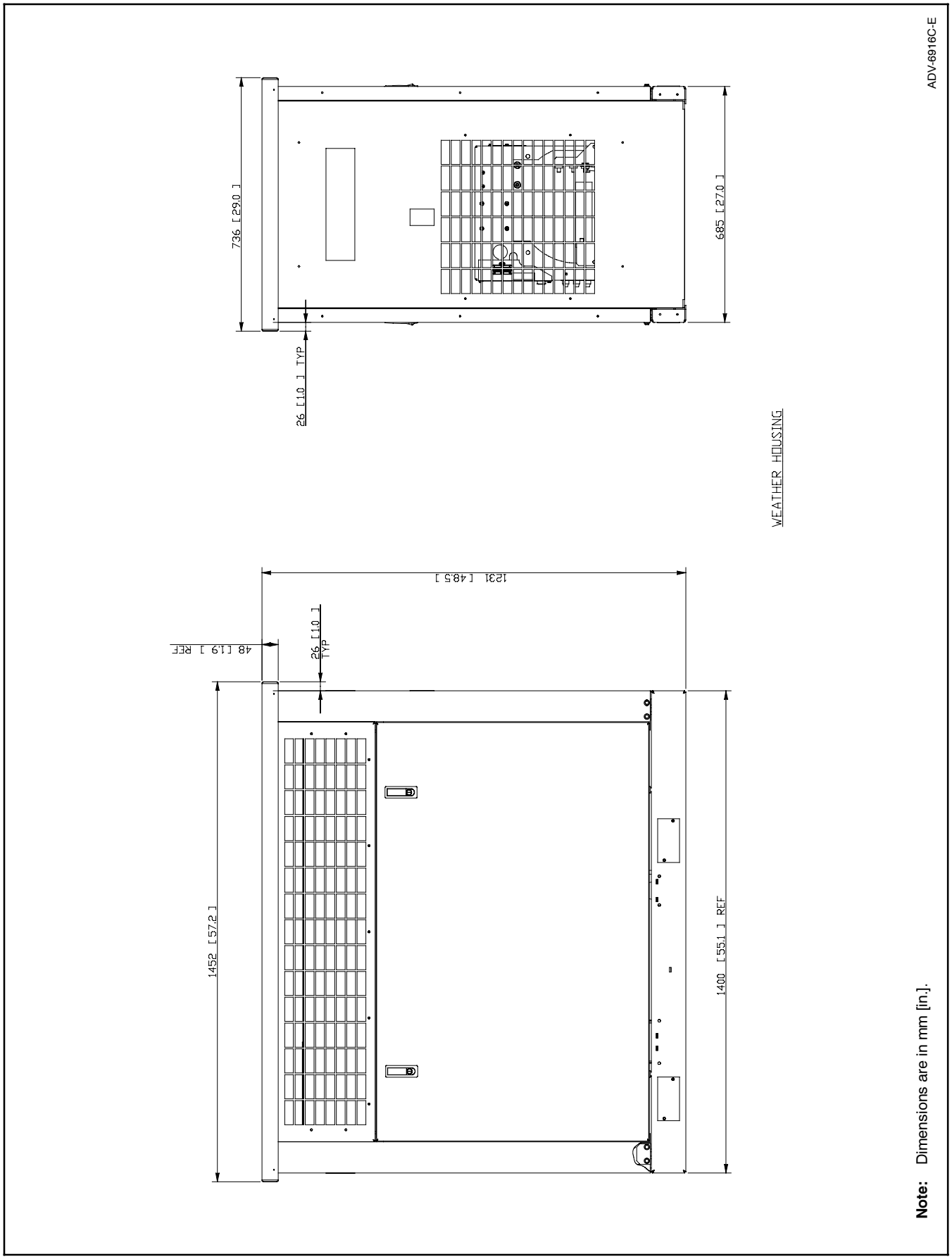


Figure 7-4 Dimension Drawing, ADV-6916C-E, Sheet 3, Weather Housing

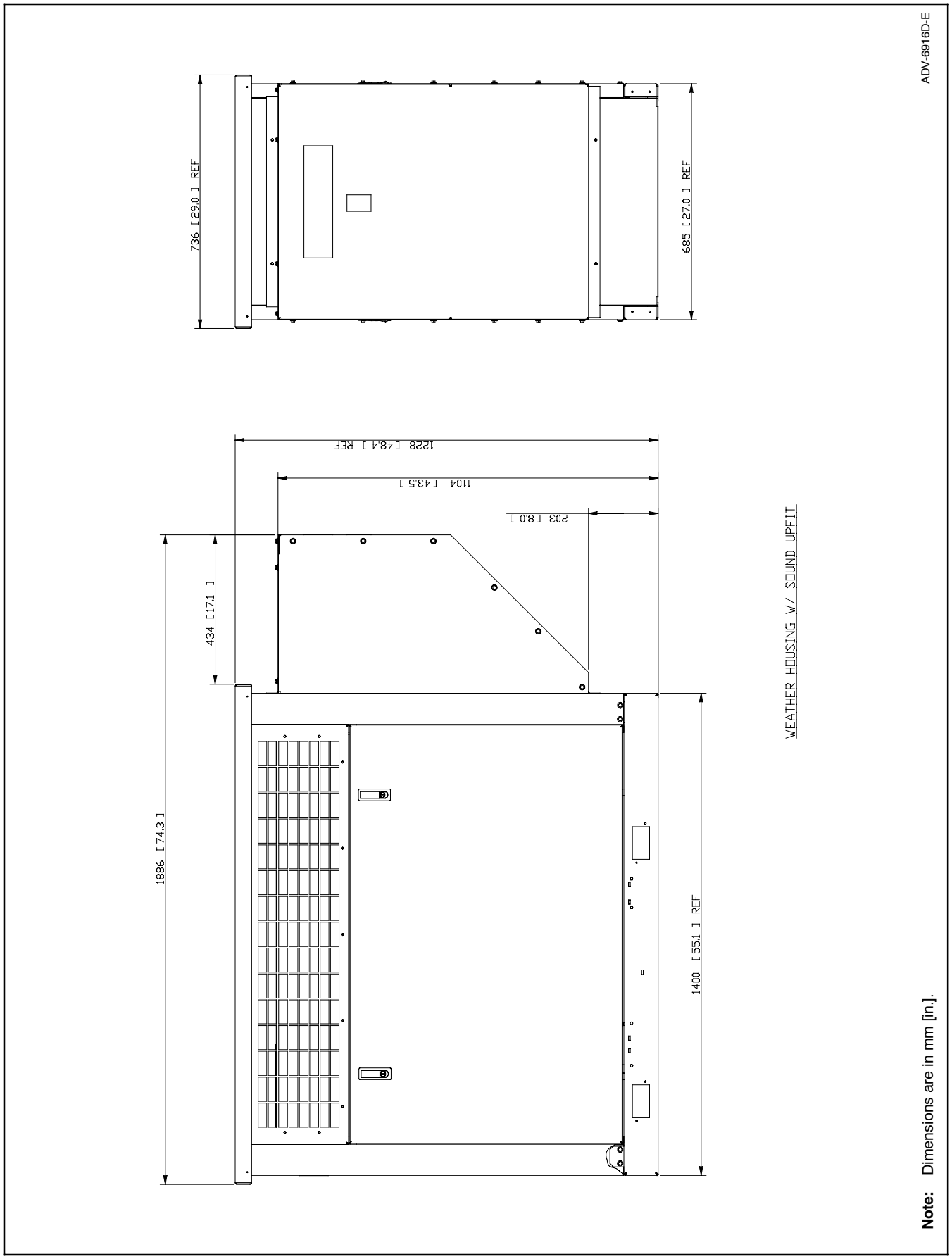


Figure 7-5 Dimension Drawing, ADV-6916D-E, Sheet 4, Weather Housing with Sound Upfit Kit

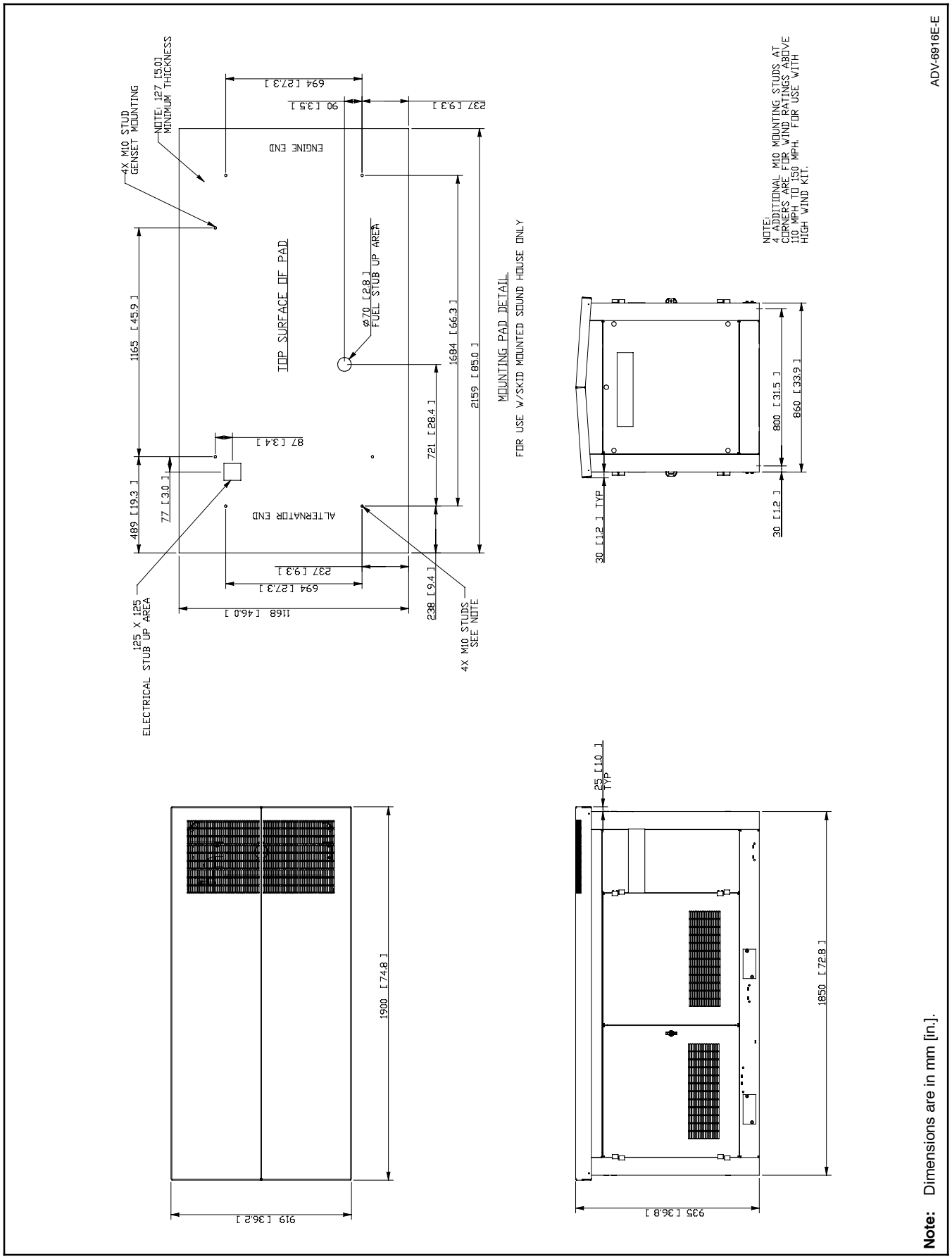


Figure 7-6 Dimension Drawing, ADV-6916E-E, Sheet 5, Sound Enclosure

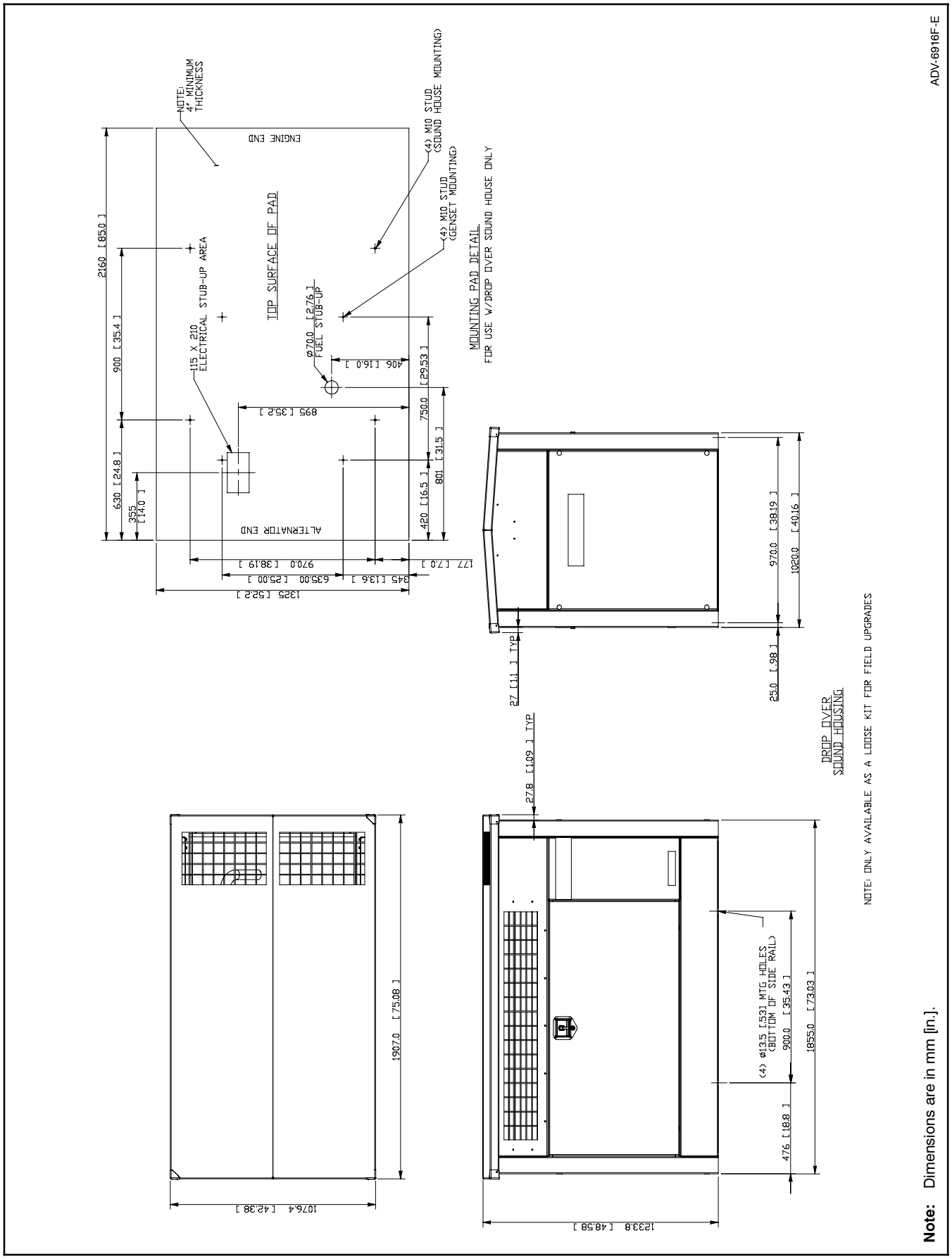


Figure 7-7 Dimension Drawing, ADV-6916F-E, Sheet 6, Drop-Over Sound Housing

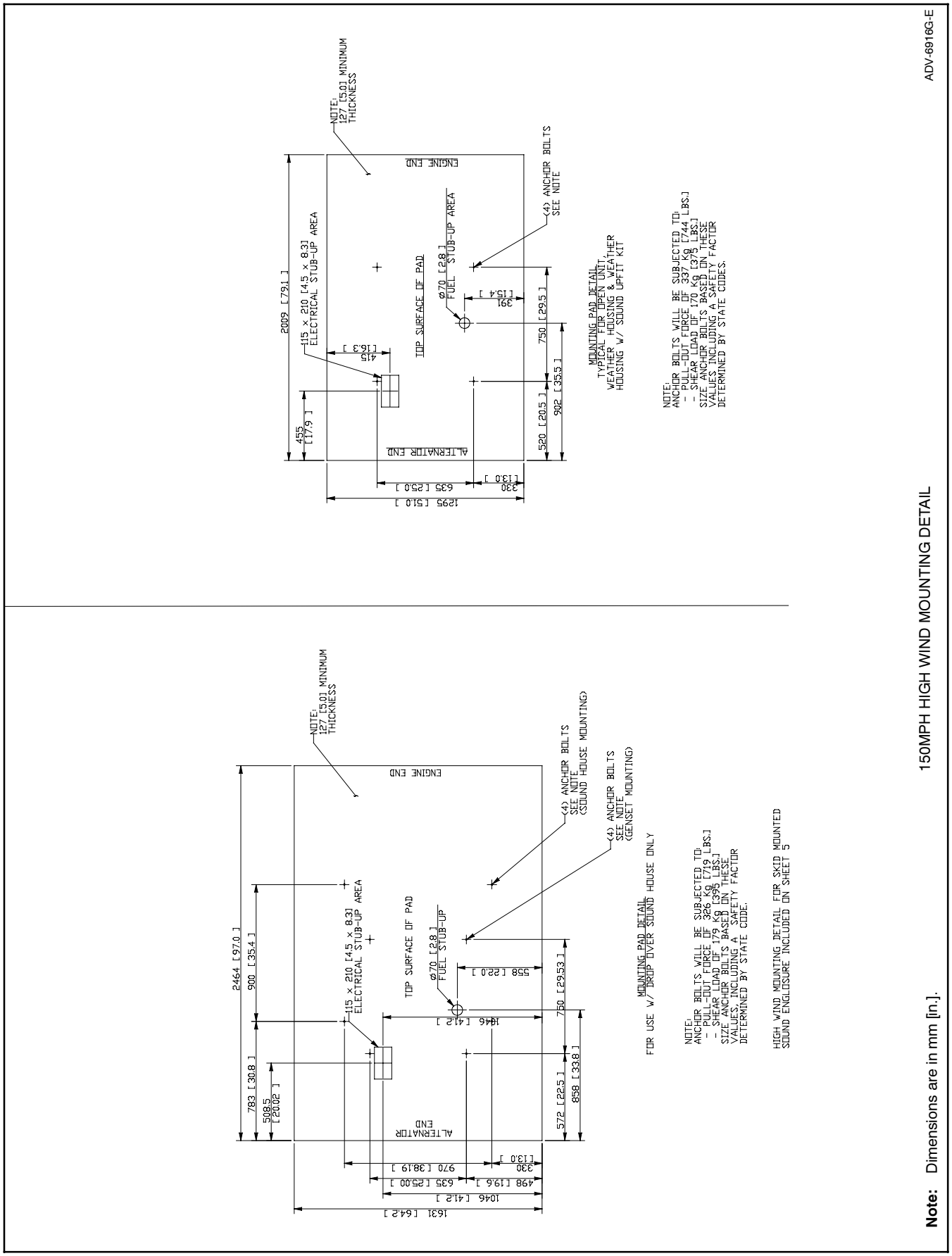


Figure 7-8 Dimension Drawing, ADV-6916G-E, Sheet 7, High-Wind Mounting Detail

Appendix A Abbreviations

The following list contains abbreviations that may appear in this publication.

A, amp	ampere
ABDC	after bottom dead center
AC	alternating current
A/D	analog to digital
ADC	advanced digital control; analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
Ah	amp-hour
AHWT	anticipatory high water temperature
AISI	American Iron and Steel Institute
ALOP	anticipatory low oil pressure
alt.	alternator
Al	aluminum
ANSI	American National Standards Institute (formerly American Standards Association, ASA)
AO	anticipatory only
APDC	Air Pollution Control District
API	American Petroleum Institute
approx.	approximate, approximately
AQMD	Air Quality Management District
AR	as required, as requested
AS	as supplied, as stated, as suggested
ASE	American Society of Engineers
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after top dead center
ATS	automatic transfer switch
auto.	automatic
aux.	auxiliary
avg.	average
AVR	automatic voltage regulator
AWG	American Wire Gauge
AWM	appliance wiring material
bat.	battery
BBDC	before bottom dead center
BC	battery charger, battery charging
BCA	battery charging alternator
BCI	Battery Council International
BDC	before dead center
BHP	brake horsepower
blk.	black (paint color), block (engine)
blk. htr.	block heater
BMEP	brake mean effective pressure
bps	bits per second
br.	brass
BTDC	before top dead center
Btu	British thermal unit
Btu/min.	British thermal units per minute
C	Celsius, centigrade
cal.	calorie
CAN	controller area network
CARB	California Air Resources Board
CB	circuit breaker
cc	cubic centimeter
CCA	cold cranking amps
ccw.	counterclockwise
CEC	Canadian Electrical Code
cert.	certificate, certification, certified
cfh	cubic feet per hour
cfm	cubic feet per minute
CG	center of gravity
CID	cubic inch displacement
CL	centerline
cm	centimeter
CMOS	complementary metal oxide substrate (semiconductor)
cogen.	cogeneration
com	communications (port)
coml	commercial
Coml/Rec	Commercial/Recreational
conn.	connection
cont.	continued
CPVC	chlorinated polyvinyl chloride
crit.	critical
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
Cu	copper
cUL	Canadian Underwriter's Laboratories
CUL	Canadian Underwriter's Laboratories
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dB(A)	decibel (A weighted)
DC	direct current
DCR	direct current resistance
deg., °	degree
dept.	department
DFMEA	Design Failure Mode and Effects Analysis
dia.	diameter
DI/EO	dual inlet/end outlet
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
DIP	dual inline package
DPDT	double-pole, double-throw
DPST	double-pole, single-throw
DS	disconnect switch
DVR	digital voltage regulator
E, emer.	emergency (power source)
ECM	electronic control module, engine control module
EDI	electronic data interchange
EFR	emergency frequency relay
e.g.	for example (*exempli gratia)*
EG	electronic governor
EGSA	Electrical Generating Systems Association
EIA	Electronic Industries Association
EI/EO	end inlet/end outlet
EMI	electromagnetic interference
emiss.	emission
eng.	engine
EPA	Environmental Protection Agency
EPS	emergency power system
ER	emergency relay
ES	engineering special, engineered special
ESD	electrostatic discharge
est.	estimated
E-Stop	emergency stop
etc.	et cetera (and so forth)
exh.	exhaust
ext.	external
F	Fahrenheit, female
fglass.	fiberglass
FHM	flat head machine (screw)
fl. oz.	fluid ounce
flex.	flexible
freq.	frequency
FS	full scale
ft.	foot, feet
ft. lb.	foot pounds (torque)
ft./min.	feet per minute
ftp	file transfer protocol
g	gram
ga.	gauge (meters, wire size)
gal.	gallon
gen.	generator
genset	generator set
GFI	ground fault interrupter
GND, ⏚	ground
gov.	governor
gph	gallons per hour
gpm	gallons per minute
gr.	grade, gross
GRD	equipment ground
gr. wt.	gross weight
H x W x D	height by width by depth
HC	hex cap
HCHT	high cylinder head temperature
HD	heavy duty
HET	high exhaust temp., high engine temp.
hex	hexagon
Hg	mercury (element)
HH	hex head
HHC	hex head cap
HP	horsepower
hr.	hour
HS	heat shrink
hsg.	housing
HVAC	heating, ventilation, and air conditioning
HWT	high water temperature
Hz	hertz (cycles per second)
IC	integrated circuit
ID	inside diameter, identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMS	improved motor starting
in.	inch
in. H_2O	inches of water
in. Hg	inches of mercury
in. lb.	inch pounds
Inc.	incorporated
ind.	industrial
int.	internal
int./ext.	internal/external
I/O	input/output
IP	iron pipe
ISO	International Organization for Standardization
J	joule
JIS	Japanese Industry Standard

k	kilo (1000)
K	kelvin
kA	kiloampere
KB	kilobyte (2^{10} bytes)
KBus	Kohler communication protocol
kg	kilogram
kg/cm^2	kilograms per square centimeter
kgm	kilogram-meter
kg/m^3	kilograms per cubic meter
kHz	kilohertz
kJ	kilojoule
km	kilometer
kOhm, kΩ	kilo-ohm
kPa	kilopascal
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt ampere
kVAR	kilovolt ampere reactive
kW	kilowatt
kWh	kilowatt-hour
kWm	kilowatt mechanical
kWth	kilowatt-thermal
L	liter
LAN	local area network
L x W x H	length by width by height
lb.	pound, pounds
lbm/ft^3	pounds mass per cubic feet
LCB	line circuit breaker
LCD	liquid crystal display
ld. shd.	load shed
LED	light emitting diode
Lph	liters per hour
Lpm	liters per minute
LOP	low oil pressure
LP	liquefied petroleum
LPG	liquefied petroleum gas
LS	left side
L_{wa}	sound power level, A weighted
LWL	low water level
LWT	low water temperature
m	meter, milli (1/1000)
M	mega (10^6 when used with SI units), male
m^3	cubic meter
m^3/hr.	cubic meters per hour
m^3/min.	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCCB	molded-case circuit breaker
MCM	one thousand circular mils
meggar	megohmmeter
MHz	megahertz
mi.	mile
mil	one one-thousandth of an inch
min.	minimum, minute
misc.	miscellaneous
MJ	megajoule
mJ	millijoule
mm	millimeter
mOhm, mΩ	milliohm
MOhm, MΩ	megohm
MOV	metal oxide varistor
MPa	megapascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
ms	millisecond
m/sec.	meters per second
MTBF	mean time between failure
MTBO	mean time between overhauls
mtg.	mounting
MTU	Motoren-und Turbinen-Union
MW	megawatt
mW	milliwatt
μF	microfarad
N, norm.	normal (power source)
NA	not available, not applicable
nat. gas	natural gas
NBS	National Bureau of Standards
NC	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	newton meter
NO	normally open
no., nos.	number, numbers
NPS	National Pipe, Straight
NPSC	National Pipe, Straight-coupling
NPT	National Standard taper pipe thread per general use
NPTF	National Pipe, Taper-Fine
NR	not required, normal relay
ns	nanosecond
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OF	overfrequency
opt.	option, optional
OS	oversize, overspeed
OSHA	Occupational Safety and Health Administration
OV	overvoltage
oz.	ounce
p., pp.	page, pages
PC	personal computer
PCB	printed circuit board
pF	picofarad
PF	power factor
ph., ∅	phase
PHC	Phillips® head Crimptite® (screw)
PHH	Phillips® hex head (screw)
PHM	pan head machine (screw)
PLC	programmable logic control
PMG	permanent magnet generator
pot	potentiometer, potential
ppm	parts per million
PROM	programmable read-only memory
psi	pounds per square inch
psig	pounds per square inch gauge
pt.	pint
PTC	positive temperature coefficient
PTO	power takeoff
PVC	polyvinyl chloride
qt.	quart, quarts
qty.	quantity
R	replacement (emergency) power source
rad.	radiator, radius
RAM	random access memory
RDO	relay driver output
ref.	reference
rem.	remote
Res/Coml	Residential/Commercial
RFI	radio frequency interference
RH	round head
RHM	round head machine (screw)
rly.	relay
rms	root mean square
rnd.	round
ROM	read only memory
rot.	rotate, rotating
rpm	revolutions per minute
RS	right side
RTU	remote terminal unit
RTV	room temperature vulcanization
RW	read/write
SAE	Society of Automotive Engineers
scfm	standard cubic feet per minute
SCR	silicon controlled rectifier
s, sec.	second
SI	*Systeme international d'unites,* International System of Units
SI/EO	side in/end out
sil.	silencer
SN	serial number
SNMP	simple network management protocol
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec	specification
specs	specification(s)
sq.	square
sq. cm	square centimeter
sq. in.	square inch
SS	stainless steel
std.	standard
stl.	steel
tach.	tachometer
TD	time delay
TDC	top dead center
TDEC	time delay engine cooldown
TDEN	time delay emergency to normal
TDES	time delay engine start
TDNE	time delay normal to emergency
TDOE	time delay off to emergency
TDON	time delay off to normal
temp.	temperature
term.	terminal
THD	total harmonic distortion
TIF	telephone influence factor
TIR	total indicator reading
tol.	tolerance
turbo.	turbocharger
typ.	typical (same in multiple locations)
UF	underfrequency
UHF	ultrahigh frequency
UL	Underwriter's Laboratories, Inc.
UNC	unified coarse thread (was NC)
UNF	unified fine thread (was NF)
univ.	universal
US	undersize, underspeed
UV	ultraviolet, undervoltage
V	volt
VAC	volts alternating current
VAR	voltampere reactive
VDC	volts direct current
VFD	vacuum fluorescent display
VGA	video graphics adapter
VHF	very high frequency
W	watt
WCR	withstand and closing rating
w/	with
w/o	without
wt.	weight
xfmr	transformer

Physical Property @ 15°C (60°F)	Butane	Propane	Natural Gas	Manufactured or Sewage Gas	Gasoline	Diesel Fuel
Normal atmospheric state	Gas	Gas	Gas	Gas	Liquid	Liquid
Boiling point,						
Initial, °C (°F)	—	—	—	—	36 (97)	177 (350)
End, °C (°F)	0 (32)	42 (-44)	-162 (-259)	—	216 (420)	357 (675)
Heating value, Btu						
/gal. (net, LHV*)	94670	83340	63310	—	116400	130300
/gal. (gross)	102032	91500	—	—	124600	139000
/ft^3 (gas)	3264	2516	1000	600-700	6390	—
Density, Ft^3 of gas/gal.	31.26	36.39	57.75	—	19.5	—
Wt./gal. liquid, lb.	4.81	4.24	2.65	—	6.16	7.08
Octane Number						
Research	94	110+	110+	—	80-100	—
Motor	90	97	—	—	75-90	—
* Lower Heating Value						

Figure 1 Engine Fuels, Physical Properties

Characteristic, LP Gas*	Butane	Propane
Formula	C_4H_{10}	C_3H_8
Boiling point, °C (°F)	0 (32)	-42 (-44)
Specific gravity of gas (air = 1.00)	2.00	1.53
Specific gravity of liquid (water = 1.00)	0.58	0.51
Btu/lb. of gas	21221	21591
Ft^3 of vapor at 16°C (60°F)/lb. of liquid at 16°C (60°F)	6.506	8.547
Latent heat of vaporization at boiling point, Btu/gal.	808.0	785.0
Combustion Data:	31.02	23.86
Ft^3 air required to burn 1 ft^3 of gas	N/A	-104 (-156)
Flash point, °C (°F)	482-538	493-549
Ignition temperature in air, °C (°F)	(900-1000)	(920-1020)
Max. flame temperature in air, °C (°F)	1991 (3615)	1979 (3595)
Limits of inflammability, percentage of gas in air mixture:		
At lower limit, %	1.9	2.4
At upper limit, %	8.6	9.6
Octane Number (ISO-Octane = 100)	92	Over 100
* Commercial quality. Figures shown in this chart represent average values.		

Figure 2 Additional LP Gas Characteristics

Appendix C Gas Fuel Vapor Pressures

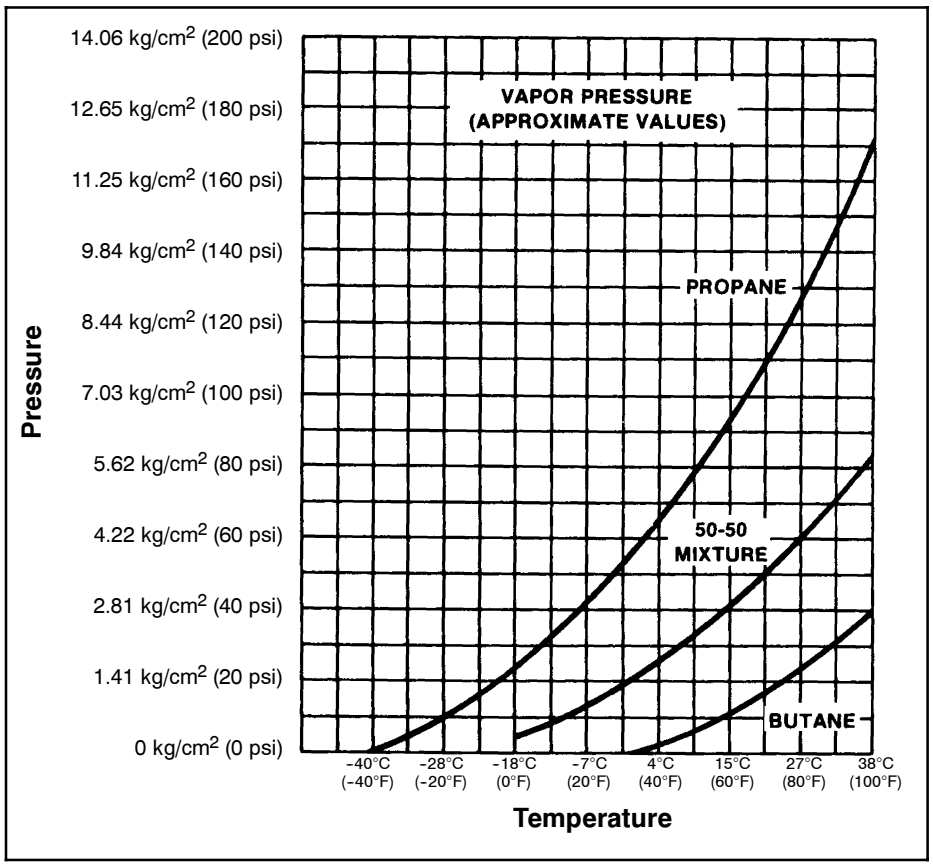


Figure 1 Heat Rejection to Ambient Air

Temperature, °C (°F)	Approximate Pressure (PSIG)	
	Propane	Butane
-40 (-40)	3.6	—
-34 (-30)	8.0	-
-29 (-20)	13.5	—
-23 (-10)	20.0	—
-18 (0)	28.0	—
-12 (10)	37.0	—
-7 (20)	47.0	—
-1 (30)	58.0	—
4 (40)	72.0	3.0
10 (50)	86.0	6.9
16 (60)	102.0	11.5
21 (70)	120.0	16.5
27 (80)	140.0	22.0
32 (90)	165.0	29.0
38 (100)	190.0	37.0
43 (110)	220.0	46.0

Figure 2 Vapor Pressures of LP Gases

Determining Propane Cylinder Quantity

Guide for Installing 100 lb. Cylinders

For continuous draws where temperatures may reach −18°C (−0°F). Assume the vaporization rate of 100 lb. cylinder as approximately 50000 Btu/hr.

Number of cylinders/side = $\frac{\text{Total load in Btu}}{50000}$

Example:

Assume total load = 200,000 Btu/hour.

Cylinders/side = $\frac{200000}{50000}$ = 4 cylinders/side

The chart in Figure 1 shows the vaporization rate of containers in terms of the temperature of the liquid and the wet surface area of the container. When the temperature is lower or if the container contains less liquid, the vaporization rate of the container is a lower value.

Lb. of Propane in Cyl.	Maximum Continuous Draw In Btu/Hour At Various Temperatures In °C (°F)				
	−18°C (0°F)	−7°C (20°F)	4°C (40°F)	16°C (60°F)	21°C (70°F)
100	113000	167000	214000	277000	300000
90	104000	152000	200000	247000	277000
80	94000	137000	180000	214000	236000
70	83000	122000	160000	199000	214000
60	75000	109000	140000	176000	192000
50	64000	94000	125000	154000	167000
40	55000	79000	105000	131000	141000
30	45000	66000	85000	107000	118000
20	36000	51000	68000	83000	92000
10	28000	38000	49000	60000	66000

Figure 1 Vaporization Rate, 100 lb. Propane Cylinders, Approximate

Determining Propane Vaporization Capacity

Guide for ASME LP Gas Storage Containers

% of Container Filled	K Equals	Propane* Vaporization Capacity at −18°C (0°F) in Btu/Hr.†
60	100	D x L x 100
50	90	D x L x 90
40	80	D x L x 80
30	70	D x L x 70
20	60	D x L x 60
10	45	D x L x 45

* These formulae allow for the temperature of the liquid to refrigerate to −29°C (−20°F), producing a temperature differential of −7°C (20°F) for the transfer of heat from the air to the container's *wetted* surface and then into the liquid. The vapor space area of the vessel is not considered since its effect is negligible.

† D=outside diameter in inches
L=overall length in inches
K=constant for percent volume of liquid in container.

Figure 2 Propane Vaporization Capacity

Vaporizing Capacities for Other Air Temperatures

Multiply the results obtained with the formulae in Figure 2 by one of the factors in the following table for the prevailing air temperature.

Prevailing Air Temperature	Multiplier
−26°C (−15°F)	0.25
−23°C (−10°F)	0.50
−21°C (−5°F)	0.75
−18°C (0°F)	1.00
−15°C (5°F)	1.25
−12°C (10°F)	1.50
−26°C (15°F)	1.75
−7°C (20°F)	2.00

Figure 3 Propane Vaporization Temperature

Notes

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Notes

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