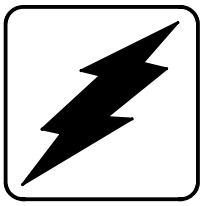
Installation

Residential/Commercial Generator Sets



Models:

12RESM1

12RESL

Controller:

DC 2200 Digital Control

ISO 9001 KOHLER POWER SYSTEMS NATIONALLY REGISTERED

KOHLER® POWER SYSTEMS

TP-6397 4/07c

Table of Contents

Notes

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***.

NOTICE

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 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 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.

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 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.

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.

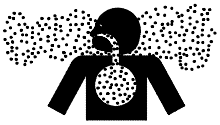
Servicing the air cleaner. A sudden backfire can cause severe injury or death. Do not operate the generator set with the air cleaner removed.

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.

Combustible materials. A fire can cause severe injury or death. Generator set engine fuels and fuel vapors are flammable and explosive. Handle these materials carefully to minimize the risk of fire or explosion. Equip the compartment or nearby area with a fully charged fire extinguisher. Select a fire extinguisher rated ABC or BC for electrical fires or as recommended by the local fire code or an authorized agency. Train all personnel on fire extinguisher operation and fire prevention procedures.

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. Never operate the generator set where exhaust gas could seep inside or be drawn into a potentially occupied building through windows, air intake vents, or other openings.

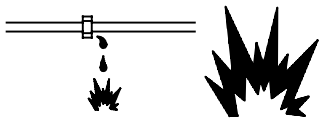
Carbon monoxide symptoms. Carbon monoxide can cause severe nausea, fainting, or death. Carbon monoxide is a poisonous gas present in exhaust gases. Carbon monoxide is an odorless, colorless, tasteless, nonirritating gas that can cause death if inhaled for even a short time. Carbon monoxide poisoning 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.

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.

Engine noise. Hazardous noise can cause hearing loss. Generator sets not equipped with sound enclosures can produce noise levels greater than 105 dBA. Prolonged exposure to noise levels greater than 85 dBA can cause permanent hearing loss. Wear hearing protection when near an operating generator set.

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.

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

Do not work on the generator set until it cools.

Servicing the alternator. Hot parts can cause severe injury or death. Avoid touching the alternator field or exciter armature. When shorted, the alternator field and exciter armature become hot enough to cause severe burns.

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.

Servicing the engine heater. Hot parts can cause minor personal injury or property damage. Install the heater before connecting it to power. Operating the heater before installation can cause burns and component damage. Disconnect power to the heater and allow it to cool before servicing the heater or nearby parts.

Notice

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 12RESM1 and 12RESL generator sets equipped with the Kohler® DC 2200 Digital Control. Refer to TPS-6398, Operation Manual, for generator set operating instructions.

The generator set is approved for use in stationary applications in locations served by a reliable utility power source.

Have an authorized distributor/dealer install the generator set outdoors according to the instructions in this manual. The generator set installation must comply with the National Electrical Code (NEC) and local code requirements. Do not install this generator set indoors.

Information in this publication represents data available at the time of print. The manufacturer of Spectrum® productsKohler 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.

List of Related Literature

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
Specification Sheet	G4-110
Installation Manual	TP-6397
Operation Manual	TP-6398
Parts Catalog*	TP-6399
Service Manual	TP-6196
* Includes the generator and engine information.	

Figure 1 Generator Set Literature

Service Assistance

For professional advice on generator set 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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(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

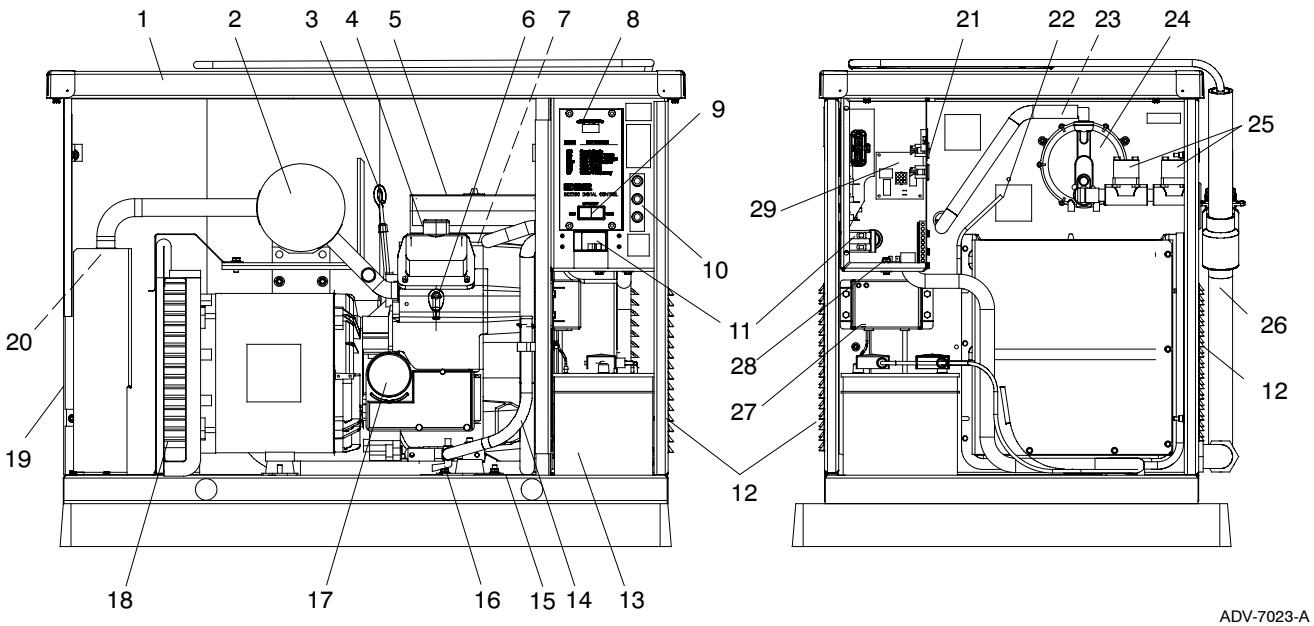
Latin America
Latin America Regional Office
Lakeland, Florida, USA
Phone: (863) 619-7568
Fax: (863) 701-7131

1.1 Specifications

Refer to the generator set specification sheet for engine and alternator specifications and generator set application data. See List of Related Materials for the spec sheet part number.

1.2 Components

See Figure 1-1 for generator set component locations.



1. Enclosure
2. Silencer
3. Oil check
4. Oil fill
5. Air cleaner
6. Spark plug locations (both sides)
7. Carburetor heater location (under air cleaner; if equipped)
8. Controller
9. Generator set master switch (RUN\OFF/RESET\AUTO)
10. Fuses
11. Line circuit breaker
12. Air intake vents
13. Engine starting battery location
14. Oil drain hose
15. Nameplate (on base)
16. Oil drain valve
17. Oil filter
18. Alternator cooling air intake
19. Exhaust outlet
20. Spark arrestor
21. 120VAC receptacle
22. DSAM leads
23. LP fuel jet location
24. Gas regulator assembly
25. Fuel solenoid valves (2)
26. Wiring kit
27. Battery charger
28. Ground stud (GND)
29. Relay board

Figure 1-1 Generator Set Component Locations

Notes

2.1 General

Have an authorized distributor/dealer install the generator set outdoors according to the instructions in this manual. The generator set installation must comply with the National Electrical Code (NEC) and local code requirements. Do not install this generator set indoors.

Use the specifications provided here only in the initial planning. Use the generator set and transfer switch spec sheets, dimension drawings, and wiring diagrams for installation.

2.2 Lifting

⚠ 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.

The generator set weighs approximately 180 kg (400 lb.). Use lifting bars inserted through the holes in the skid to lift the unit. See Figure 2-1 for lifting hole locations.

2.3 Generator Set Inspection

Complete a thorough inspection of the generator set. Check for the following:

- Inspect the generator set for loose or damaged parts or wires. Repair or tighten any loose parts before installation.
- Check the engine oil. Fill, if necessary, with the recommended viscosity and grade of oil. Use synthetic oil, API (American Petroleum Institute) Service Class SG or higher. See TP-6398, Operation Manual, for additional information.

2.4 Location and Mounting

See Figure 2-1 for the generator set dimensions and fuel and electric inlet locations. The drawing dimensions are shown in millimeters, with inches in brackets. The wiring kit is shown as packaged for shipping.

Locate the generator set outdoors. See Figure 2-2 for the minimum clearance around the generator set. Select a location where the generator set exhaust does not blow on plants or other combustible materials. Do not install the generator set where exhaust gas could accumulate and seep inside or be drawn into a potentially occupied building.

2.4.1 Standard Mounting

The generator set is shipped on a plastic mounting pad. Prepare a flat, level mounting area covered with a weed barrier and gravel as shown in Figure 2-2. Set the plastic mounting pad directly on the gravel. Do not install the mounting pad directly on grass.

2.4.2 High-Wind Enclosure Mounting

See Figure 2-3 for mounting details for the optional high-wind enclosure.

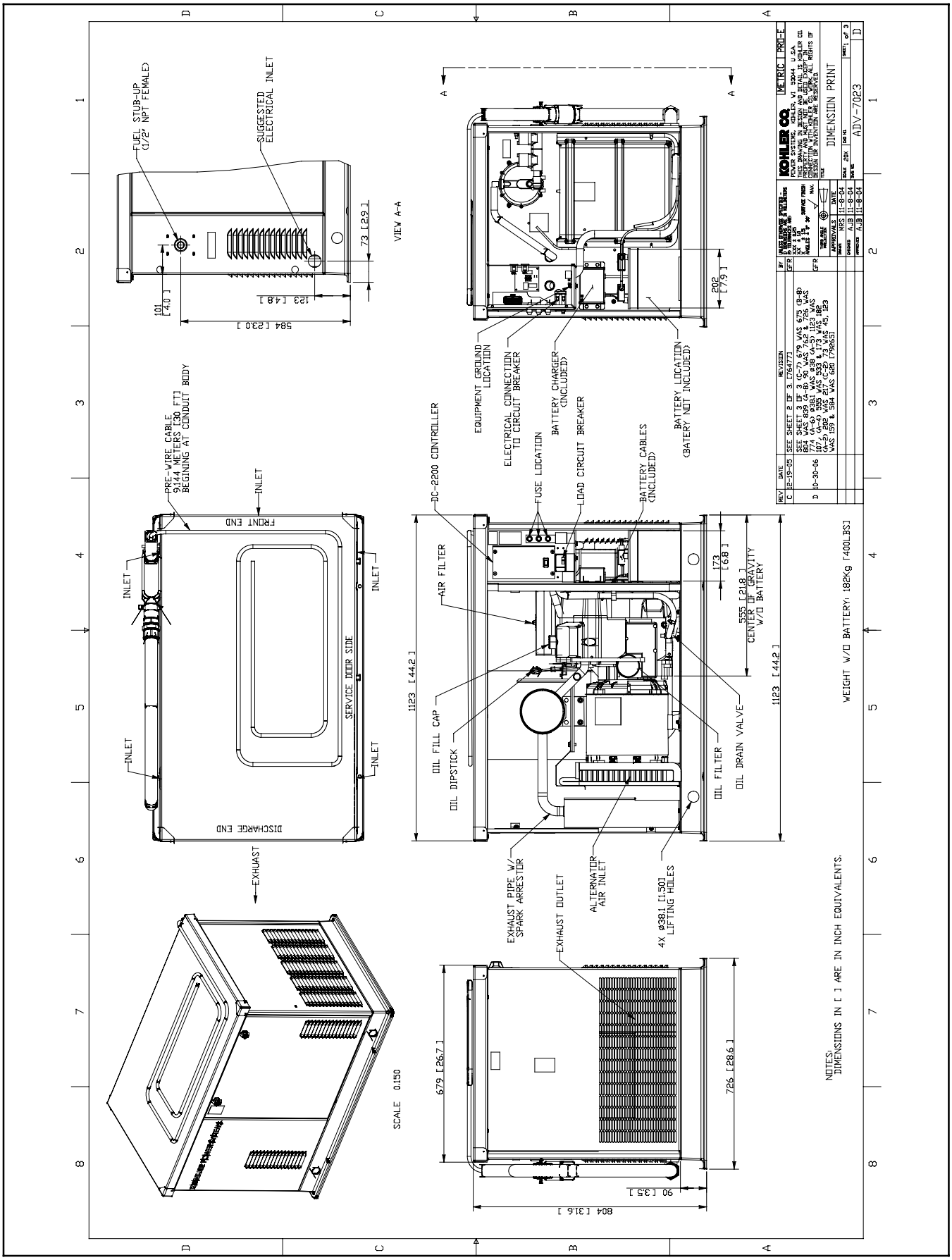


Figure 2-1 Generator Set Mounting Details and Dimensions, ADV-7023A-D

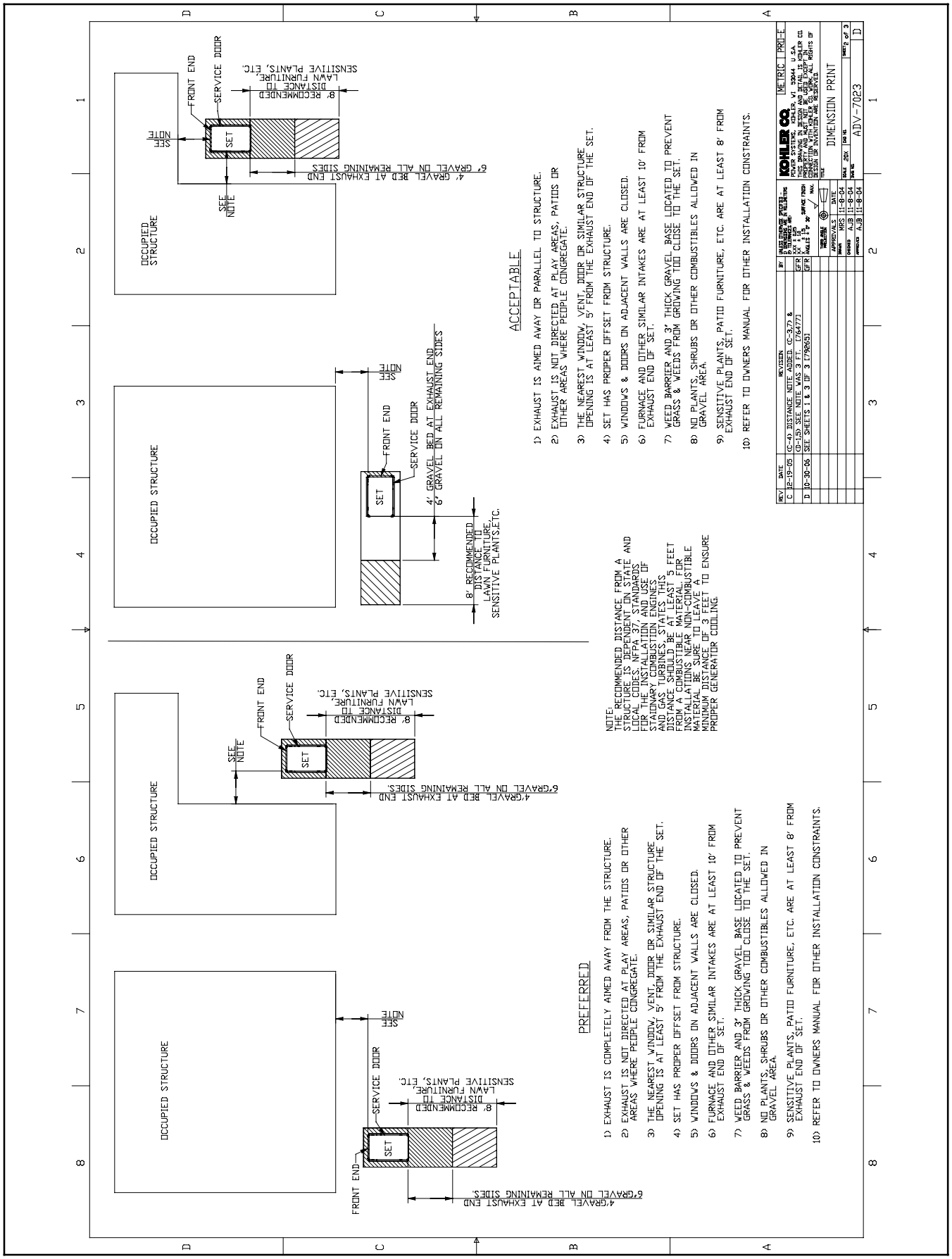


Figure 2-2 Generator Set Clearances, ADV-7023B-C

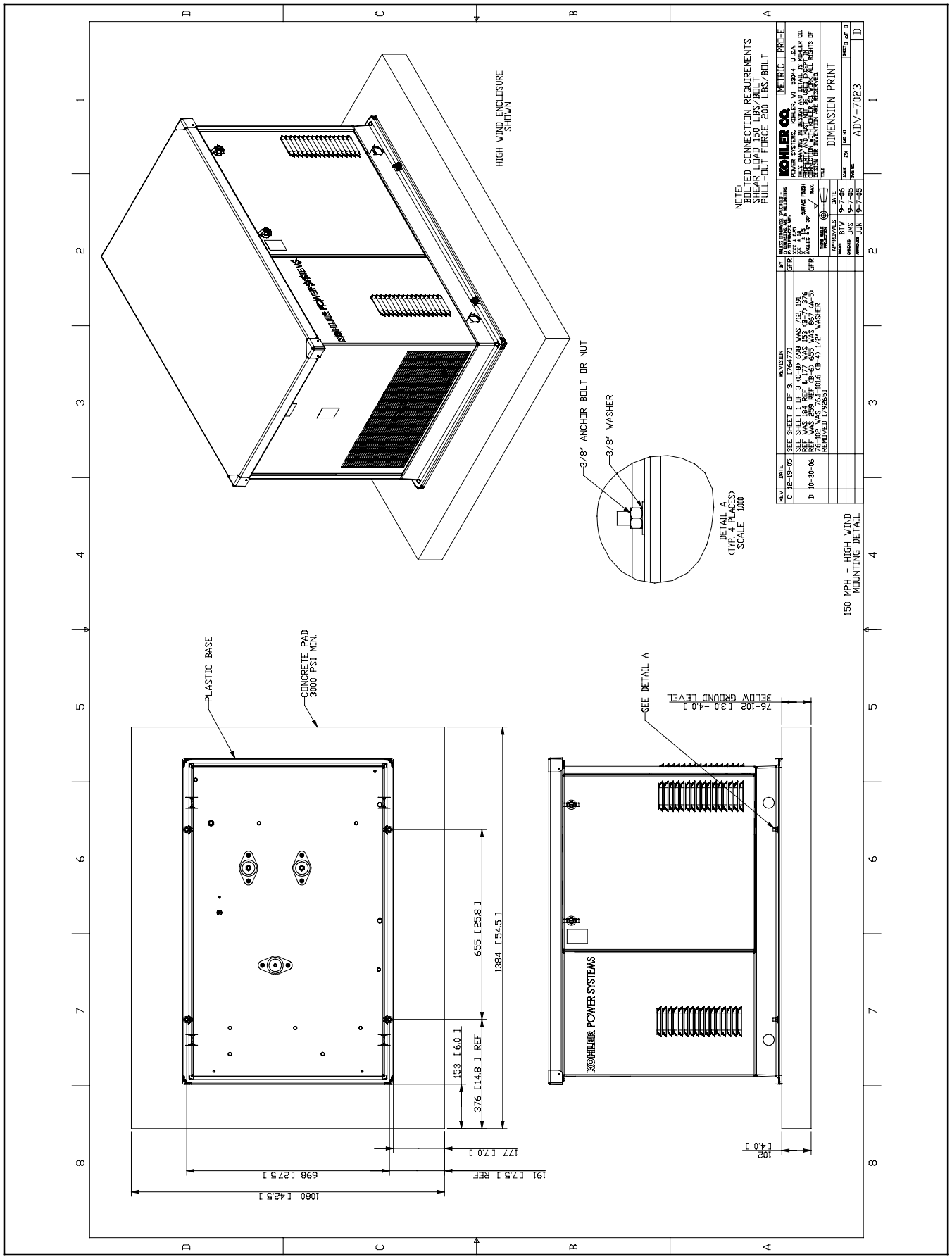
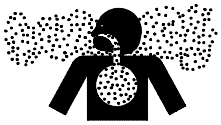


Figure 2-3 High Wind Enclosure and Mounting, ADV-7023C-D

2.4.3 Exhaust Requirements

⚠ 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. Never operate the generator set where exhaust gas could seep inside or be drawn into a potentially occupied building through windows, air intake vents, or other openings.

The exhaust system is complete for generator sets installed outdoors. Do not install this generator set indoors.

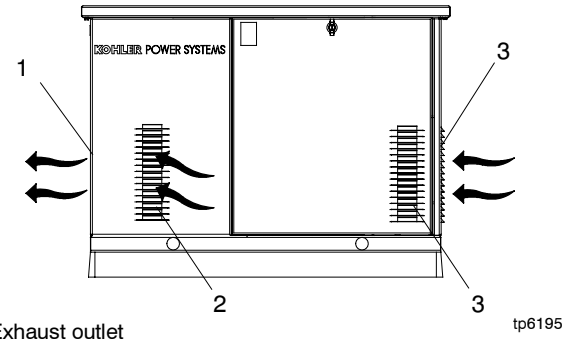
Figure 2-4 gives the exhaust flow and temperature at rated load. The engine exhaust mixes with the generator set cooling air at the exhaust end of the enclosure. Mount the generator set so that the hot exhaust does not blow on plants or other combustible materials. Maintain the clearances shown in Figure 2-2.

Exhaust System	
Exhaust flow at rated kW, m^3/min. (cfm)	3.8 (135)
Engine exhaust temperature at rated kW, dry exhaust, °C (°F)	816 (1500)
Exhaust gas exiting the enclosure at rated kW, °C (°F)	316 (600)

Figure 2-4 Exhaust Flow and Temperature

2.4.4 Air Requirements

The generator set requires correct air flow for cooling and combustion. The inlet and outlet openings in the sound enclosure provide the cooling and combustion air. Figure 2-5 shows the locations of the cooling air intake and exhaust vents. Inspect the air inlet and outlet openings inside and outside the housing to ensure that the air flow is not blocked.



1. Exhaust outlet
2. Alternator air intake (both sides)
3. Engine air intake

Figure 2-5 Cooling Air Intake and Exhaust

Cooling Air Requirements	
Cooling air, m^3/min. (cfm)	26.9 (950)
Total inlet air requirement, m^3/min. (cfm)	28.0 (990)
Combustion air, m^3/min. (cfm)	1.1 (39.2)

Figure 2-6 Cooling Air Requirements

2.5 Fuel System

The generator set operates using natural gas or LP vapor fuel. The generator set is CARB- and EPA-certified for both natural gas and LP vapor fuels.

The fuel system installation must comply with all applicable state and local codes.

2.5.1 Fuel Supply

Because of variable climates and geographical considerations, contact the local fuel supplier for fuel system planning and installation. Figure 2-7 lists the recommended fuel ratings for natural gas and LP vapor fuels.

Fuel System	
Fuel types	Natural Gas or LP Vapor
Fuel supply inlet	1/2 NPT
Fuel supply pressure, kPa (in. H_2O):	
Natural gas	1.2–2.7 (5-11)
LP	1.7–2.7 (7-11)
Gas flow rate, Btu/hr.	193,000
Nominal Fuel Rating, Btu/ft^3	
Natural gas	1000
LP vapor	2500

Figure 2-7 Fuel Supply

Verify that the output pressure from the primary gas utility (or LP tank) pressure regulator is within the fuel supply pressure range shown in Figure 2-7 and that the utility gas meter flow rate is sufficient to supply the generator set plus all other gas-consuming appliances. Figure 2-7 shows the flow rate required for the generator set and Figure 2-8 shows the fuel consumption. Contact the fuel supplier for flow rate information or a gas meter upgrade.

Fuel Consumption at % rated load		
Natural Gas	**m^3/hr. (cfh)**	
100%	5.4 (193)	
75%	4.7 (163)	
50%	3.5 (124)	
25%	2.6 (93)	
LP Vapor	**m^3/hr. (cfh)**	**kg/hr. (lb./hr.)**
100%	2.3 (81)	4.3 (9.4)
75%	2.1 (75)	3.9 (8.7)
50%	1.8 (60)	3.4 (7.0)
25%	1.2 (45)	2.2 (5.2)

Figure 2-8 Fuel Consumption

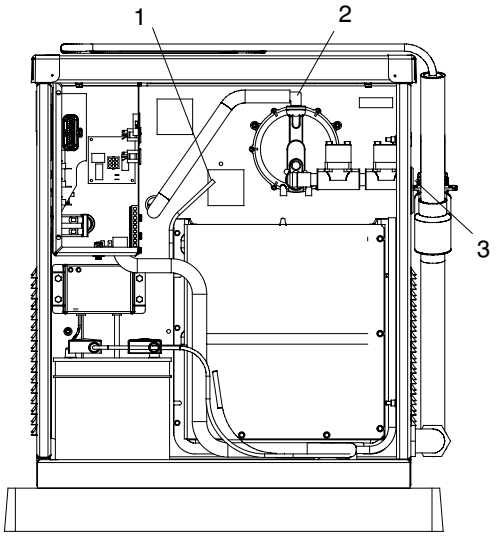
Ensure that the natural gas pipe size and length meet the specifications in Figure 2-9. Measure the pipe length from the primary gas pressure regulator to the pipe connection on the generator set fuel inlet. Add 2.4 m (8 ft.) to the measured length for each 90 degree elbow. Compare the pipe size and length with the chart in Figure 2-9. If the piping is longer than the maximum length shown for that size, replace it with the specified size before proceeding.

Pipe Size	Maximum Pipe Length, m (ft.)
3/4 in. NPT	9.2 (30)
1 in. NPT	30 (100)
1 1/4 in. NPT	68.6 (225)

Figure 2-9 Maximum Natural Gas Pipe Length

Contact the local LP provider for LP pipe size information.

Figure 2-10 shows the location of the fuel inlet connection. Use flexible sections to prevent fuel line breakage caused by vibration. Hold the fuel solenoid valve with a wrench when tightening the fuel connections. Protect all fuel lines from machinery or equipment contact, adverse weather conditions, and environmental damage.



1. DSAM connector location
2. Fuel hose and elbow fitting
3. Fuel inlet, 1/2 in. NPT female

Figure 2-10 Fuel System Locations, Air Inlet Side

2.5.2 Fuel Conversion

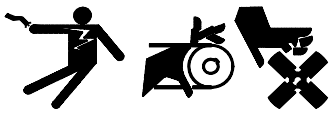
The multi-fuel system allows conversion from natural gas to LP vapor (or vice-versa) in the field while maintaining emissions-standard compliance. A trained technician or authorized distributor/dealer can convert the fuel system.

An LP fuel jet is included with the generator set. Conversion to LP fuel involves the following:

- Installation of the fuel jet.
- Disconnection of the digital spark-advance module (DSAM) leads.

Use the following procedure to convert from natural gas to LP vapor. See Figure 2-10 for the fuel system component locations.

⚠ WARNING

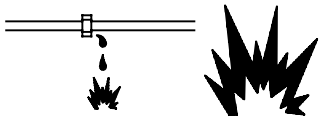


Accidental starting.
Can cause severe injury or death.

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

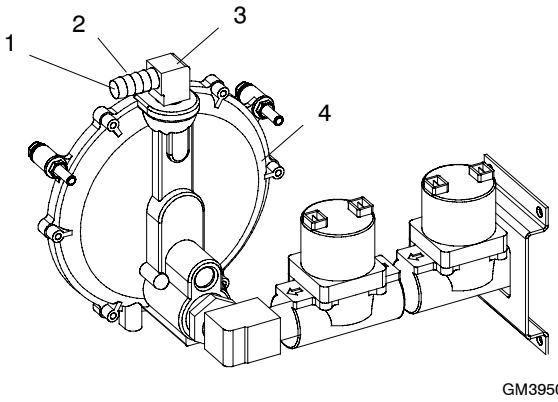


Explosive fuel vapors.
Can cause severe injury or death.

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

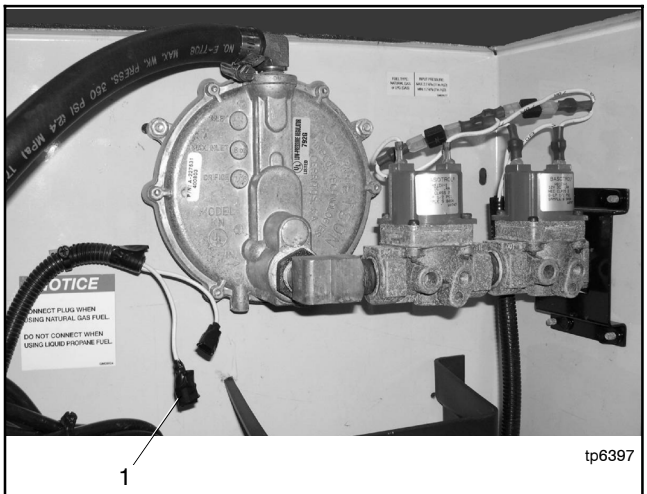
Fuel Conversion Procedure

1. Place the generator set master switch in the OFF position.
2. Disconnect the power to the battery charger.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Turn off the fuel supply.
5. Remove the enclosure roof or end panel to gain access to the fuel system. See Figure 2-10.
6. Remove the hose clamp and fuel hose from the hose fitting in the regulator. See Figure 2-10.
7. Use a screwdriver to install the LP fuel jet into the elbow fitting. See Figure 2-11.
8. Slide the hose onto the hose fitting and secure it with the clamp.
9. Disconnect the digital spark-advance module (DSAM) leads for LP. See Figure 2-12.
10. Connect and turn on the new fuel supply.
11. Check that the generator set master switch is in the OFF position.
12. Reconnect the generator set engine starting battery leads, negative (-) lead last.
13. Reconnect power to the battery charger.



1. LP fuel jet (24 337 35) location (hose and clamp removed)
2. Hose fitting
3. Elbow fitting
4. Regulator

Figure 2-11 Fuel Conversion



1. DSAM leads: connect for natural gas, disconnect for LP.

Figure 2-12 Digital Spark Advance Module (DSAM) Leads (located in generator set air intake area)

14. Start the generator set by moving the generator set master switch to the RUN position.
15. Check for leaks using a gas leak detector.
16. Move the generator set master switch to the OFF/RESET position to shut down the generator set.

To convert from LP vapor to natural gas, reverse the fuel conversion procedure, removing the LP fuel jet and connecting the DSAM leads for natural gas. See Figure 2-12.

2.6 Electrical Connections

⚠ 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.

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.

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.

Have an authorized distributor/dealer or a licensed electrician make the following electrical connections. Verify that the electrical installation complies with the National Electrical Code (NEC) and all applicable local codes. Ground generator set according to applicable codes.

2.6.1 Generator Set Connections

The factory-installed wiring kit eliminates the need to make field connections inside the generator set junction box. The wiring kit includes a wiring harness and an AC outlet mounted inside the generator set enclosure for the battery charger and accessories. See Figure 2-13.

The wiring harness includes the engine start leads, power leads to the AC outlet, and the emergency power leads. The leads exit the generator set in 1 1/4 inch conduit with liquid-tight connections. Cut a 2-inch hole through the building wall to bring the PVC end of the conduit into the building. Secure the PVC assembly to the wall using the clamp provided. Seal the gap around the conduit with caulk. Use duct seal inside the conduit if desired.

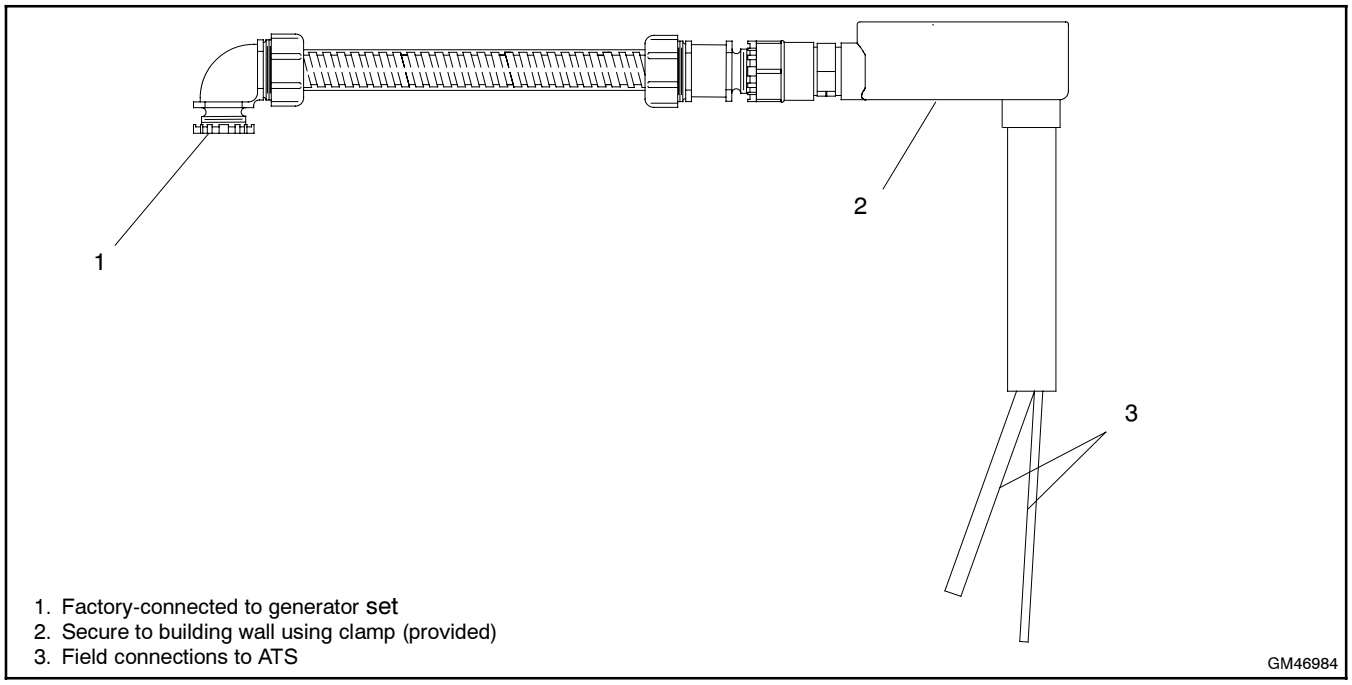


Figure 2-13 Wiring Kit

Cut the leads to the length required and route the leads to the ATS. Add conduit if required by local codes. Refer to Figure 2-14 and the wiring diagram in Section 3 for the wiring kit connections. Connect and ground the system in accordance with the NEC and all applicable local codes.

Lead Identification		Connection
14 ga.	Red	Engine start leads 3 and 4 to the ATS
	White/Red	
	Black	120 VAC circuit on essential loads panel for battery charger and accessories. See Section 2.6.2.
	White	
	Uninsulated	
6 ga.	Red	ATS emergency source lugs EL1 and EL2
	Black	
	White	Neutral
	Uninsulated	Ground

Figure 2-14 Wiring Kit Field Connections

2.6.2 Power Supply

Power must be supplied to the generator set location for the battery charger and the optional carburetor heater. A 120 VAC receptacle is located inside the air intake compartment. Power to the receptacle must be supplied through leads in the wiring kit harness. See Figure 2-14.

Connect the power leads to a 120 VAC circuit in the essential loads panel so that the battery charger is powered by the generator set when utility power is not available. Figure 2-15 lists the power requirements for the battery charger and accessories.

Equipment	Power Requirement, Max.		
	Watts	Amps	Volts
Battery charger	192	1.60	120
Carburetor heater *	38	0.32	
* Not included on all models			

Figure 2-15 Power Requirements

2.6.3 Grounding

Ground the generator set. The grounding method must comply with NEC and local codes. The wiring kit includes 2 ground leads. See Figure 2-14 and also Figure 2-18 in Section 2.7, Transfer Switch Connections.

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.

2.6.4 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.

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 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.

⚠ 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.

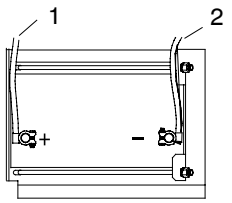
Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the 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.

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).

Use a 12-volt battery with a minimum rating of 525 cold cranking amps at 0°F. The generator set uses a negative ground with a 12-volt engine electrical system. See Figure 2-16 for battery connections. Make sure that the battery is correctly connected and the terminals are tight.

Note: The generator set will not start and circuit board damage may occur if the battery is connected in reverse.

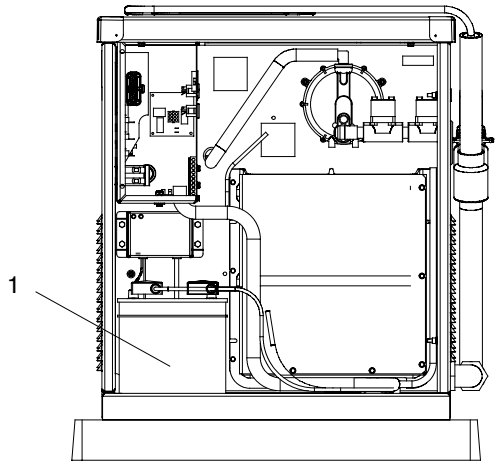
Figure 2-17 shows the location of the engine starting battery. Standard battery cables provide easy connection to the battery. Use the following procedure to install and connect the battery.



EZ-273000-J

1. To positive (+) terminal on starter solenoid.
2. To ground (-) terminal on or near starter motor.

Figure 2-16 12-Volt Engine Electrical System Single Starter Motor Typical Battery Connection



1. Engine starting battery location

ADV-7023A

Figure 2-17 Battery Location, Air Intake End

Battery Installation Procedure

1. Ensure that the starting battery is fully charged before placing the battery in service.
2. Clean the battery posts and/or adapters if necessary.
3. Install the battery post adapters, if needed.
4. Place the battery in the housing.
5. Verify that the controller master switch is in the OFF position.
6. Connect the positive (+) lead to the engine starting battery.
7. Connect the negative (-) lead to the engine starting battery.

2.6.5 Battery Charger

A 6-amp battery charger is factory-installed in the battery compartment. The battery charger's DC leads are factory-connected. The battery charger is required in order to keep the engine starting battery fully charged. Plug the battery charger's power cord into the 120 VAC receptacle inside the air intake compartment. See Section 2.6.2 for instructions to connect power to the receptacle. Refer to the generator set operation manual for battery charger operation information.

2.7 Transfer Switch Connections

Connect the engine start leads and power cables from the generator wiring kit to the transfer switch. See Figure 2-18 and the wiring diagrams in Section 3.

Follow the instructions in ATS Operation/Installation Manual TP-6345 for transfer switch installation, operation, test, and maintenance instructions.

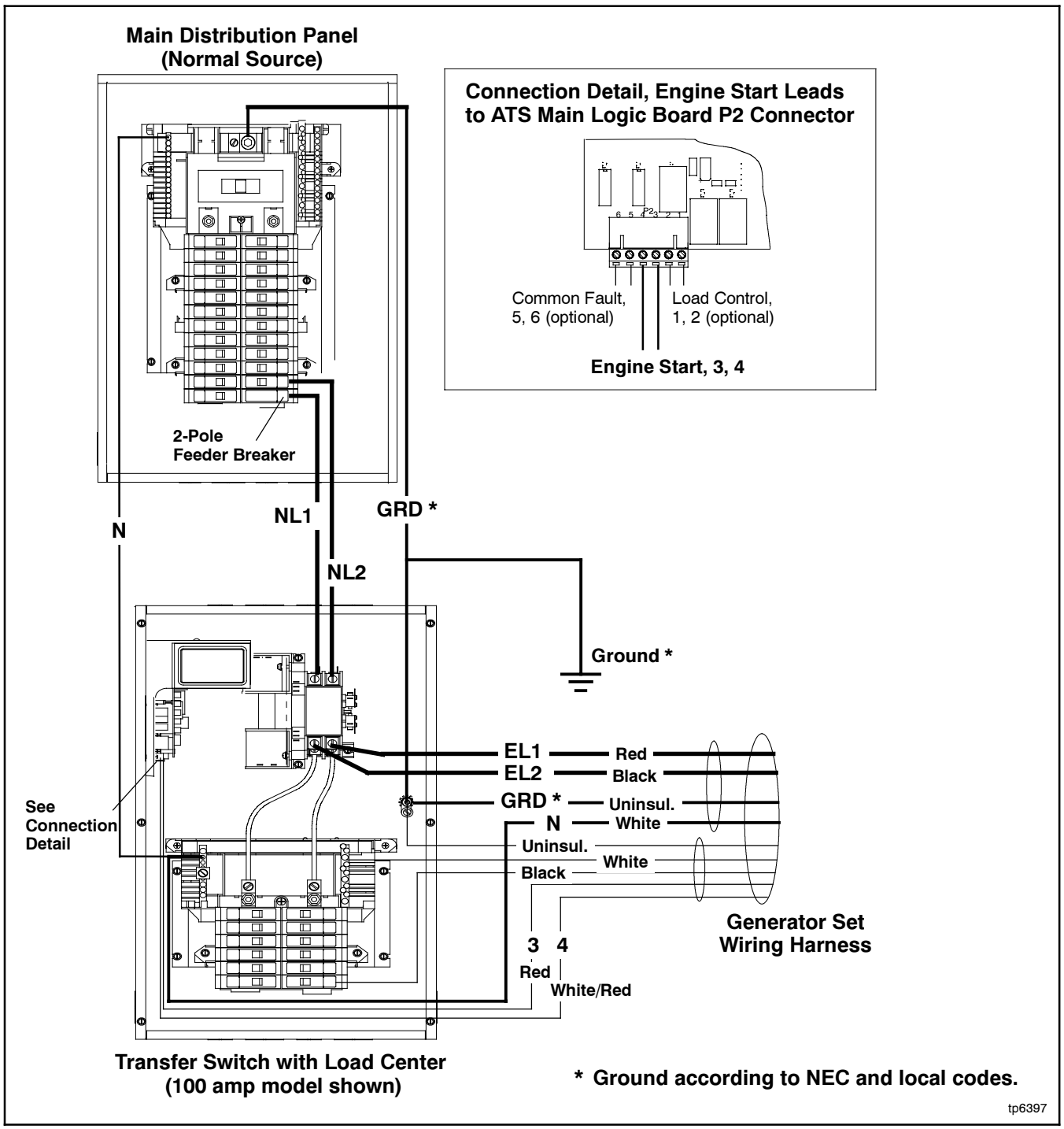


Figure 2-18 Transfer Switch Connections

2.8 Carburetor Heater

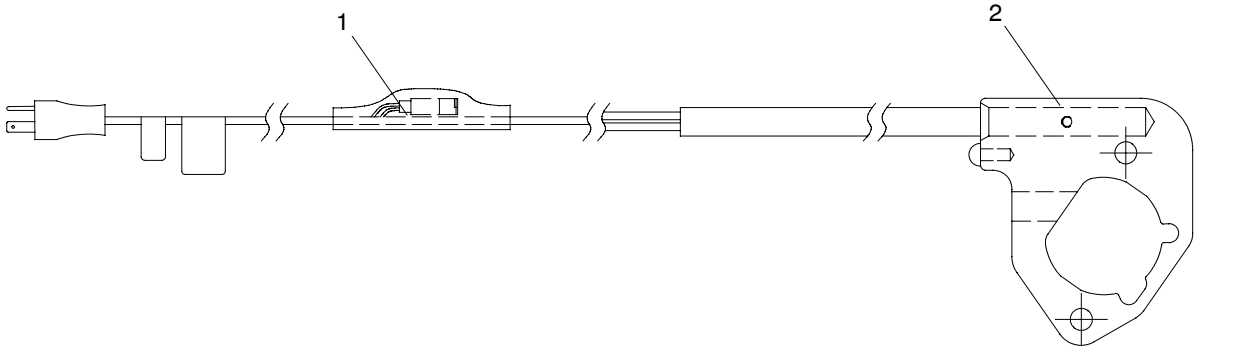
Generator sets are available with or without the carburetor heater. The carburetor heater is recommended for improved cold starting in locations where the ambient temperature drops below 0°C (32 °F). The carburetor heater prevents condensation and carburetor icing. The heater turns on when the temperature at the thermostat falls below approximately 4°C (40°F) and turns off when the temperature rises above approximately 16°C (60°F).

The heater requires a continuous source of 120 VAC power. A 120 VAC receptacle is located inside the generator set housing air intake area. See Figure 1-1. The wiring kit includes leads for the receptacle. Connect the receptacle leads to a circuit breaker in the essential load panel in the ATS enclosure to ensure that the receptacle is always powered. See Section 2.6.1 for connection information.

The carburetor heater is installed between the carburetor and the air cleaner. See Figure 1-1 for the location.

The heater thermostat is installed in the cord. Figure 2-19 shows the location of the thermostat on the power cord. The thermostat is located in the air intake area.

Note: Do not place the heater thermostat inside the generator set engine compartment. The thermostat must be exposed to the ambient air. The thermostat will shut off power to the heater when the ambient temperature reaches approximately 16°C (60°F).



1. Thermostat
2. Heater

Figure 2-19 Carburetor Heater with Thermostat

2.9 Prestart Installation Check

Review the entire installation section. Inspect all wiring and connections to verify that the generator set is ready for operation. Check all items in the following Prestart Checklist.

Prestart Checklist

Air Cleaner. Check that a clean air cleaner element is installed to prevent unfiltered air from entering the engine.

Air Inlets. Check for clean and unobstructed air inlets.

Battery. Check for tight battery connections. Consult the battery manufacturer's instructions regarding battery care and maintenance.

Exhaust System. Check for exhaust leaks and blockages. Check the silencer and piping condition.

- Inspect the exhaust system components (exhaust manifold, exhaust line, flexible exhaust, clamps, silencer, and outlet pipe) for cracks, leaks, and corrosion. Check for tight exhaust system connections.
- Check for corroded or broken metal parts and replace them as needed.
- Check that the exhaust outlet is unobstructed.

Oil Level. Maintain the oil level at or near, not over, the full mark on the dipstick.

Operating Area. Check for obstructions that could block the flow of cooling air. Keep the air intake area clean. Do not leave rags, tools, or debris on or near the generator set.

2.10 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.

Notes

3.1 Specification Numbers

At the time of print, this manual applied to the model numbers and specification (spec) numbers in Figure 3-1.

Model No.	Spec. No.
12RESL and 12RESM1	GM39503-SA1
	GM39503-SA2
	GM39503-SA3
	GM39503-SA4

Figure 3-1 Generator Set Specification Numbers

3.2 Controller Wiring Diagram Reference

Figure 3-2 lists the wiring diagram numbers and locations.

Wiring Diagram Description	Drawing Number	Page
Schematic Diagram		
Sheet 1	ADV-7296A-	28
Sheet 2	ADV-7296B-	29
Point-to-Point Wiring Diagram	GM49761-A	30

Figure 3-2 Controller Wiring Diagrams

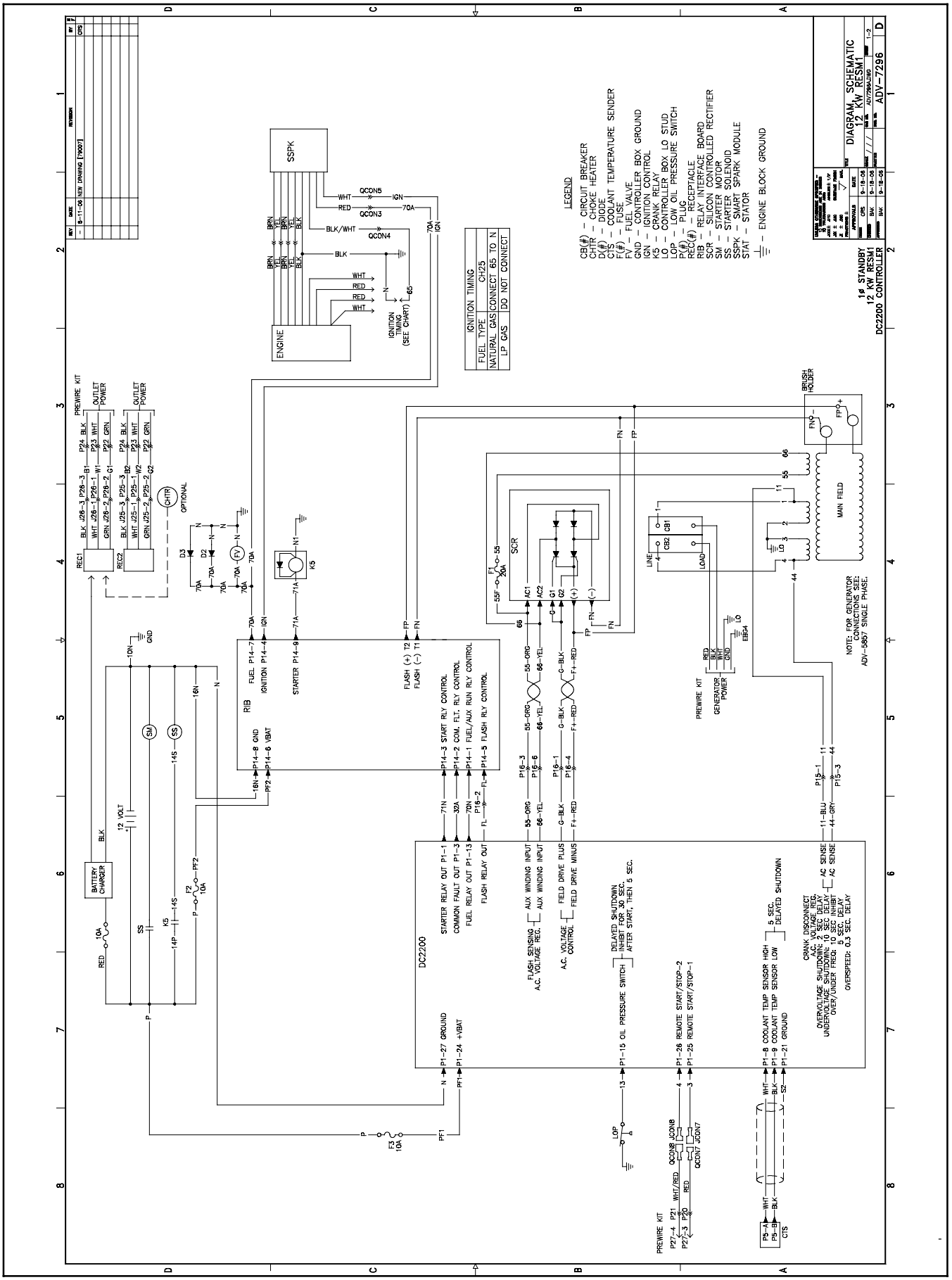


Figure 3-3 Schematic Diagram, Sheet 1, ADV-7296A-

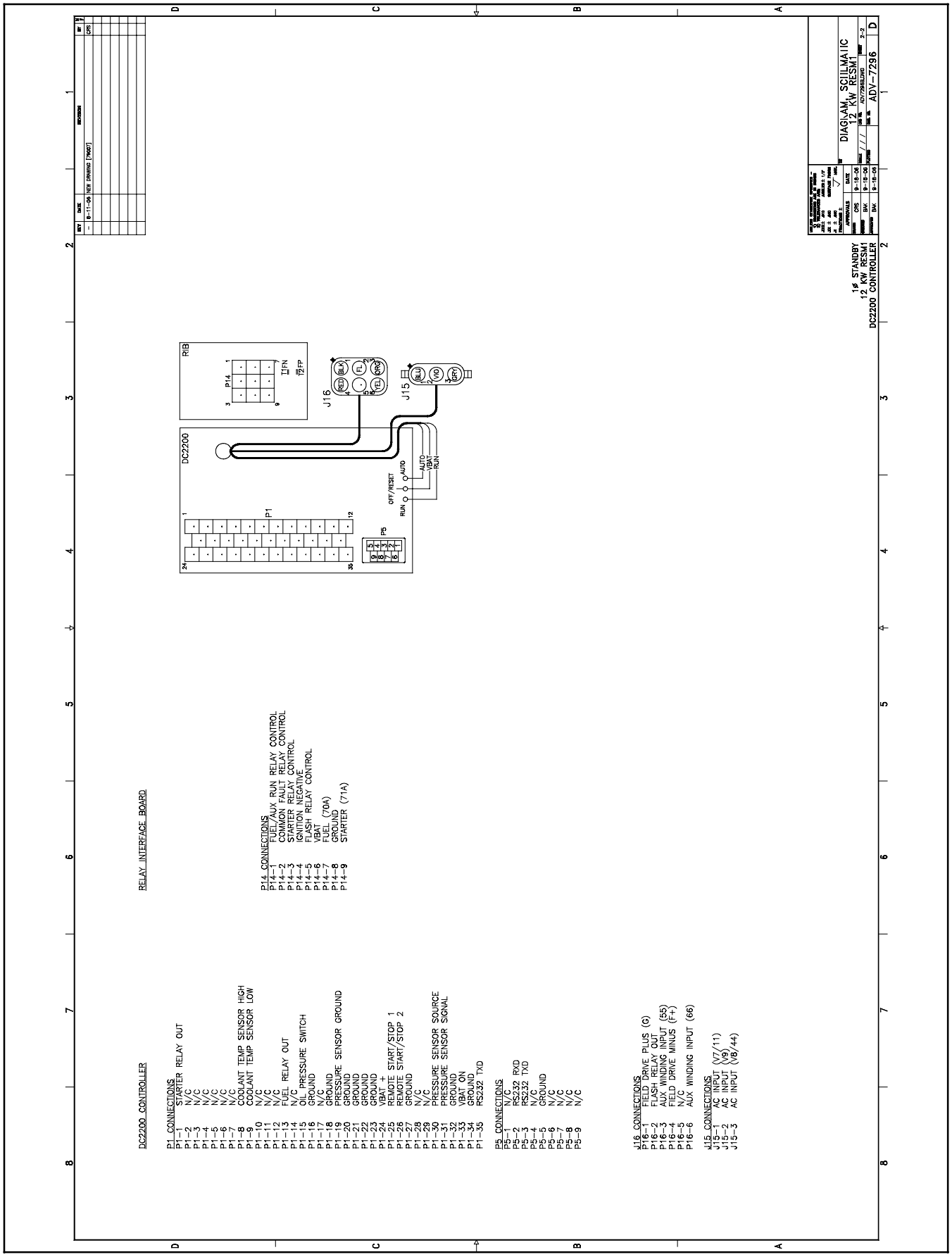


Figure 3-4 Schematic Diagram, Sheet 2, ADV-7296B-

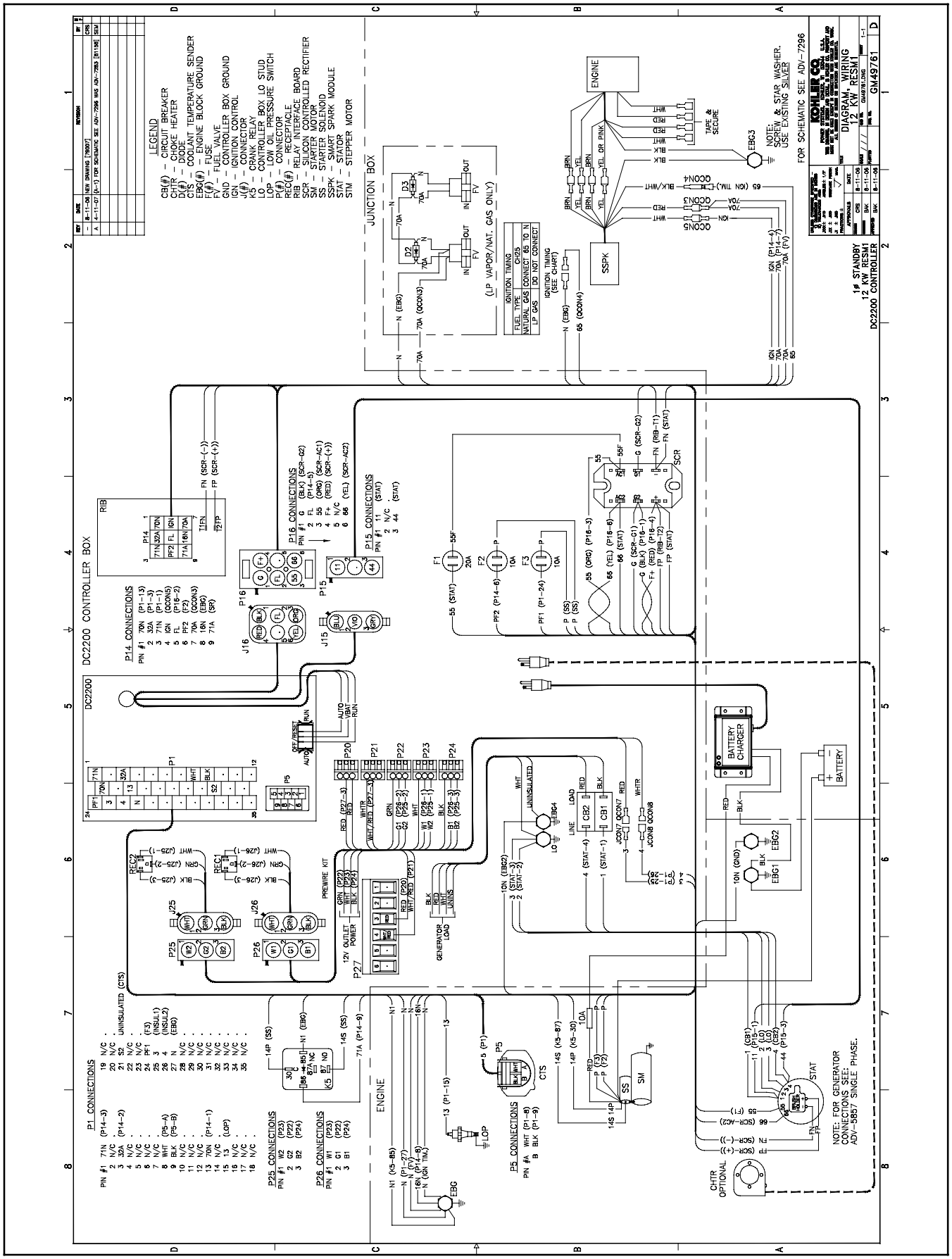


Figure 3-5 Point-to-Point Wiring Diagram, GM49761-A

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

Appendix B Common Hardware Application Guidelines

Use the information below and on the following pages to identify proper fastening techniques when no specific reference for reassembly is made.

Bolt/Screw Length: When bolt/screw length is not given, use Figure 1 as a guide. As a general rule, a minimum length of one thread beyond the nut and a maximum length of 1/2 the bolt/screw diameter beyond the nut is the preferred method.

Washers and Nuts: Use split lock washers as a bolt locking device where specified. Use SAE flat washers with whiz nuts, spiralock nuts, or standard nuts and preloading (torque) of the bolt in all other applications.

See Appendix C, General Torque Specifications, and other torque specifications in the service literature.

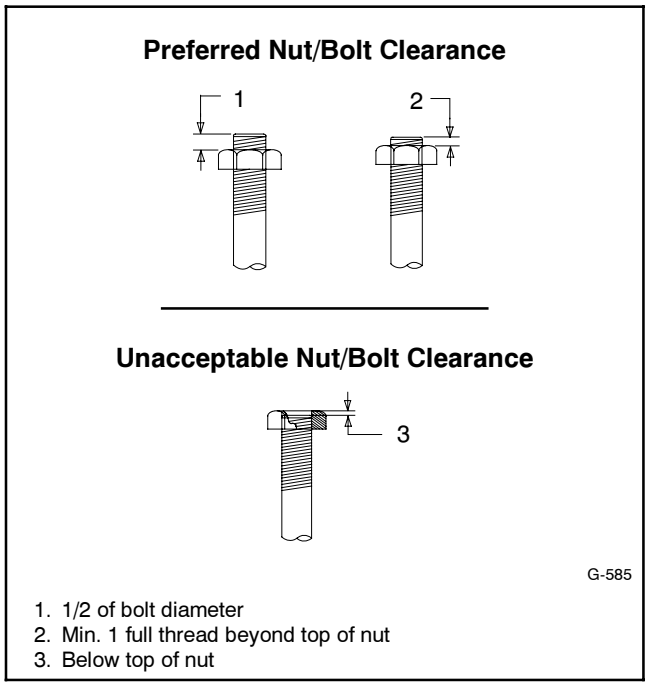


Figure 1 Acceptable Bolt Lengths

Steps for common hardware application:

1. Determine entry hole type: round or slotted.

2. Determine exit hole type: fixed female thread (weld nut), round, or slotted.

   For round and slotted exit holes, determine if hardware is greater than 1/2 inch in diameter, or 1/2 inch in diameter or less. Hardware that is *greater than 1/2 inch* in diameter takes a standard nut and SAE washer. Hardware *1/2 inch or less* in diameter can take a properly torqued whiz nut or spiralock nut. See Figure 2.

3. Follow these SAE washer rules after determining exit hole type:

   a. Always use a washer between hardware and a slot.

   b. Always use a washer under a nut (see 2 above for exception).

   c. Use a washer under a bolt when the female thread is fixed (weld nut).

4. Refer to Figure 2, which depicts the preceding hardware configuration possibilities.

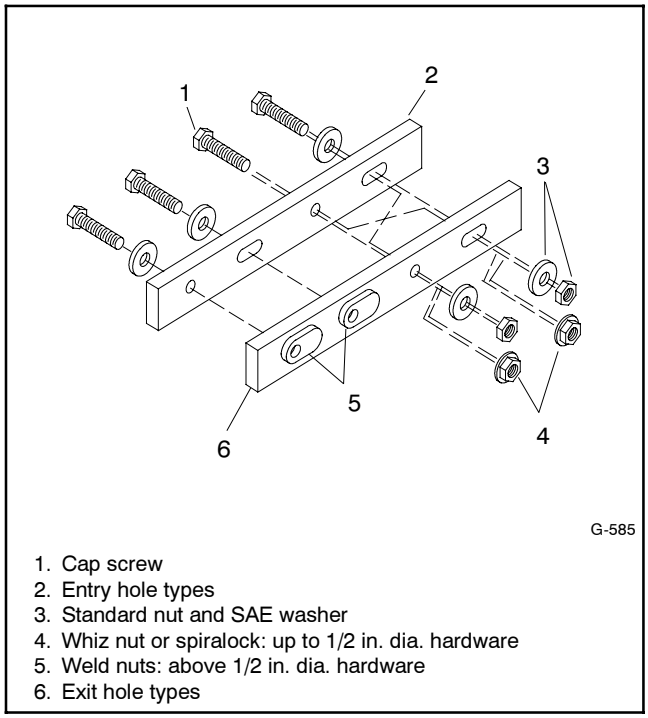


Figure 2 Acceptable Hardware Combinations

Appendix C General Torque Specifications

American Standard Fasteners Torque Specifications								
Size	Torque Measurement	Assembled into Cast Iron or Steel						Assembled into Aluminum Grade 2 or 5
		Grade 2		Grade 5		Grade 8		
8-32	Nm (in. lb.)	1.8	(16)	2.3	(20)	—		See Note 3
10-24	Nm (in. lb.)	2.9	(26)	3.6	(32)	—		
10-32	Nm (in. lb.)	2.9	(26)	3.6	(32)	—		
1/4-20	Nm (in. lb.)	6.8	(60)	10.8	(96)	14.9	(132)	
1/4-28	Nm (in. lb.)	8.1	(72)	12.2	(108)	16.3	(144)	
5/16-18	Nm (in. lb.)	13.6	(120)	21.7	(192)	29.8	(264)	
5/16-24	Nm (in. lb.)	14.9	(132)	23.1	(204)	32.5	(288)	
3/8-16	Nm (ft. lb.)	24.0	(18)	38.0	(28)	53.0	(39)	
3/8-24	Nm (ft. lb.)	27.0	(20)	42.0	(31)	60.0	(44)	
7/16-14	Nm (ft. lb.)	39.0	(29)	60.0	(44)	85.0	(63)	
7/16-20	Nm (ft. lb.)	43.0	(32)	68.0	(50)	95.0	(70)	
1/2-13	Nm (ft. lb.)	60.0	(44)	92.0	(68)	130.0	(96)	
1/2-20	Nm (ft. lb.)	66.0	(49)	103.0	(76)	146.0	(108)	
9/16-12	Nm (ft. lb.)	81.0	(60)	133.0	(98)	187.0	(138)	
9/16-18	Nm (ft. lb.)	91.0	(67)	148.0	(109)	209.0	(154)	
5/8-11	Nm (ft. lb.)	113.0	(83)	183.0	(135)	259.0	(191)	
5/8-18	Nm (ft. lb.)	128.0	(94)	208.0	(153)	293.0	(216)	
3/4-10	Nm (ft. lb.)	199.0	(147)	325.0	(240)	458.0	(338)	
3/4-16	Nm (ft. lb.)	222.0	(164)	363.0	(268)	513.0	(378)	
1-8	Nm (ft. lb.)	259.0	(191)	721.0	(532)	1109.0	(818)	
1-12	Nm (ft. lb.)	283.0	(209)	789.0	(582)	1214.0	(895)	

Metric Fasteners Torque Specifications, Measured in Nm (ft. lb.)								
Size (mm)	Assembled into Cast Iron or Steel						Assembled into Aluminum Grade 5.8 or 8.8	
	Grade 5.8		Grade 8.8		Grade 10.9			
M6 x 1.00	6.2	(4.6)	9.5	(7)	13.6	(10)	See Note 3	
M8 x 1.25	15.0	(11)	23.0	(17)	33.0	(24)		
M8 x 1.00	16.0	(11)	24.0	(18)	34.0	(25)		
M10 x 1.50	30.0	(22)	45.0	(34)	65.0	(48)		
M10 x 1.25	31.0	(23)	47.0	(35)	68.0	(50)		
M12 x 1.75	53.0	(39)	80.0	(59)	115.0	(85)		
M12 x 1.50	56.0	(41)	85.0	(63)	122.0	(90)		
M14 x 2.00	83.0	(61)	126.0	(93)	180.0	(133)		
M14 x 1.50	87.0	(64)	133.0	(98)	190.0	(140)		
M16 x 2.00	127.0	(94)	194.0	(143)	278.0	(205)		
M16 x 1.50	132.0	(97)	201.0	(148)	287.0	(212)		
M18 x 2.50	179.0	(132)	273.0	(201)	390.0	(288)		
M18 x 1.50	189.0	(140)	289.0	(213)	413.0	(305)		

Notes:

1. The torque values above are general guidelines. Always use the torque values specified in the service manuals and/or assembly drawings when they differ from the above torque values.
2. The torque values above are based on new plated threads. Increase torque values by 15% if non-plated threads are used.
3. Hardware threaded into aluminum must have either two diameters of thread engagement or a 30% or more reduction in the torque to prevent stripped threads.
4. Torque values are calculated as equivalent stress loading on American hardware with an approximate preload of 90% of the yield strength and a friction coefficient of 0.125.

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