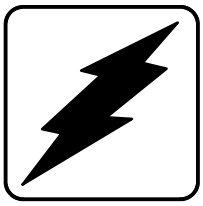
Installation

Residential/Commercial Generator Sets



Models:

8.5RES
12RES

Controller:
Advanced Digital Control

ISO 9001
KOHLER POWER SYSTEMS
NATIONALLY REGISTERED

KOHLER®
POWER SYSTEMS

TP-6328 5/04

Table of Contents

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***.

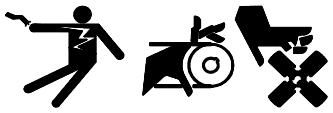
NOTICE

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.

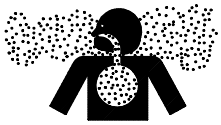
Servicing the air cleaner. A sudden backfire can cause severe injury or death. Do not operate the generator set with the air cleaner removed.

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 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/ Electrical Shock

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect all power sources before opening the enclosure.

⚠ WARNING

Hazardous voltage. Moving rotor.
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. Open the main circuit breakers of all power sources before servicing the equipment. Configure the installation to electrically ground the generator set, transfer switch, and related equipment and electrical circuits to comply with applicable codes and standards. 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.

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.

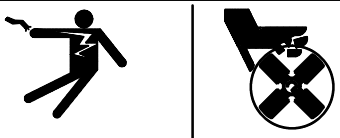
Servicing the generator. Hot parts can cause severe injury or death. Avoid touching the generator set field or exciter armature. When shorted, the generator set field and exciter armature become hot enough to cause severe burns.

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.

Moving Parts

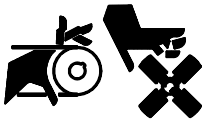
⚠ WARNING



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

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

⚠ WARNING



Rotating parts.
Can cause severe injury or death.

Operate the generator set only when all guards, screens, and covers are in place.

⚠ WARNING

Airborne particles.
Can cause severe injury or blindness.

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

Tightening the hardware. Flying projectiles can cause severe injury or death. Loose hardware can cause the hardware or pulley to release from the generator set engine and can cause personal injury. Retorque all crankshaft and rotor hardware after servicing. Do not loosen the crankshaft hardware or rotor thrubolt when making adjustments or servicing the generator set. Rotate the crankshaft manually in a clockwise direction only. Turning the crankshaft bolt or rotor thrubolt counterclockwise can loosen the hardware.

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.

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

Hardware damage. The engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

NOTICE

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. To indicate hardness, American Standard hardware uses a series of markings, and metric hardware uses a numeric system. Check the markings on the bolt heads and nuts for identification.

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.

NOTICE

Electrostatic discharge damage. Electrostatic discharge (ESD) damages electronic circuit boards. Prevent electrostatic discharge damage by wearing an approved grounding wrist strap when handling electronic circuit boards or integrated circuits. An approved grounding wrist strap provides a high resistance (about 1 megohm), *not a direct short*, to ground.

Notes

Section 1 Introduction

This manual provides installation instructions for model 8.5RES and 12RES generator sets equipped with the Kohler® Advanced Digital Control (ADC 2100). Refer to TP-6331, Operation Manual, for generator set operating instructions.

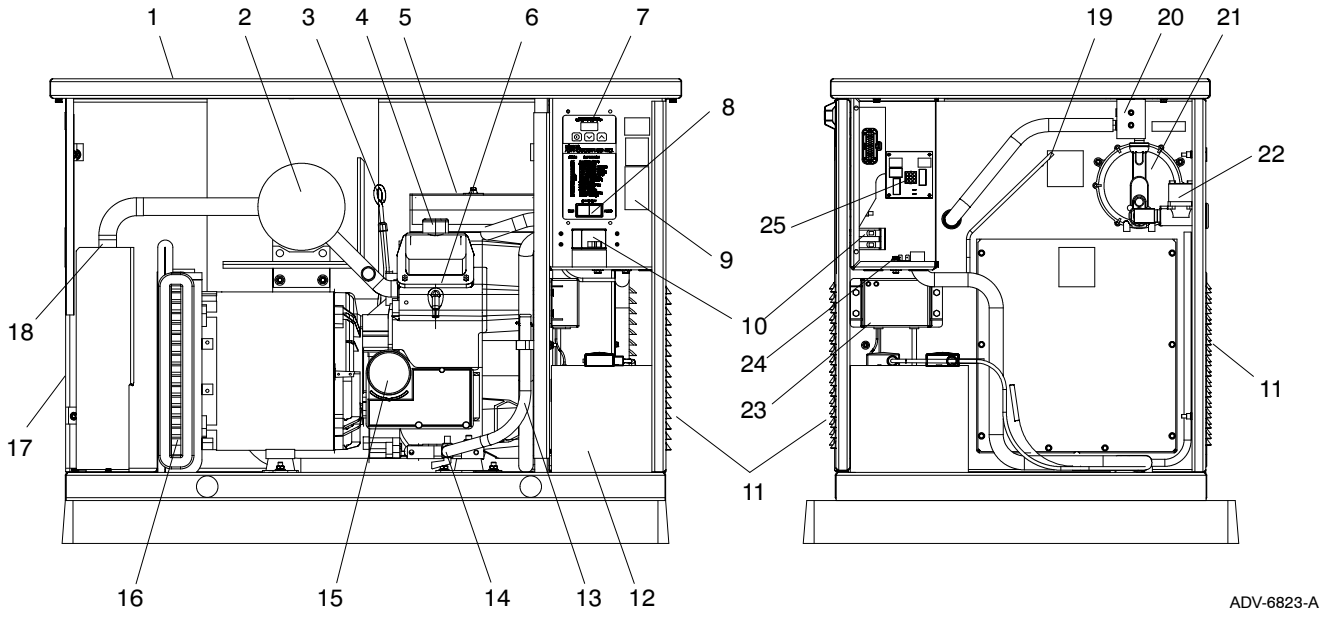
The generator set is approved for use in stationary applications in locations served by a reliable utility power source.

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. 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.

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. Controller
8. Generator set master switch (RUN\OFF/RESET\AUTO)
9. Nameplate
10. Line circuit breaker
11. Air intake vents
12. Engine starting battery location
13. Oil drain hose
14. Oil drain valve
15. Oil filter
16. Alternator cooling air intake
17. Exhaust outlet
18. Spark arrestor
19. DSAM leads
20. Multi-fuel block
21. Gas regulator assembly
22. Fuel solenoid valve
23. Battery charger
24. Ground stud (GND)
25. Relay board

Figure 1-1 Generator Set Component Locations

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 KohlerPowerSystems.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

Headquarters Europe, Middle East, Africa (EMEA)
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94517 Thiais Cedex
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Power Systems Asia Pacific Regional Office
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North China Regional Office, Beijing
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(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

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 186 kg (410 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:

1. Inspect the generator set for loose or damaged parts or wires. Repair or tighten any loose parts before installation.

2. 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 TPTPS-6331, 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.

Install the generator set outdoors. Provide the minimum clearance around the generator set shown in Figure 2-2. Locate the generator set so that the hot 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.

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.

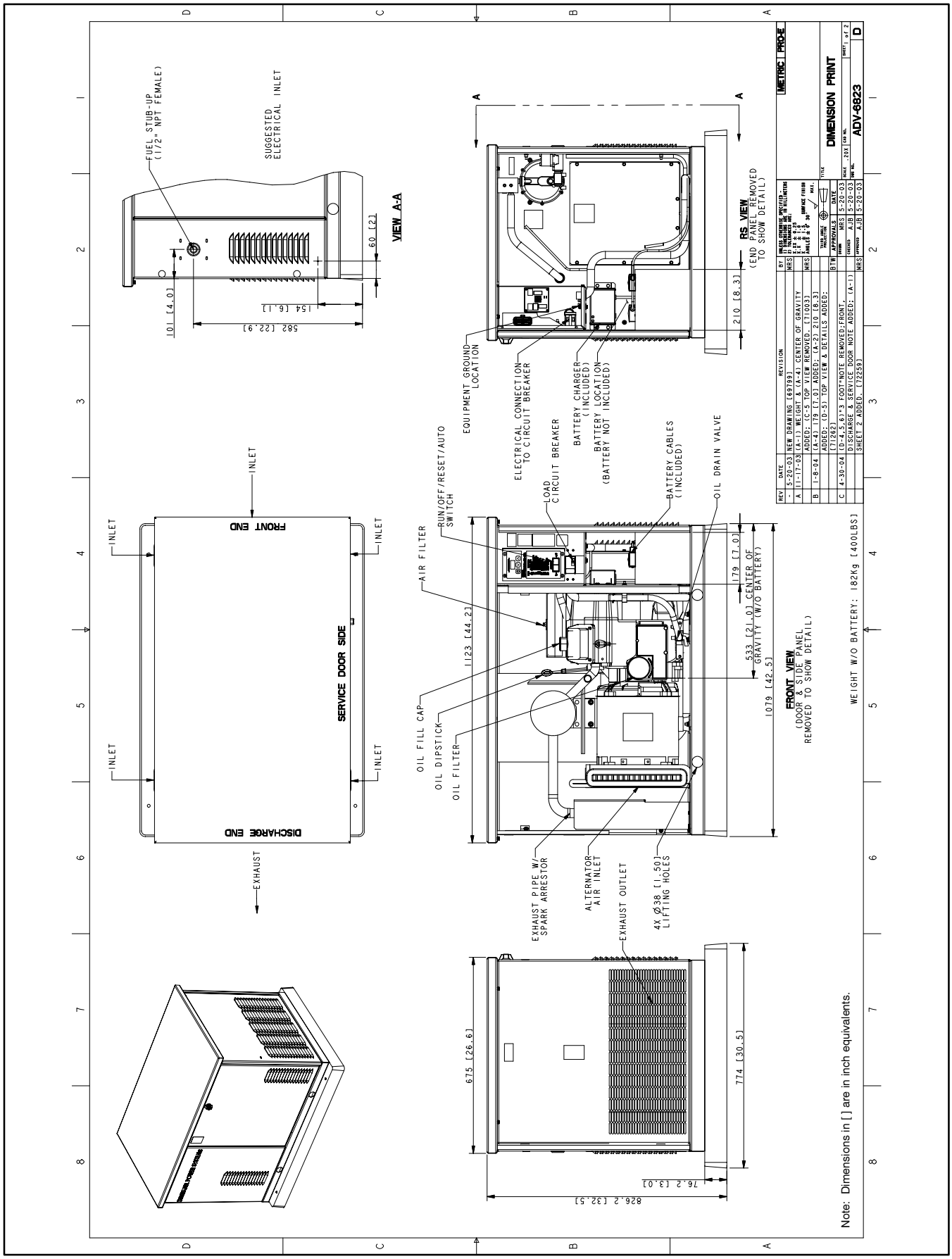


Figure 2-1 Generator Set Mounting Details and Dimensions, ADV-6823A-C

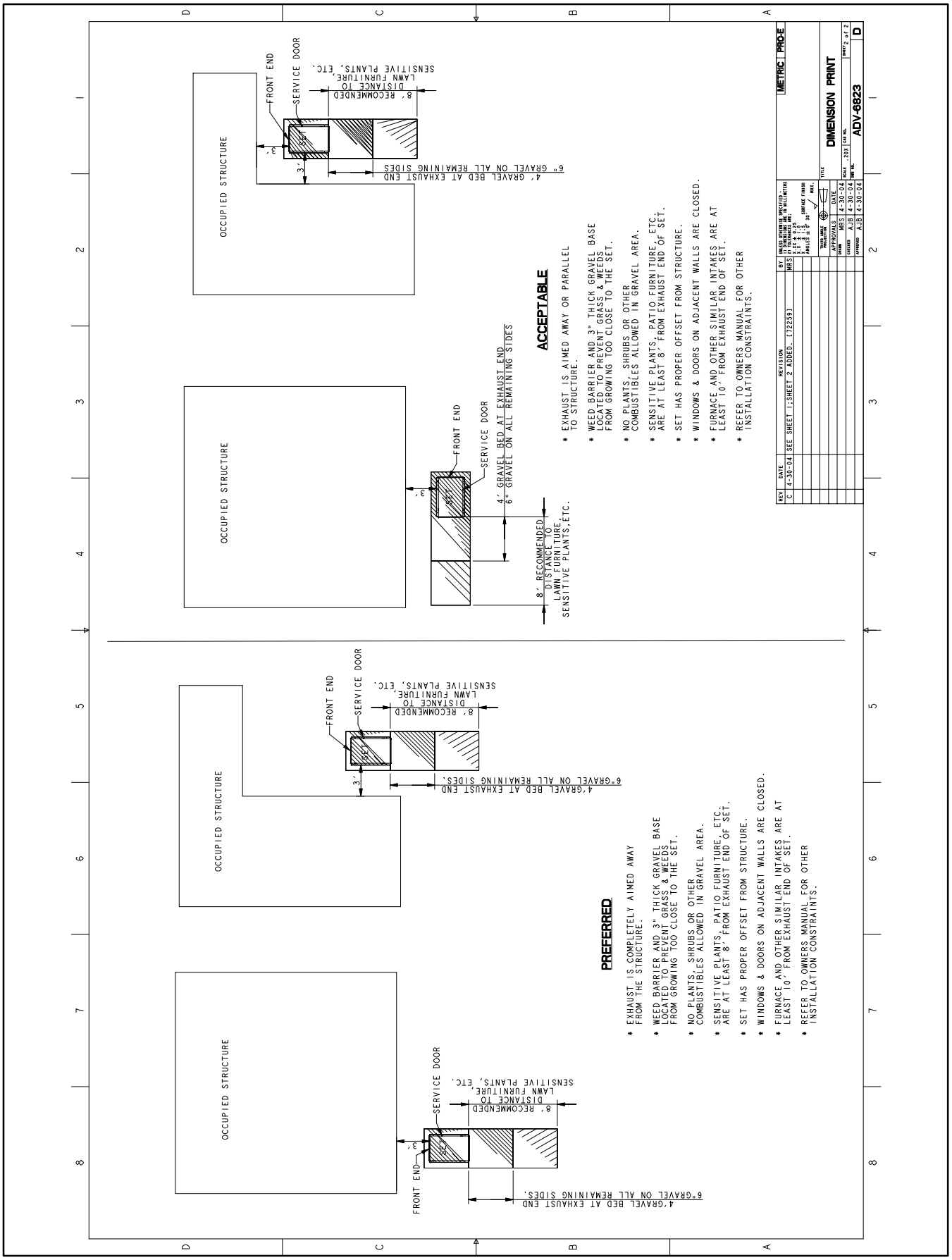
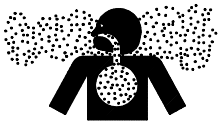


Figure 2-2 Generator Set Clearances, ADV-6823B-C

2.4.1 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.

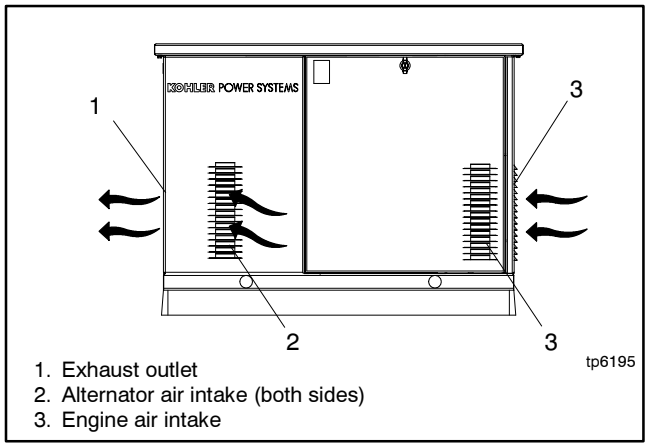
Figure 2-3 gives the exhaust flow and temperature at rated load. The engine exhaust mixes with the generator set cooling air at the exhaust end of the enclosure. Mount the generator set so that the hot exhaust does not blow on plants or other combustible materials. Maintain the clearances shown in Figure 2-2.

Exhaust System	60 Hz	50 Hz
Exhaust flow at rated kW, m^3/min. (cfm)		
8.5RES	3.3 (115)	2.7 (96)
12RES	3.8 (135)	3.2 (113)
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 2-3 Exhaust Flow and Temperature

2.4.2 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 2-4 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 2-4 Cooling Air Intake and Exhaust

Cooling Air Requirements	8.5RES		12RES	
	60 Hz	50 Hz	60 Hz	50 Hz
Cooling air, m^3/min. (cfm)	26.9 (950)	22.4 (790)	26.9 (950)	22.4 (790)
Total inlet air requirement, m^3/min. (cfm)	27.8 (980)	23.2 (820)	28.0 (990)	23.4 (825)
Combustion air, m^3/min. (cfm)	0.94 (33.4)	0.8 (28.0)	1.1 (39.2)	0.9 (32.6)

Figure 2-5 Cooling Air Requirements

2.5 Power Supply

Power must be supplied to the generator set location for the battery charger and the optional carburetor heater. Install a 120-VAC receptacle powered from the essential loads panel. Figure 2-6 lists the power requirements for the battery charger and accessories.

The installation of the receptacle must comply with the NEC and local code requirements.

Equipment	Power Requirement, Max.		
	Watts	Amps	Volts
Battery charger	192	1.60	120
Carburetor heater	38	0.32	
Battery heater	110	0.92	
Total with accessories	340	2.84	120

Figure 2-6 Power Requirements

2.6 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 the NEC and local codes.

2.6.1 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.

Verify that the output pressure from the primary gas utility (or LP tank) pressure regulator is 1.7–2.7 kPa (7–11 in. water column) and that the utility gas meter flow rate is sufficient to supply the generator set plus all other gas-consuming appliances. Figure 2-8 shows the flow rate required for the generator set and Figure 2-9 shows the fuel consumption. Contact the fuel supplier for flow rate information or a gas meter upgrade.

Figure 2-1 shows the location of the fuel inlet connection. Use flexible sections to prevent fuel line breakage caused by vibration. Remove the housing end panel and 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.

2.6.2 Fuel Pipe Size

Ensure that the natural gas pipe size and length meet the specifications in Figure 2-10. 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 2-10. If the piping is longer than the maximum length shown for that size, replace it with the specified size before proceeding.

Contact the local LP provider for LP installation information.

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

Figure 2-7 Fuel Supply

Model	**Gas Flow Rate, Btu/hr.**
8.5RES	132,000
12RES	202,000

Figure 2-8 Natural Gas Flow Rate (Btu/hr.)

Fuel Consumption, m^3/hr. (cfh)	**8.5RES**		**12RES**	
	60 Hz	**50 Hz**	**60 Hz**	**50 Hz**
Natural gas at % load				
100%	3.7 (132)	3.3 (118)	5.9 (209)	4.9 (175)
75%	3.2 (113)	2.9 (101)	4.8 (168)	4.0 (141)
50%	2.6 (93)	2.3 (83)	3.6 (127)	3.0 (106)
25%	2.2 (77)	1.9 (69)	2.4 (85)	2.0 (71)
LP vapor at % load				
100%	2.0 (72)	1.7 (61)	3.1 (108)	2.5 (89)
75%	1.3 (45)	1.1 (38)	2.5 (87)	2.0 (72)
50%	1.0 (36)	0.9 (31)	1.9 (65)	1.5 (53)
25%	0.8 (29)	0.7 (25)	1.2 (44)	1.0 (36)
LP vapor conversion factors: 8.58 ft^3 = 1 lb. 36.39 ft^3 = 1 gal.				

Figure 2-9 Fuel Consumption

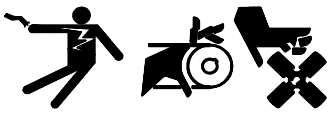
	Maximum Pipe Length m (ft.)	
Pipe Size	**8.5RES**	**12RES**
3/4 in. NPT	18.3 (60)	9.2 (30)
1 in. NPT	61 (200)	30 (100)
1 1/4 in. NPT	91.5 (300)	68.6 (225)

Figure 2-10 Maximum Natural Gas Pipe Length

2.6.3 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.

⚠ WARNING

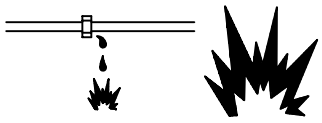


Accidental starting.
Can cause severe injury or death.

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.

Two fuel connections on the fuel block allow field-conversion between natural gas and LP vapor. The fuel metering valves are factory-set and sealed to comply with applicable emission standards and to provide the best possible hot and cold starting.

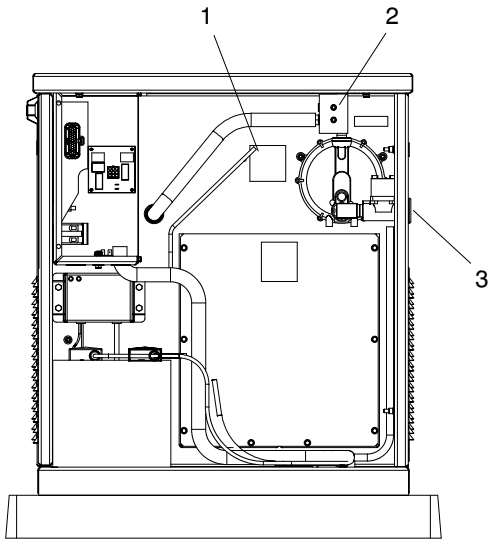
Note: Do not adjust the factory-sealed fuel-metering adjustments on the fuel block. Changing the fuel-metering adjustments may violate federal or state laws.

Use the following procedure to convert from natural gas to LP vapor, moving the fuel connection from the natural gas to the LP port, plugging the natural gas port, and connecting the leads to the digital spark advance module (DSAM). See Figure 2-11 for the fuel system component locations.

Fuel Conversion Procedure

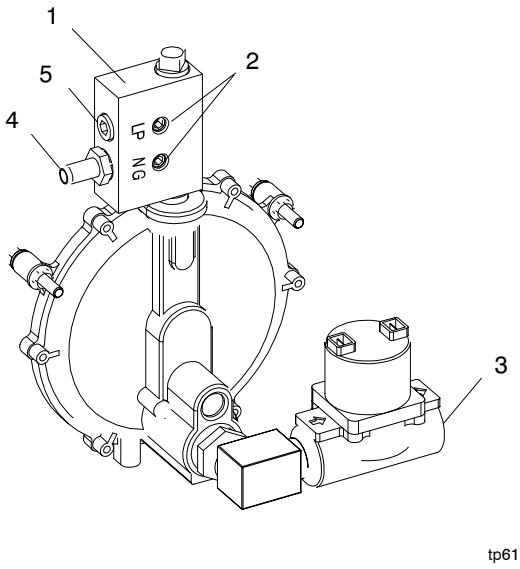
1. Place the generator set master switch in the OFF position.
2. Disconnect the power to the battery charger.
3. Disconnect the generator set engine starting battery, negative (-) lead first.
4. Turn off the fuel supply.
5. Remove the hose clamp and fuel hose from the hose fitting in the fuel block. See Figure 2-12.
6. Remove the hose fitting from the natural gas outlet port in the fuel block. See Figure 2-12.
7. Remove the plug from the LP port in the fuel block. See Figure 2-12. Clean the plug with a dry cloth or brush, apply fresh pipe sealant, and install the plug into the natural gas outlet port.
8. Clean the hose fitting with a dry cloth or brush, apply fresh pipe sealant to the threads, and install the fitting into the LP port.

   Note: Do not adjust the fuel metering valves.



1. DSAM connector location
2. Fuel block
3. Fuel inlet, 1/2 in. NPT female

Figure 2-11 Fuel System Locations, Air Inlet Side

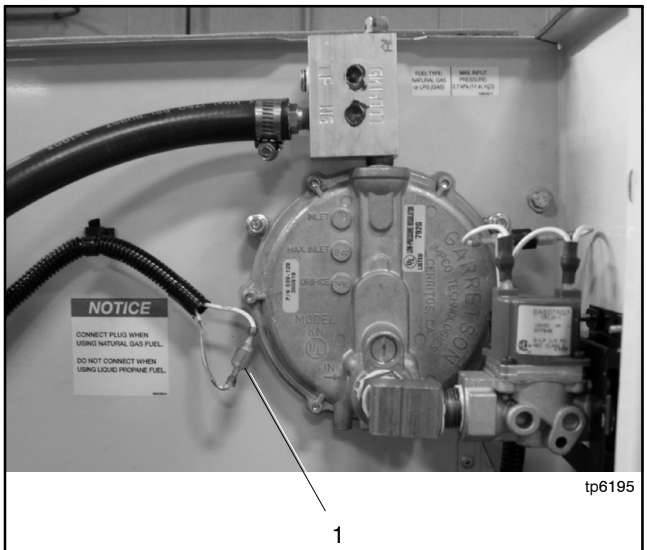


1. Fuel block
2. Fuel metering valves—*factory-sealed, do not adjust*
3. Fuel inlet, 1/2 in. NPT
4. Hose fitting
5. Plug

Figure 2-12 Fuel Block Connections, Natural Gas System Shown

9. Slide the hose onto the hose fitting and secure it with the clamp.
10. For the 12RES only: Connect the digital spark-advance module (DSAM) leads together for natural gas. (Disconnect leads for LP.) See Figure 2-13.
11. Connect and turn on the new fuel supply.
12. Check that the generator set master switch is in the OFF position.
13. Reconnect the generator set engine starting battery leads, negative (–) lead last.
14. Reconnect power to the battery charger.
15. Start the generator set by moving the generator set master switch to the RUN position.
16. Check for leaks using a gas leak detector.
17. 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, follow the same fuel conversion procedure, moving the hose fitting to the natural gas port and plugging the LP port. For the 12RES model, disconnect the DSAM leads for LP vapor. See Figure 2-13.



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

Figure 2-13 Digital Spark Advance Module (DSAM) Leads (located in generator set air intake area)

2.7 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. Open the main circuit breakers of all power sources before servicing the equipment. Configure the installation to electrically ground the generator set, transfer switch, and related equipment and electrical circuits to comply with applicable codes and standards. 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 the generator set from the GRD terminal inside the controller compartment according to applicable codes. See Figure 2-14.

2.7.1 AC Load Lead Connections

Connect the AC output leads in the controller compartment to the AC circuit breaker. Route AC leads through flexible conduit directly to the AC circuit breaker box. See Figure 2-1 for the recommended electrical inlet location. Verify that the leads and conduit do not interfere with the operation of the generator set or obstruct the service areas.

See Figure 2-14 and Section 3, Wiring Diagrams, for the generator set electrical connections. Make the following AC connections:

1. Connect the output leads going to the transfer switch (L1/L2 black leads) to the AC circuit breaker load side.

2. Connect the L0 white leads from the ATS and the main panel to the neutral terminal.

3. Connect the green lead to the ground terminal (labeled GRD).

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

2.7.2 Grounding

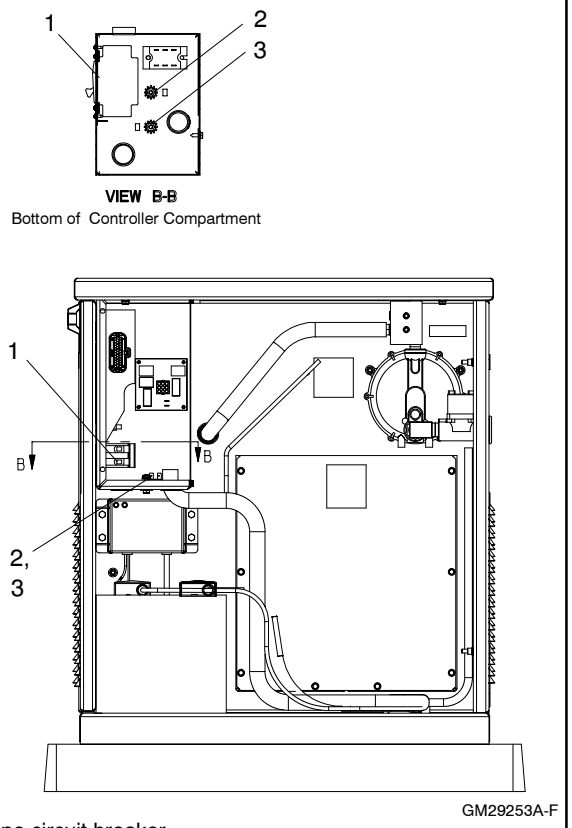
Ground the generator set. The grounding method must comply with NEC and local codes. Connect the gounding strap to the generator set ground lug, terminal GND inside the controller compartment.

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.

2.7.3 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. Route the engine start leads through separate conduit from the AC power and load leads.



1. Line circuit breaker
2. Ground terminal (GRD)
3. Neutral terminal (L0)

Figure 2-14 Field-Installed Wiring Connections

2.7.4 Continuous Power Mode Jumper

A jumper across controller pins P7-1 and P7-2 maintains power to the controller at all times. See Figure 2-15. Controllers are shipped with jumper connected for continuous power.

The P7 connector has either 2 or 3 pins. Disconnecting the jumper or moving the jumper to pins P7-2 and P7-3 allows the controller to power down automatically 48 hours after the generator set shuts down if the generator set master switch is in the AUTO position. A remote start signal (from a transfer switch or a remote start/stop switch connected to controller leads 3 and 4) or moving the generator set master switch to the RUN position turns the controller back on.

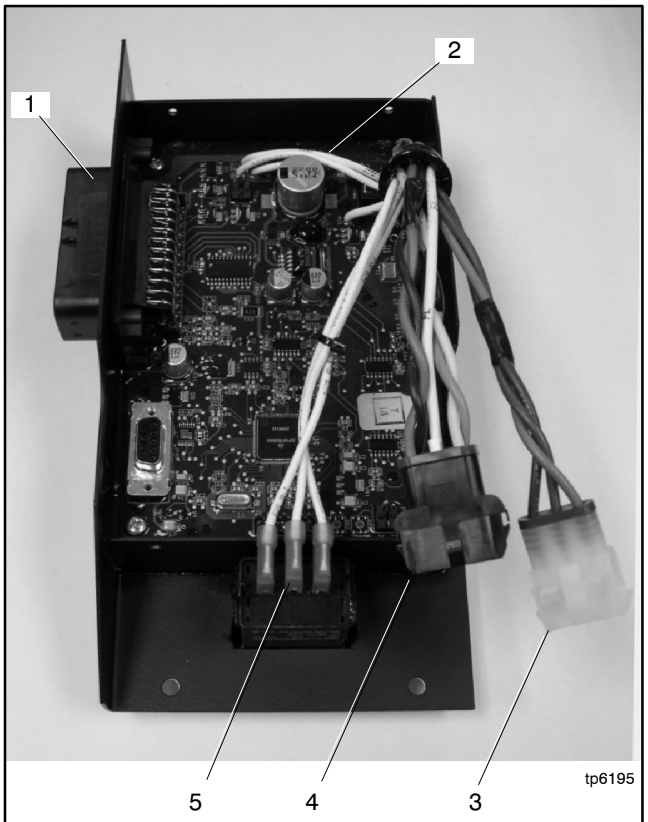
Note: For most applications, it is not necessary to disconnect the continuous power mode jumper. The 8.5 and 12 RES generator sets are equipped with factory-installed battery chargers to prevent battery discharge.

Use the following procedure to disconnect the jumper, if desired.

Procedure to disconnect the continuous power mode jumper (optional).

1. Prevent the generator set from starting.
   a. Move the generator set master switch to the OFF/RESET position.
   b. Disconnect power to the battery charger.
   c. Disconnect the generator set engine starting battery, negative (–) lead first.
2. Remove the controller from the generator set housing.
   a. Disconnect the engine wiring harness connector P1 plug (35-pin) from the controller. Disconnect the J15 and J16 connectors. See Figure 2-15.
   b. Remove the controller from the generator set housing in order to access back of controller.
3. Remove the controller's back cover to access the jumper.
   a. Note the labels on the three leads connected to generator set master switch for reconnection later. Disconnect the leads at the pink connectors. See Figure 2-15.
   b. Remove the cover screws and remove the controller's back cover. See Figure 2-15.
4. Locate the P7 connector near the top of the controller. See Figure 2-15. Remove the jumper from pins 1 and 2 of the P7 connector. If the P7 connector has three pins, connect the jumper across pins 2 and 3 for storage.
5. Replace the controller's back cover and secure the cover screws.
6. Reconnect the three pink connectors to the generator set master switch.
7. Reconnect the J15 and J16 connectors.

8. Reconnect the generator set engine starting battery, negative (-) lead last.
9. Reconnect power to the battery charger.
10. Place the generator set master switch in the AUTO position.



1. Engine wiring harness connector plug (P1)
2. Continuous power mode jumper location (P7)
3. J15 connector
4. J16 connector
5. Generator set master switch connectors

Figure 2-15 Advanced Digital Control Connections

2.7.5 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.

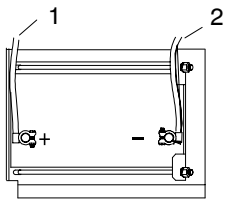
Battery short circuits. Explosion can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage. Disconnect the battery before generator set installation or maintenance. Remove all jewelry before servicing the equipment. Use tools with insulated handles. Remove the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

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 675 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.

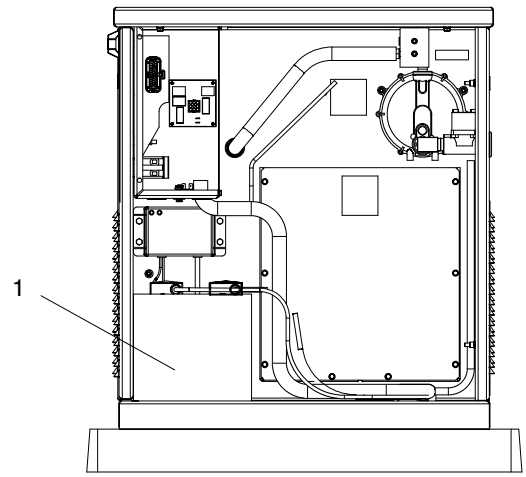
Figure 2-17 shows the location of the engine starting battery. Standard battery cables provide easy connection to the battery. Use the following procedure to install and connect the battery.



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



GM29253

1. Engine starting battery location

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.

Refer to the generator set Operation Manual for battery maintenance instructions.

2.7.6 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 to keep the starting battery fully charged.

Plug the battery charger's power cord into a 120 VAC receptacle on the load side of the system. Refer to the generator set Operation Manual for battery charger operation information.

2.8 Accessories

Have accessories installed by an authorized distributor/ dealer or a licensed electrician. Follow the installation instructions provided with each kit. Use separate conduit for AC and DC leads to reduce the possibility of electrical interference. Verify that the leads and conduit do not interfere with the operation of the generator set or obstruct the service areas. Verify that the electrical installation complies with the National Electrical Code (NEC) and all applicable local codes. See Section 3, Wiring Diagrams, for more information regarding generator set electrical connections.

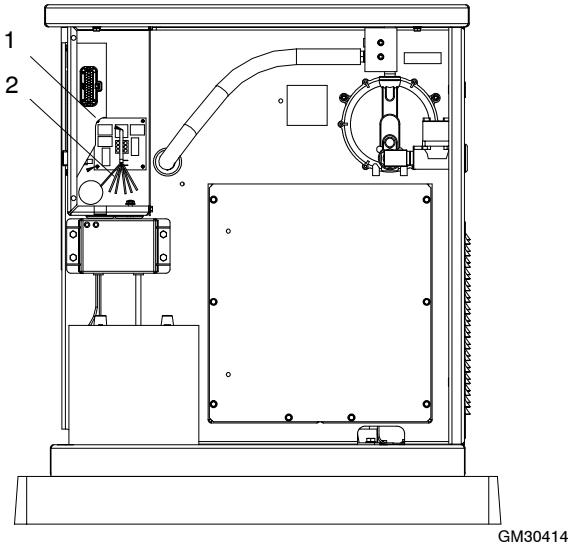
2.8.1 Common Fault and Run Relay Board

The optional relay board provides two additional relays to control customer-provided equipment:

- Common fault relay
- Auxiliary run relay

The optional relay board replaces the standard relay board. The relay board location is shown in Figure 2-18. Connect customer equipment to the relay board harness. Figure 2-19 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
2. Relay board harness

Figure 2-18 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

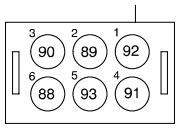


Figure 2-19 Common Fault and Run Relay Board Harness Connections

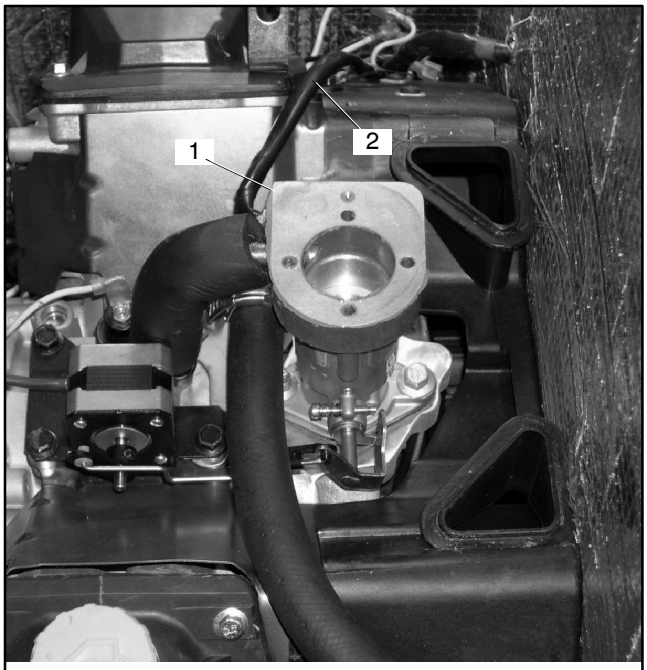
2.8.2 Carburetor Heater

An optional 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. The heater power cord and thermostat are located in the generator set housing air intake area/ battery compartment. See Figure 2-17. Plug the carburetor heater into an outlet that supplies continuous 120 VAC power.

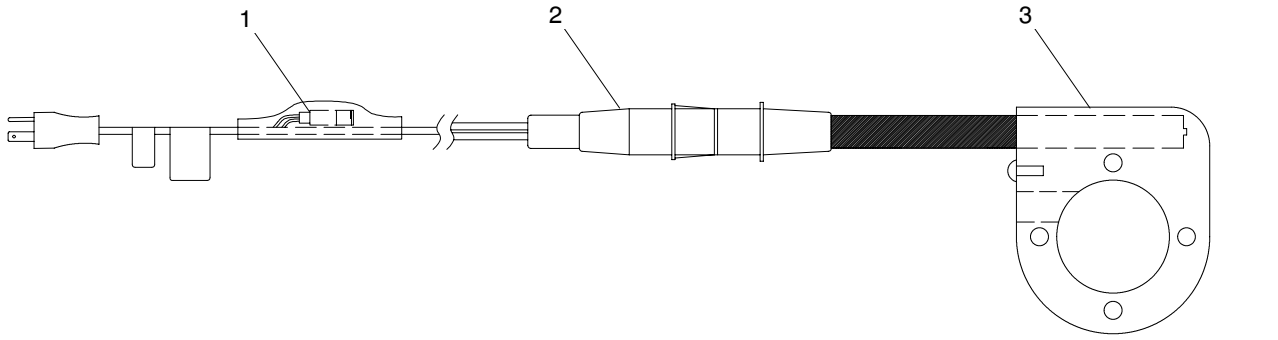
The heater thermostat is installed in the cord. Figure 2-21 shows the location of the thermostat on the power cord.

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 60°F (16°C).



1. Carburetor heater (air cleaner removed to show heater)
2. Carburetor heater power cord

Figure 2-20 Carburetor Heater



1. Thermostat
2. Connector
3. Heater

Figure 2-21 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 muffler and piping condition.

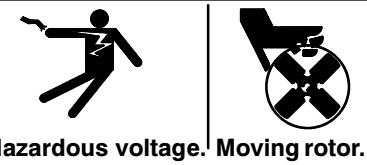
- Inspect the exhaust system components (exhaust manifold, exhaust line, flexible exhaust, clamps, muffler, and outlet pipe) for cracks, leaks, and corrosion. Check for tight exhaust system connections.
- Check for corroded or broken metal parts and replace them as needed.
- Check that the exhaust outlet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

⚠ WARNING



Hazardous voltage. Moving rotor. 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 and frequency, if necessary. Have adjustments performed by an authorized distributor/dealer or service technician.

Note: A digital multimeter that measures voltage and frequency is required for these adjustments.

Use a digital multimeter to check the output voltage and frequency. If the output voltage or frequency is not within specifications, use the ADC controller to adjust the output voltage and engine speed (frequency) while the generator set is running. The flowcharts in Figure 2-25 through Figure 2-27 outline the adjustment procedures.

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

Changes in voltage and speed adjustments are lost if they are not saved before the generator set shuts down. 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 if the changes have not been saved.

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

2.10.1 Voltage Adjustment

Note: Refer to the flowcharts in Figure 2-25 through Figure 2-27 for instructions to adjust the voltage using the ADC controller.

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 2-22 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 2-22 Voltage Adjustment (approximate)

4. Adjust the voltage stability (gain, parameter 2P) to minimize light flicker.

5. Readjust the voltage, if necessary.

6. Set the multimeter to measure frequency.

7. Adjust the engine speed to the cut-in frequency shown in Figure 2-23 by adjusting the engine governor speed (parameter 4P).

Frequency	Cut-In Frequency
60 Hz	57.5 Hz
50 Hz	47.5 Hz

Figure 2-23 Cut-In Frequencies

8. Adjust the volts/Hz (parameter 3P) until the voltage level measured by the multimeter begins to drop. When the volts/Hz is set correctly, the generator (as load is applied) attempts to maintain normal output until the engine speed drops below the cut-in frequency set in step 7.

9. Reset the engine speed to the operating frequency (50 or 60 Hz) by adjusting the engine governor speed (parameter 4P).

10. Readjust the voltage stability (gain, parameter 2P), if necessary.

11. Readjust the voltage (parameter 1P), if necessary.

12. Stop the generator set.

2.10.2 Frequency Adjustment

The engine speed determines the generator output frequency; 60 Hz units operate at 3600 rpm and 50 Hz units run at 3000 rpm. Adjust the engine governor speed to change the output frequency using the following procedure.

Note: Refer to the flowcharts in Figure 2-25 through Figure 2-27 for instructions to adjust the engine speed using the ADC controller.

Frequency Adjustment Procedure

1. Attach a frequency meter to the AC output leads or an electrical outlet on the load side of the generator set.

2. Start and run the generator set until it reaches normal operating temperature (at least 10 minutes).

3. Adjust the electronic governor speed (parameter 4P) to obtain a frequency reading of 60 Hz (or 50 Hz on 50 Hz models). Each step changes the engine speed about 3.6 RPM, which changes the output frequency about 0.06 Hz.

4. Check stability with the generator set running and with no load applied. If the generator set speed is unstable, hunts, or surges, adjust the governor stability (gain, parameter 5P) until the generator set becomes stable with no hunting or surging. (Increasing the gain slows the governor response.)

5. Check the frequency reading. Repeat steps 3 and 4 if necessary to obtain the rated frequency and stable operation.

2.11 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. Use the instructions in this section to check the configuration after installation and change them to match the settings shown in Figure 2-24, if necessary.

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 2-28 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.

Voltage/frequency setting (Uu). Select the system voltage and frequency from the table in Figure 2-24.

Note: This parameter sets the nominal system voltage and frequency. To adjust the output (measured) voltage and frequency, see Section 2.10.

Unit configuration (Uc). This parameter sets the generator set type: marine, standby, or mobile. The setting for the 8.5/12RES is Uc01, standby.

Engine configuration (Ec). The engine configuration must match the generator set engine type. The engine configuration setting for the 8.5/12RES is Ec00.

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. Use Ed05 for the 8.5/12RES.

Battery voltage (Bt). This setting toggles between 12 and 24 VDC for the engine starting battery voltage. The 8.5/12RES uses a 12-volt battery, Bt12.

Communications setting (Cn). This setting allows the user to set the controller for communication with optional meters, which are available for marine and mobile units only. The 8.5/12RES is factory-set for no CAN communications, Cn00.

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.

2.12 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.

Parameter	Setting	Definition
Unit's system voltage and frequency.	Uu01	Single phase, 60 Hz, 120/240 VAC
	Uu06	Single phase, 50 Hz, 115/230 VAC
Unit configuration	Uc01	8.5/12 RES (standby)
Engine type	Ec00	8.5/12 RES
Engine data input types	Ed05	Digital low coolant level, digital pressure, analog temp, with mag. pickup
Battery voltage	Bt12	Engine starting battery voltage, 12 VDC
Communications	Cn00	No CAN communications

Figure 2-24 8.5/12RES Controller Configuration Parameters

Output Voltage and Frequency 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.

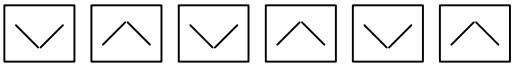
Display: X X X X

Hold:

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

Display: X. X X

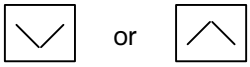
Press the down arrow key and then the up arrow key 3 times to enter the adjustment mode. (This is the controller "password.")



Display: 1 P X X

The controller is now in the voltage coarse adjustment mode.

Press:

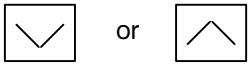


To raise or lower the voltage in large increments (approximately 5–7 volts per step).

Display: 1 P X X

To enter fine voltage adjustment mode.

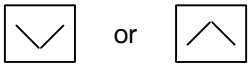
Display: 1 P X X



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

To enter coarse voltage stability (gain) adjustment mode.

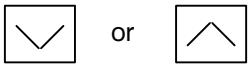
Display: 2 P X X



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

To enter fine voltage stability (gain) adjustment mode.

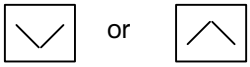
Display: 2 P X X



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

To enter volts/Hz adjustment mode.

Display: 3 P 0 X



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

Continued on Figure 2-26.

* 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 2-25 Output Voltage and Frequency Adjustments

Continued from Figure 2-25:

Press:			Display : *
⊙		To enter engine governor speed coarse adjustment mode.	4 P *x* *x*
∨	or ∧	To raise or lower the engine speed in large increments.	
⊙		To enter engine governor speed fine adjustment mode.	4 P *x* *x*
∨	or ∧	To raise or lower the engine speed in smaller increments.	
⊙		To enter engine governor stability (gain) coarse adjustment mode.	5 P *x* *x*
∨	or ∧	To raise or lower the engine governor stability (gain) in large increments.	
⊙		To enter engine governor stability (gain) fine adjustment mode.	5 P *x* *x*
∨	or ∧	To raise or lower the engine governor stability (gain) in smaller increments.	
⊙		To enter SAVE mode. Go to Figure 2-27.	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.

* 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.

Figure 2-26 Output Voltage and Frequency Adjustments, Continued

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

SAVE

To return to the first parameter, coarse voltage adjustment, to check or change settings before saving. See Figure 2-25.

1Pxx

or

To save changes.

YES

or

To discard changes without saving.

no

"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.

xxxx

Now move the master switch to OFF/RESET.

Figure 2-27 Save Mode

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 to Uu01 for 60 Hz or Uu06 for 50 Hz models.

Display: Uu01 60 Hz
Uu06 50 Hz

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 Ec05, if necessary.

Display: Ec05

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 2-29.**

Display: Ed05

or

or

To proceed to the save mode without entering the advanced configuration mode. **Go to Figure 2-30.**

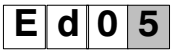
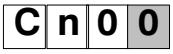
Display: SAVE

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

Figure 2-28 Configuration Mode (system voltage/frequency, unit configuration, and engine type parameters)

Pressing the up arrow key at the Adnc display (See Figure 2-28) puts you into the Advanced Configuration Mode.

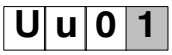
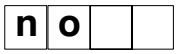
Press:

 or 	To set the engine data input type to Ed05.	
	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.	
	To enter SAVE mode. Go to Figure 2-30.	

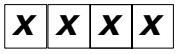
Note: Be sure to save your settings before exiting the configuration mode. The controller reverts to the last *saved* settings when the master switch is moved to the OFF/RESET position.

Figure 2-29 Advanced Configuration Mode (engine data input types, battery voltage, and engine communications)

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

	To return to the first parameter, system voltage/frequency Uu, to check or change settings before saving. See Figure 2-28.	
or		
	To save changes.	
or		
	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 2-30 Save Mode (after configuring generator set parameters)

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. On occasion, the manufacturer may provide this manual with units that are not listed below, such as when similar new specs are created prior to the updated reprint or in other cases when the manual is a suitable substitute for a manual under development.

Model No.	Spec. No.
8.5RES	GM29253-GA1
12RES	GM29253-GA2

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-6835A-B	26
Sheet 2	ADV-6835B-B	27
Point-to-Point Wiring Diagram	GM29358-C	28

Figure 3-2 Controller Wiring Diagrams

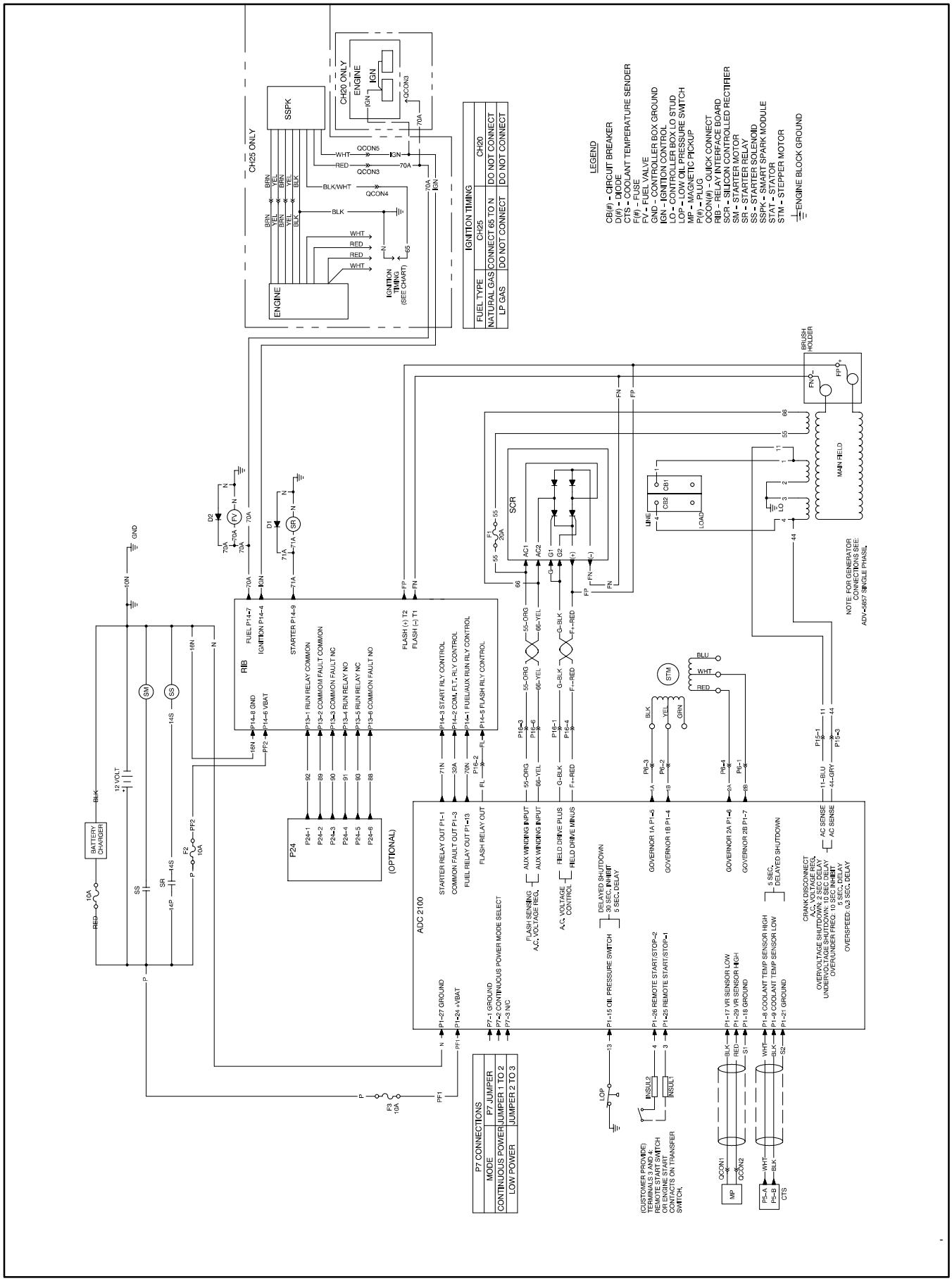


Figure 3-3 8.5/12RES Schematic Diagram, Single Phase, Sheet 1, ADV-6835A-E

ADC 2100 CONTROLLER

P1 CONNECTIONS
P1–1 STARTER RELAY OUT
P1–2 SPARE OUTPUT
P1–3 COMMON FAULT
P1–4 GOVERNOR 1B
P1–5 GOVERNOR 1A
P1–6 GOVERNOR 2A
P1–7 GOVERNOR 2B
P1–8 COOLANT TEMP SENSOR HIGH
P1–9 COOLANT TEMP SENSOR LOW
P1–10 EXTERNAL CAN H
P1–11 EXTERNAL CAN L
P1–12 AUX SHUTDOWN
P1–13 FUEL RELAY OUT
P1–14 TACH OUT
P1–15 OIL PRESSURE SWITCH
P1–16 GROUND
P1–17 VR SENSOR LOW
P1–18 GROUND
P1–19 PRESSURE SENSOR GROUND
P1–20 GROUND
P1–21 GROUND
P1–22 GROUND
P1–23 GROUND
P1–24 VBAT +
P1–25 REMOTE START/STOP 1
P1–26 REMOTE START/STOP 2
P1–27 GROUND
P1–28 COOLANT LEVEL/LOSS HIGH
P1–29 VR SENSOR HIGH
P1–30 PRESSURE SENSOR SOURCE
P1–31 PRESSURE SENSOR SIGNAL
P1–32 GROUND
P1–33 VBAT ON
P1–34 GROUND
P1–35 RS232 TXD

P5 CONNECTIONS
P5–1 N/C
P5–2 RS232 RXD
P5–3 RS232 TXD
P5–4 N/C
P5–5 GROUND
P5–6 N/C
P5–7 N/C
P5–8 N/C
P5–9 N/C

P7 CONNECTIONS
P7–1 N/C
P7–2 CONTINUOUS POWER MODE SELECT
P7–3 GROUND

J16 CONNECTIONS
P16–1 FIELD DRIVE PLUS (G)
P16–2 FLASH RELAY OUT
P16–3 AUX WINDING INPUT (55)
P16–4 FIELD DRIVE MINUS (F+)
P16–5 N/C
P16–6 AUX WINDING INPUT (66)

J15 CONNECTIONS
J15–1 AC INPUT (V7/11)
J15–2 AC INPUT (V9)
J15–3 AC INPUT (V8/44)

RELAY INTERFACE BOARD

P13 CONNECTIONS
P13–1 RUN RELAY COMMON
P13–2 COMMON FAULT COMMON
P13–3 COMMON FAULT NC
P13–4 RUN RELAY NO
P13–5 RUN RELAY NC
P13–6 COMMON FAULT NO

P14 CONNECTIONS
P14–1 FUEL/AUX RUN RELAY CONTROL
P14–2 COMMON FAULT RELAY CONTROL
P14–3 STARTER RELAY CONTROL
P14–4 IGNITION NEGATIVE
P14–5 FLASH RELAY CONTROL
P14–6 VBAT
P14–7 FUEL (70A)
P14–8 GROUND
P14–9 STARTER (71A)

Figure 3-4 8.5/12RES Schematic Diagram, Single Phase, Sheet 2, ADV-6835B-E

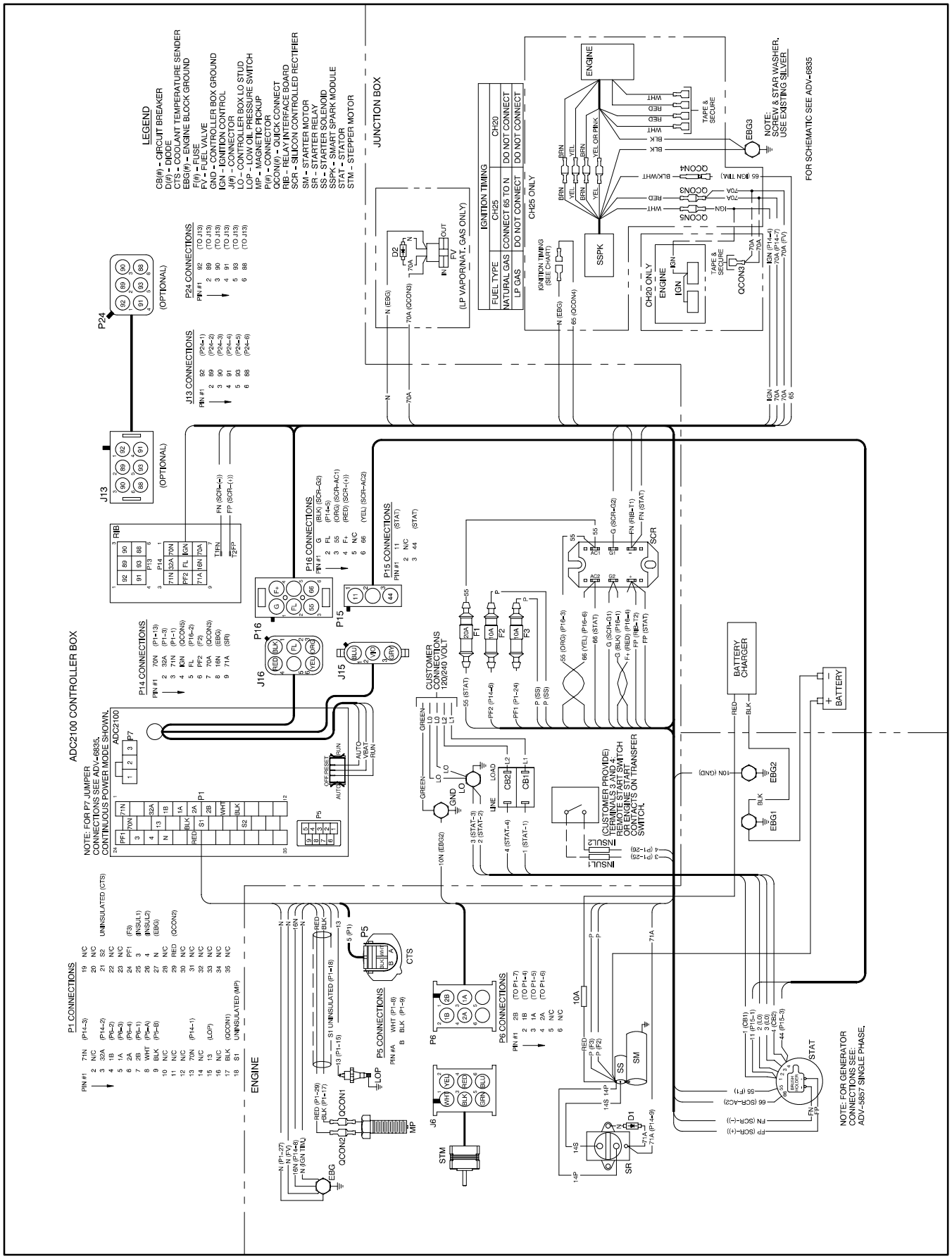


Figure 3-5 8.5/12RES Point-to-Point Wiring Diagram, Single Phase, GM29358-D

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	analog to digital converter
adj.	adjust, adjustment
ADV	advertising dimensional drawing
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
API	American Petroleum Institute
approx.	approximate, approximately
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
A/V	audiovisual
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
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
cu. in.	cubic inch
cw.	clockwise
CWC	city water-cooled
cyl.	cylinder
D/A	digital to analog
DAC	digital to analog converter
dB	decibel
dBA	decibel (A weighted)
DC	direct current
DCR	direct current resistance
deg., °	degree
dept.	department
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
DSAM	digital spark-advance module
DVR	digital voltage regulator
E, emer.	emergency (power source)
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. lbs.	foot pounds (torque)
ft./min.	feet per minute
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 temperature, high engine temperature
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. lbs.	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)
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
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/min.	cubic meters per minute
mA	milliampere
man.	manual
max.	maximum
MB	megabyte (2^{20} bytes)
MCM	one thousand circular mils
MCCB	molded-case circuit breaker
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
m/sec.	meters per second
MTBF	mean time between failure
MTBO	mean time between overhauls
mtg.	mounting
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
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
RTV	room temperature vulcanization
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
SPDT	single-pole, double-throw
SPST	single-pole, single-throw
spec, 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
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.

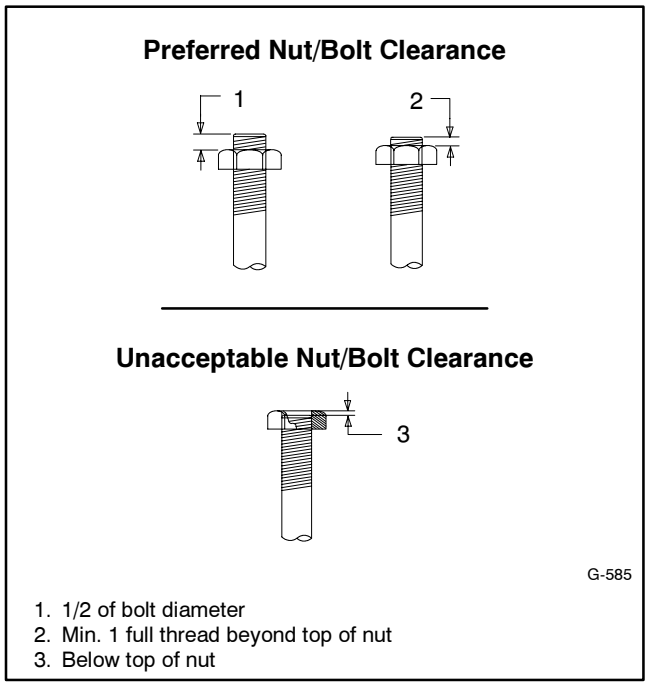


Figure 1 Acceptable Bolt Lengths

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.

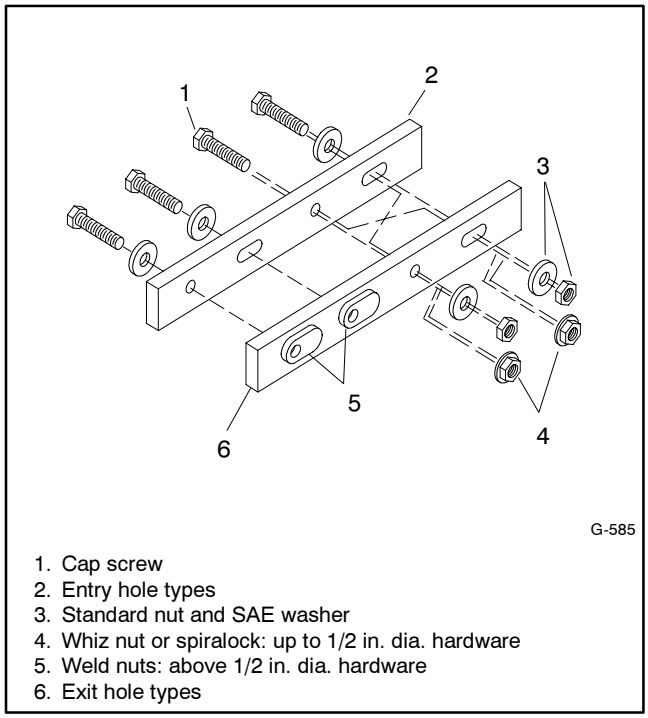


Figure 2 Acceptable Hardware Combinations

Appendix C General Torque Specifications

Use the following torque specifications when service literature instructions give no specific torque values. The charts list values for new plated, zinc phosphate, or oiled threads. Increase values by 15% for nonplated threads. All torque values are +0%/–10%.

American Standard Fasteners Torque Specifications					
		Assembled into Cast Iron or Steel			Assembled into Aluminum
Size	Torque Measurement	Grade 2	Grade 5	Grade 8	Grade 2 or 5
8-32	Nm (in. lb.)	1.8 (16)	2.3 (20)	—	1.8 (16)
10-24	Nm (in. lb.)	2.9 (26)	3.6 (32)	—	2.9 (26)
10-32	Nm (in. lb.)	2.9 (26)	3.6 (32)	—	2.9 (26)
1/4-20	Nm (in. lb.)	6.8 (60)	10.8 (96)	14.9 (132)	6.8 (60)
1/4-28	Nm (in. lb.)	8.1 (72)	12.2 (108)	16.3 (144)	8.1 (72)
5/16-18	Nm (in. lb.)	13.6 (120)	21.7 (192)	29.8 (264)	13.6 (120)
5/16-24	Nm (in. lb.)	14.9 (132)	23.1 (204)	32.5 (288)	14.9 (132)
3/8-16	Nm (ft. lb.)	24.0 (18)	38.0 (28)	53.0 (39)	24.0 (18)
3/8-24	Nm (ft. lb.)	27.0 (20)	42.0 (31)	60.0 (44)	27.0 (20)
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.)				
	Assembled into Cast Iron or Steel			Assembled into Aluminum
Size (mm)	Grade 5.8	Grade 8.8	Grade 10.9	Grade 5.8 or 8.8
M6 x 1.00	5.6 (4)	9.9 (7)	14.0 (10)	5.6 (4)
M8 x 1.25	13.6 (10)	25.0 (18)	35.0 (26)	13.6 (10)
M8 x 1.00	21.0 (16)	25.0 (18)	35.0 (26)	21.0 (16)
M10 x 1.50	27.0 (20)	49.0 (35)	68.0 (50)	27.0 (20)
M10 x 1.25	39.0 (29)	49.0 (35)	68.0 (50)	39.0 (29)
M12 x 1.75	47.0 (35)	83.0 (61)	117.0 (86)	—
M12 x 1.50	65.0 (48)	88.0 (65)	125.0 (92)	—
M14 x 2.00	74.0 (55)	132.0 (97)	185.0 (136)	—
M14 x 1.50	100.0 (74)	140.0 (103)	192.0 (142)	—
M16 x 2.00	115.0 (85)	200.0 (148)	285.0 (210)	—
M16 x 1.50	141.0 (104)	210.0 (155)	295.0 (218)	—
M18 x 2.50	155.0 (114)	275.0 (203)	390.0 (288)	—
M18 x 1.50	196.0 (145)	305.0 (225)	425.0 (315)	—

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