Service

DETROIT DIESEL®

mtu

Industrial Generator Sets

Models:

350–2800 kW

Alternators:

Pilot-Excited, Permanent Magnet Alternator

DETROIT DIESEL ISO CERTIFIED ORGANIZATION 9001 CORPORATION

MP-6373 11/06a

California Proposition 65

⚠ WARNING

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

Product Identification Information

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

Generator Set Identification Numbers

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

Model Designation _____

Specification Number _____

Serial Number _____

Accessory Number	Accessory Description

Controller Identification

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

Controller Description _____

Engine Identification

Record the product identification information from the engine nameplate.

Manufacturer _____

Model Designation _____

Serial Number _____

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***.

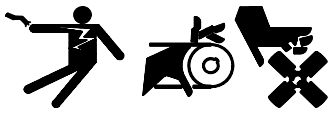
NOTICE

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.

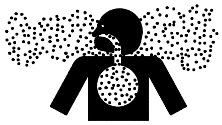
Servicing the fuel system. A flash fire can cause severe injury or death. Do not smoke or permit flames or sparks near the carburetor, fuel line, fuel filter, fuel pump, or other potential sources of spilled fuels or fuel vapors. Catch fuels in an approved container when removing the fuel line or carburetor.

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

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 unless the exhaust gas is piped safely outside. Never operate the generator set where exhaust gas could accumulate and seep back inside a potentially occupied building.

Carbon monoxide 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.

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

Gasoline—Store gasoline only in approved red containers clearly marked GASOLINE.

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

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

Fuel tanks. Explosive fuel vapors can cause severe injury or death. Gasoline and other volatile fuels stored in day tanks or subbase fuel tanks can cause an explosion. Store only diesel fuel in tanks.

Draining the fuel system. Explosive fuel vapors can cause severe injury or death. Spilled fuel can cause an explosion. Use a container to catch fuel when draining the fuel system. Wipe up spilled fuel after draining the system.

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.

LP liquid withdrawal fuel leaks. Explosive fuel vapors can cause severe injury or death. Fuel leakage can cause an explosion. Check the LP liquid withdrawal gas fuel system for leakage by using a soap and water solution with the fuel system test pressurized to at least 90 psi (621 kPa). 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.

Disconnecting the electrical load. Hazardous voltage can cause severe injury or death. Disconnect the generator set from the load by opening the line circuit breaker or by disconnecting the generator set output leads from the transfer switch and heavily taping the ends of the leads. High voltage transferred to the load during testing may cause personal injury and equipment damage. Do not use the safeguard circuit breaker in place of the line circuit breaker. The safeguard circuit breaker does not disconnect the generator set from the load.

High voltage test. Hazardous voltage can cause severe injury or death. Follow the instructions of the test equipment manufacturer when performing high-voltage tests on the rotor or stator. An improper test procedure can damage equipment or lead to generator set failure.

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

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

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

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

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

Handling the capacitor. Hazardous voltage can cause severe injury or death. Electrical shock results from touching the charged capacitor terminals. Discharge the capacitor by shorting the terminals together.
(Capacitor-excited models only)

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.

Testing live electrical circuits. Hazardous voltage or current can cause severe injury or death. Have trained and qualified personnel take diagnostic measurements of live circuits. Use adequately rated test equipment with electrically insulated probes and follow the instructions of the test equipment manufacturer when performing voltage tests. Observe the following precautions when performing voltage tests: (1) Remove all jewelry. (2) Stand on a dry, approved electrically insulated mat. (3) Do not touch the enclosure or components inside the enclosure. (4) Be prepared for the system to operate automatically.
(600 volts and under)

Heavy Equipment

⚠ WARNING

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

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

Hot Parts

⚠ WARNING

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

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

⚠ WARNING

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

Do not work on the generator set until it cools.

Servicing the 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.

Checking the coolant level. Hot coolant can cause severe injury or death. Allow the engine to cool. Release pressure from the cooling system before removing the pressure cap. To release pressure, cover the pressure cap with a thick cloth and then slowly turn the cap counterclockwise to the first stop. Remove the cap after pressure has been completely released and the engine has cooled. Check the coolant level at the tank if the generator set has a coolant recovery tank.

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.

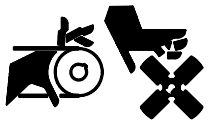
Moving Parts

⚠ 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.

Notes

This manual provides repair instructions for the generator set models listed on the front cover using pilot-excited, permanent magnet alternators.

Wiring diagram manuals are available separately.

Refer to the generator set controller operation manual for operating instructions. Refer to the engine operation manual for the generator set engine scheduled maintenance information. Refer to the engine service manual for generator set engine repair and overhaul information.

Information in this publication represents data available at the time of print. The manufacturer of DDC/MTU Power Generation products reserves the right to change this publication and the products represented without notice and without any obligation or liability whatsoever.

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

The equipment service requirements are very important to safe and efficient operation. Inspect the parts often and perform required service at the prescribed intervals. Maintenance work must be performed by appropriately skilled and suitably trained maintenance personnel familiar with generator set operation and service.

List of Related Materials

Separate literature contains alternator and voltage regulator troubleshooting and repair information not provided in this manual. Figure 1 lists the available literature part numbers.

Manual Description	Literature Part No.
Voltage Regulator Spec Sheet	M6-58
Installation, Operation, and Maintenance Manual (up to 600 V Alternators)	TP-5578
Technical Manual for DVR®2000 Voltage Regulator	TP-5579
Installation, Operation, and Maintenance Manual for DVR®2000E Voltage Regulator	TP-6199
Installation, Operation, and Maintenance Manual (Medium Voltage Alternators)	TP-6221
550 Controller Operation Manual	MP-6200

Figure 1 Related Literature

DVR® is a registered trademark of Marathon Electric Mfg. Corp.

Service Assistance

For professional advice on generator power requirements and conscientious service, please contact your nearest DDC/MTU Power Generation distributor.

- Consult the Yellow Pages under the heading Generators—Electric.
- Visit the DDC/MTU Power Generation website at ddcmtupowergeneration.com.
- Look at the labels and stickers on your DDC/MTU Power Generation product or review the appropriate literature or documents included with the product.

1.1 Introduction

The specification sheets for each generator set provide specific alternator and engine information. Refer to the respective specification sheet for data not supplied in this manual. Consult the generator set operation manual, installation manual, engine operation manual, and engine service manual for additional specifications.

1.2 350–2800 kW Pilot-Excited Permanent Magnet Alternator

The generator set is a 4 pole, rotating-field with brushless, pilot-excited (PE), permanent magnet (PM) excitation system. The PE system provides short-circuit excitation current up to 300% at 60 Hz (approximately 275% at 50 Hz) for a minimum of 10 seconds to allow selective circuit breaker tripping.

Solid state voltage regulator is PM powered, maintenance free, and encapsulated for moisture protection. The voltage regulator provides ±1/2%, no load to full load voltage regulation, adjustable volts/Hz, underspeed protection, 3-phase RMS sensing, paralleling protection, and over excitation protection as standard.

This series of generator sets uses the 550 controller voltage regulator when equipped with the 550 controller. Otherwise, a digital DVR®2000E voltage regulator is used.

1.3 Digital DVR®2000E Voltage Regulator Features

- The sealed electronic, solid-state microprocessor-based digital voltage regulator controls the generator set output by regulating the current flow into the exciter field.
- The digital voltage regulator is equipped with single- and/or three-phase sensing. Single-phase sensing is achieved by connecting terminal E2 and E3 to the same generator set terminal.
- Provisions are included in the regulator to allow the paralleling of two or more generator sets using either reactive droop or reactive differential (cross current) compensation with the addition of an external 5-amp 5VA current transformer (paralleling capability with optional DVR® 2000EC model only).
- The underfrequency function allows the generator set to operate with a constant volts-per-hertz characteristic.
- The over-excitation function monitors the voltage regulator output voltage and causes the voltage regulator to shut down when the output voltage exceeds the preset trip level of 80 volts for 15 seconds.
- The overvoltage function monitors the voltage regulator sensed voltage and causes the voltage regulator to shut down when the sensed voltage exceeds the preset trip levels of 120% for 0.75 seconds.
- The voltage regulator is equipped with a sensor that monitors the ambient temperature and will turn itself off when the temperature exceeds 70°C (158°F).
- The loss of the sensing function causes the voltage regulator to shut down if an open circuit occurs in one or more of the sensing leads.
- The field current limit function monitors voltage regulator output current and limits current should a heavy load or short circuit occur across the field output terminals.
- The manual mode of field current controls aid in setup and troubleshooting.
- The alarm output contacts provide remote indication of fault condition.

Status and Mode Adjustments

Status and Shutdown Indicators

- Field Amp Limit
- Loss of Sensing
- Manual Mode
- Over Excitation
- Over Temperature
- Over Voltage
- Under Frequency
- VAR/PF Active

Adjustments

- Coarse Voltage Adjustment
- Droop
- Fine Voltage Adjustment
- Gain
- Manual Mode Adjustment
- Manual Mode On/Off
- Phase Sensing, 1-3
- Stability Range
- Under Frequency
- VAR/PF Adjustment
- VAR/PF Select

1.4 Voltage Regulator Specifications

Generator Set Capability	20-2800 kW Models	350-2000 kW Models
Type	Microprocessor based	
Status and Shutdown Indicators	LEDs and Digital Display	LEDs
Operating Temperature	-40°C to 70°C (-40°F to 158°F)	
Storage Temperature	-40°C to 85°C (-40°F to 185°F)	
Humidity	5-95% Non-Condensing	MIL-STD-750, Method 711-1C Compliant
Circuit Protection	Solid-State, Redundant Software and Fuses	5 Amp Ceramic Fuse
Sensing, Nominal	100-240 Volts (L-N), 50-60 Hz	95-600 Volts (L-L), 25-420 Hz
Sensing Mode	RMS, Single- or 3-Phase	
Input Requirements	8-36 VDC	180-240 VAC, 200-360 Hz (PMG)
Continuous Output	100 mA at 12 VDC	3 Amps at 75 VDC
Maximum Output	100 mA at 12 VDC	7.5 Amps at 150 VDC (1 minute)
Transition Frequency	50-70 Hz	40-70 Hz
Exciter Field Resistance	NA	18-25 Ohms
No-Load to Full-Load Voltage Regulation	±0.25%	±0.25%
Thermal Drift	<0.5% (-40°C to 70°C range) [-40°F to 158°F]	Less than 0.5% for 40°C (104°F) Ambient Temperature Change (15°C to 70°C range) [59°F to 158°F]
Response Time	Less Than 5μS	Less Than 7μS
Voltage Adjustment (of system voltage)	±10%	
Voltage Adjustment	Controller Keypad	Pushbutton Switches
Remote Voltage Adjustment	Digital Input Standard/ Analog 0-5 VDC Input Optional	Remote-Mounted Digital or Analog Input Optional, 46 m (150 ft.) Max.
Paralleling Capability	Reactive Droop Standard	Optional Reactive Droop Kit Required
VAR/PF Control Input	Standard	Optional
DVR® is a registered trademark of Marathon Electric Mfg. Corp.		

1.5 Alternator Adapter to Flywheel Housing Torque Values

Model	Engine	Alternator	Hardware Type	Torque, Nm (ft. lb.)	Hardware Sequence
350/400 kW	DDC Series 60	4M, 5M	7/16-14, grade 8 bolt	85 (63) steel/cast iron	Bolt, hardened washer
				60 (44) aluminum	
450 kW	DDC Series 60	5M	7/16-14, grade 8 bolt	85 (63) steel/cast iron	Bolt, hardened washer
				60 (44) aluminum	
450–600 kW	DDC Series 2000	5M	M10-1.5, grade 10.9 bolt	53 (39)	Bolt, plain washer
650/750 kW	DDC/MTU Series 2000	5M	M12-1.75, grade 10.9 bolt	115 (85)	Bolt, plain washer
900/1000 kW	DDC/MTU Series 2000	5M, 7M			
1350–2000 kW	DDC/MTU Series 4000	7M	M12-1.75, grade 10.9 bolt	115 (85)	Bolt, hardened washer
2500/2800 kW	DDC/MTU Series 4000	10M	M16-2.0, grade 10.9 bolt	278 (205)	Bolt, hardened washer

1.6 Drive Discs to Flywheel Torque Values

Model	Engine	Alternator	Hardware Type	Torque, Nm (ft. lb.)	Hardware Sequence
350/400 kW	DDC Series 60	4M, 5M	1/2-13, grade 8 bolt	130 (96)	Bolt, hardened washer
450 kW	DDC Series 60	5M			
450–600 kW	DDC Series 2000	5M			
650/750 kW	DDC/MTU Series 2000	5M	M16-2.0, grade 10.9 bolt	278 (205)	
900/1000 kW	DDC/MTU Series 2000	5M, 7M			
1350–2000 kW	DDC/MTU Series 4000	7M			
2500/2800 kW	DDC/MTU Series 4000	10M	See Section 3.4, Dual Bearing Alternator Installation and Alignment		

Notes

Section 2 Troubleshooting

This section contains generator set troubleshooting, diagnostic, and repair information.

Use the chart on the following pages to diagnose and correct common problems. First check for simple causes such as a dead engine starting battery or an open circuit breaker. The chart includes a list of common problems, possible causes of the problem, recommended corrective actions, and references to detailed information or repair procedures.

Maintain a record of repairs and adjustments performed on the equipment. If the procedures in this manual do not explain how to correct the problem, contact an authorized distributor/dealer. Use the record to help describe the problem and repairs or adjustments made to the equipment.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Controller												
x	x									Controller circuit board(s) inoperative	Replace the controller circuit board.	—
				x						Controller fault	Troubleshoot the controller.†	Generator set O/M
x	x			x						Controller fuse blown	Replace the blown controller fuse. If the fuse blows again, troubleshoot the controller.†	W/D
x										Controller master switch inoperative	Replace the controller master switch.	—
x										Controller master switch in the OFF/RESET position	Move the controller master switch to the RUN or AUTO position.	Generator set O/M
x										Engine start circuit open	Move the controller master switch to the RUN position to test the generator set. Troubleshoot the auto start circuit and time delays.	Generator set O/M, W/D, ATS O/M, S/M
Cooling System												
						x		x		Air openings clogged	Clean the air openings.	—
						x				Coolant level low	Restore the coolant to normal operating level.	Generator set O/M
						x				Cooling water pump inoperative	Tighten or replace the belt. Replace the water pump.	Eng. O/M or S/M
				x						High temperature shutdown	Allow the engine to cool down. Then troubleshoot the cooling system.	Generator set O/M, Eng. O/M
				x						Low coolant level shutdown, if equipped	Restore the coolant to normal operating level.	Generator set O/M
						x				Thermostat inoperative	Replace the thermostat.	Eng. S/M

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Electrical System (DC circuits)												
x	x									Battery connections loose, corroded, or incorrect	Verify that the battery connections are correct, clean, and tight.	Generator set O/M
x	x									Battery weak or dead	Recharge or replace the battery. The spec sheet provides recommended battery CCA rating.	Generator set O/M, S/S
x	x									Starter/starter solenoid inoperative	Replace the starter or starter solenoid.	Eng. S/M
x				x						Engine harness connector(s) not locked tight	Disconnect the engine harness connector(s) then reconnect it to the controller.	W/D
				x						High water temperature switch inoperative	Replace the inoperative switch.	Engine S/M, or W/D
				x						Fault shutdown	Reset the fault switches and troubleshoot the controller.	Generator set O/M
				x						High exhaust temperature switch inoperative	Replace the inoperative switch.	Engine S/M, or W/D
Engine												
	x	x			x			x		Air cleaner clogged	Clean or replace the filter element.	Eng. O/M
	x	x				x		x	x	Compression weak	Check the compression.†	Eng. S/M
			x		x	x		x	x	Engine overload	Reduce the electrical load. See the generator set spec sheet for wattage specifications.	S/S
									x	Exhaust system leak	Inspect the exhaust system. Replace the inoperative exhaust system components.†	I/M
									x	Exhaust system not securely installed	Inspect the exhaust system. Tighten the loose exhaust system components.†	I/M
		x	x		x			x		Governor inoperative	Adjust the governor.†	Governor literature
					x				x	Valve clearance incorrect	Adjust the valves.†	Eng. S/M
									x	Vibration excessive	Tighten all loose hardware.	—
	x	x			x					Ignition system inoperative (gas/gasoline only)	Check the ignition system (spark plugs, spark plug wires, etc.).	Eng. O/M

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Fuel System												
	x	x			x					Air in fuel system (diesel only)	Bleed the diesel fuel system.	Eng. O/M
	x	x								Ether canister empty or system inoperative, if equipped (diesel only)	Replace or repair the ether starting system.	Eng. O/M
	x			x						Fuel tank empty or fuel valve shut off	Add fuel and move the fuel valve to the ON position.	—
	x				x			x		Fuel feed or injection pump inoperative (diesel only)	Rebuild or replace the injection pump.†	Eng. S/M
	x	x			x					Fuel or fuel injectors dirty or faulty (diesel only)	Clean, test, and/or replace the inoperative fuel injector.†	Eng. S/M
	x	x		x	x					Fuel filter restriction	Clean or replace the fuel filter.	Eng. O/M
	x									Fuel solenoid inoperative	Troubleshoot the fuel solenoid.†	Eng. S/M
	x				x					Fuel pressure insufficient (gas only)	Check the fuel supply and valves.†	S/S, Gen. O/M
	x	x			x			x		Fuel injection timing out of adjustment (diesel only)	Adjust the fuel injection timing.†	Eng. S/M
Alternator												
			x							AC output circuit breaker open	Reset the breaker and check for AC voltage at the generator side of the circuit breaker.	—
x										Transfer switch test switch in the OFF position	Move the transfer switch test switch to the AUTO position.	ATS O/M
			x							Transfer switch fails to transfer load	Move the ATS test switch to the AUTO position. Troubleshoot the transfer circuit and time delays.	ATS O/M, S/M
			x							Wiring, terminals, or pin in the exciter field open	Check for continuity.	Alternator Technical Manual, W/D
			x							Main field (rotor) inoperative (open or grounded)	Test and/or replace the rotor.†	Alternator Technical Manual
			x							Stator inoperative (open or grounded)	Test and/or replace the stator.†	Alternator Technical Manual
									x	Vibration excessive	Tighten loose components.†	—
			x	x						Voltage regulator digital settings incorrect (digital controller only)	Adjust the voltage regulator.	Voltage Regulator Technical Manual ‡
			x	x						Voltage regulator inoperative	Replace the voltage regulator fuse, If the fuse blows again, troubleshoot the voltage regulator.	Voltage Regulator Technical Manual ‡
			x	x						Voltage regulator out of adjustment	Adjust the voltage regulator.	Voltage Regulator Technical Manual ‡

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

Trouble Symptoms										Probable Causes	Recommended Actions	Section or Publication Reference*
Does not crank	Cranks but does not start	Starts hard	No or low output voltage	Stops suddenly	Lacks power	Overheats	Low oil pressure	High fuel consumption	Excessive or abnormal noise			
Lube System												
	x	x					x		x	Crankcase oil type incorrect for ambient temperature	Change the oil. Use oil with a viscosity suitable for the operating climate.	Eng. O/M
						x	x		x	Oil level low	Restore the oil level. Inspect the generator set for oil leaks.	Eng. O/M
				x						Low oil pressure shutdown	Check the oil level.	Eng. O/M

* Sec./Section—numbered section of this manual; ATS—Automatic Transfer Switch; Eng.—Engine; Gen.—Generator Set; I/M—Installation Manual; O/M—Operation Manual; S/M—Service Manual; S/S—Spec Sheet; W/D—Wiring Diagram Manual

† Have an authorized service distributor/dealer perform this service.

‡ If the unit has a 550 controller, refer to the 550 controller operation manual for voltage regulator settings. Go to Menu 20, Factory Setup and verify that the application software (code version) is correct for the generator set model and alternator voltage.

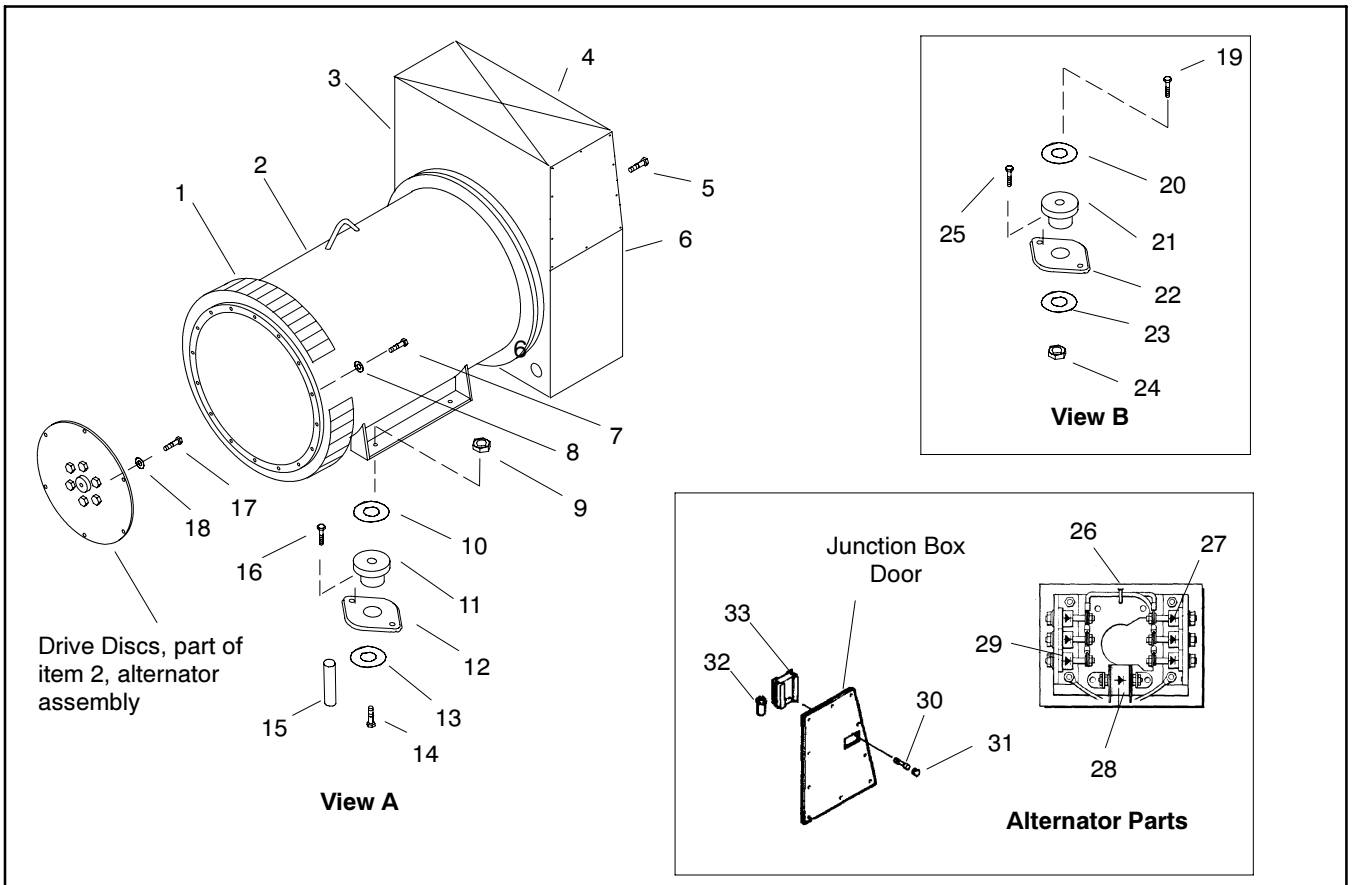
Notes

Section 3 Alternator Disassembly/Reassembly

Before beginning alternator disassembly procedure, carefully read all safety precautions at the beginning of this manual. Please observe these precautions and those included in text during the disassembly/ reassembly procedure.

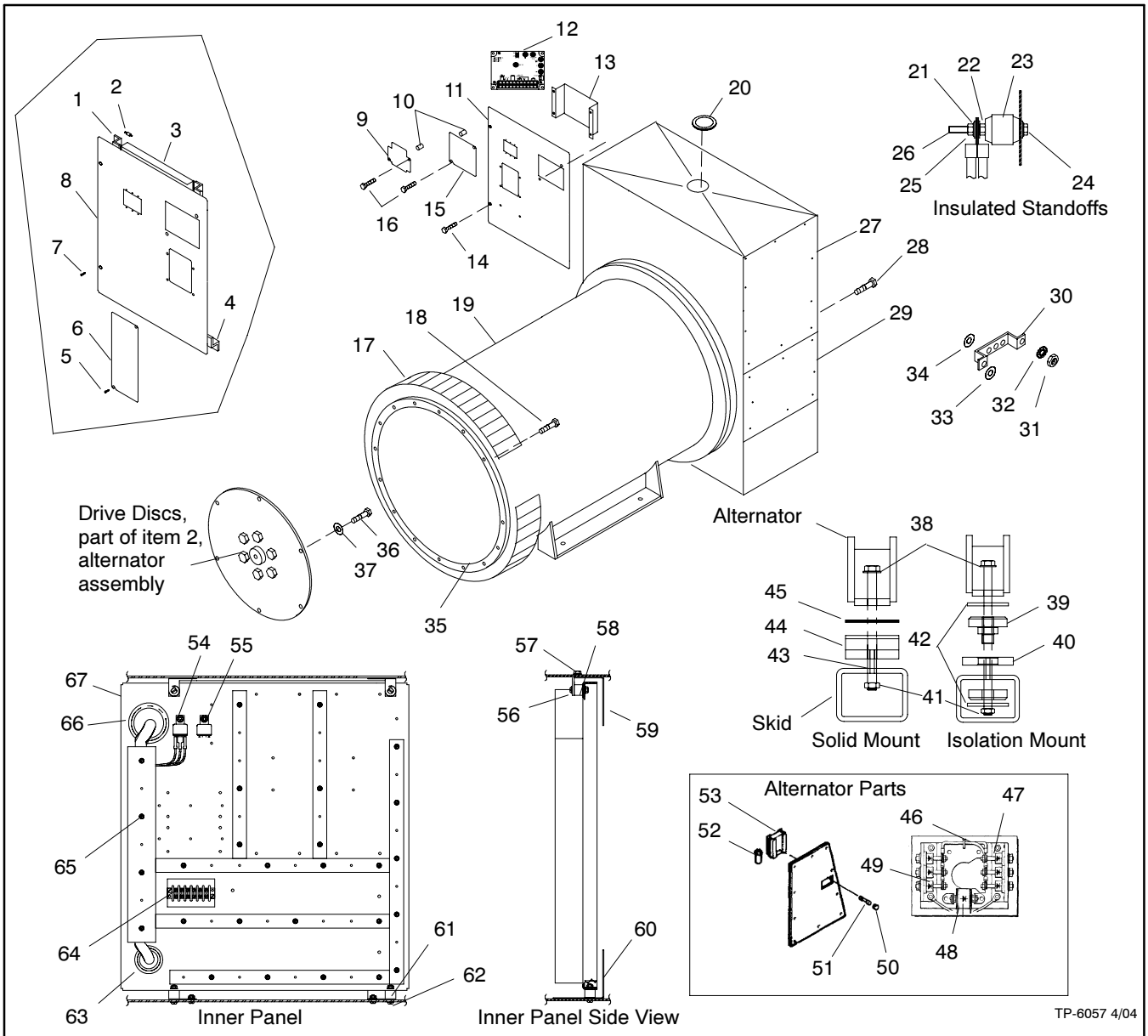
The following procedures cover many models and some steps may not apply to a particular engine. Use Figure 3-1 or Figure 3-2 to help understand component descriptions and general configuration of the alternator.

Use disassembly procedure as a step-by-step means to help disassemble the alternator. The disassembly procedure provides important information to minimize disassembly time and indicates where special configurations exist that may require taking notes. The reassembly procedure includes important alignment steps and provides critical torque specs.



1. Screen
2. Alternator assembly
3. Junction box assembly
4. Cover, top back
5. Screw, hex flange
6. Cover, louvered
7. Screw, hex cap
8. Washer, hardened
9. Nut, hex elastic stop
10. Washer, plain
11. Vibromount
12. Plate, alternator mounting
13. Washer, plain
14. Screw, hex head
15. Spacer
16. Screw, hex
17. Screw, hex cap
18. Washer, hardened
19. Bolt, hex cap
20. Washer, plain
21. Vibromount
22. Plate, alternator mounting
23. Washer, plain
24. Nut, hex elastic stop
25. Screw, hex
26. Exciter rectifier assembly (includes items 27-29)
27. Diode standard polarity
28. Surge suppressor
29. Diode, reverse polarity
30. Fuse, 5 amp
31. Fuse cap
32. Capacitor
33. Voltage regulator

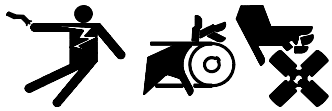
Figure 3-1 Alternator Components, Slanted Box Type



1. Door panel mounting bracket (top)
2. Vibromount
3. Inner door panel
4. Door panel mounting bracket (bottom)
5. Slotted pan head machine screw
6. Access cover
7. Hex flange machine screw and retainer
8. Junction box door
9. DVR access cover
10. Threaded 1/4-20 in. insert
11. Junction box door
12. Governor controller
13. Governor mounting bracket, vibromount, and lock washer
14. Hex flange machine screw and retainer
15. Access cover
16. Hex flange machine screw
17. Screen
18. Hex cap screw and hardened washer
19. Alternator assembly
20. Bushing
21. Plain washer
22. Hex nut
23. Standoff insulator
24. Plain washer
25. Spring washer
26. Threaded rod
27. Junction box panel (front)
28. Hex flange machine screw
29. Louvered cover
30. Ground bus
31. Hex nut
32. Lock washer
33. Spring washer
34. Plain washer
35. Alternator guard
36. Hex cap screw
37. Hardened washer
38. Hex cap screw
39. Vibromount
40. Mounting plate
41. Hex elastic stop nut
42. Plain washer
43. Hex nut
44. Mounting plate
45. Shim
46. Exciter rectifier assembly
47. Standard polarity diode
48. Surge suppressor
49. Reversing polarity diode
50. Fuse cap
51. 5 amp fuse
52. Capacitor
53. Voltage regulator
54. Relay
55. Relay
56. Lock washer
57. Hex nut
58. Controller Mount
59. Inner panel mounting bracket
60. Inner panel retainer
61. Controller mount
62. Lock washer
63. Bushing
64. Terminal block
65. Thread cutting screw
66. Bushing
67. Inner panel junction box

Figure 3-2 Alternator Components, Square Box Type

⚠ 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.

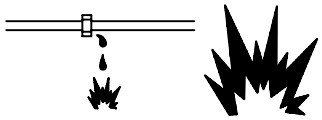
⚠ WARNING

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

Do not work on the generator set until it cools.

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

⚠ WARNING



Explosive fuel vapors.
Can cause severe injury or death.

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

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

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

Gasoline—Store gasoline only in approved red containers clearly marked GASOLINE.

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

Perform the following steps prior to disassembling the generator set.

1. Disconnect (negative lead first) and remove starting batteries from work area to prevent fire hazard. Disconnect AC-powered accessories, such as battery charger, block heater, and fuel transfer pump.

2. Shut off fuel supply. Drain fuel system as necessary by emptying fuel into proper containers. Remove any fuel containers from work area to prevent fire hazard. Ventilate work area to clear fumes.

3. Disconnect fuel, cooling, and exhaust systems as necessary to tilt generator set. Disconnect output leads or load circuit cables at generator set.

4. Any cranes, hoists, or other lifting devices used in the disassembly or reassembly procedure must be rated for the weight of the generator set. Check generator set nameplate or spec sheet for weight.

3.1 Disassembly

1. Disconnect all controller-to-engine and engine-to-alternator harnesses and wiring. Disconnect alarm horn circuit board connector, if equipped. Remove the controller as a unit.

2. Remove bolts (and shims, if used) between the alternator assembly and skid.

3. **Vibromount models.** Suspend the alternator at both ends with hooks in lifting eyes. Use a hoist to raise the alternator end off the vibromounts.

   Rigid mount models. Suspend the alternator at both ends with hooks in lifting eyes. Use a hoist to raise the alternator end from skid.

4. Support the engine by placing wood blocks under flywheel housing. Lower alternator end until alternator flywheel housing rests on blocks.

5. Remove fan guard. Remove bolts holding adapter to flywheel housing.

6. Remove hardware attaching drive discs to flywheel.

7. Separate alternator from engine.

8. Set alternator assembly on the floor in a horizontal position. Remove support slings or chains.

9. Use the appropriate technical manual for alternator assembly.

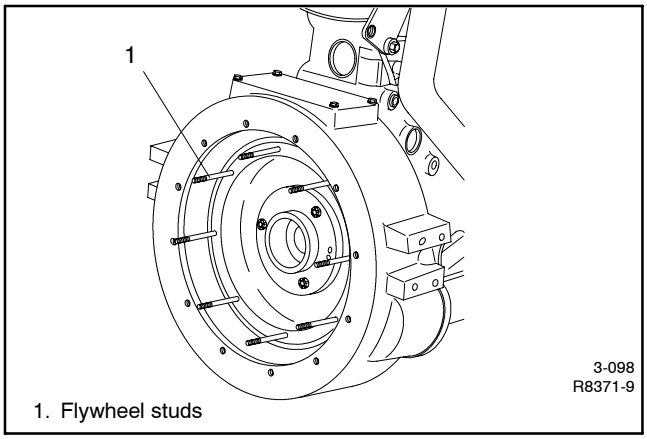
3.2 Reassembly, Vibromount Models

Vibromount models use rubber cushion mounts between the generator set and skid.

Use the torque values given in Section 1, Specifications, for torquing alternator adapter to flywheel housing and drive discs to flywheel. Use Appendix C, General Torque Specifications, when no specific values are shown in the reassembly procedure.

1. Use the appropriate technical manual for alternator reassembly.

2. If studs are used, apply Loctite® No. 271 red to stud threads and install into flywheel as shown in Figure 3-3. Install studs completely into flywheel. Apply Loctite® No. 242 blue to stud threads on nut side.



1. Flywheel studs

Figure 3-3 Flywheel Studs, Typical

3. Attach hoist to lifting eyes and place alternator assembly in a horizontal position. Take care not to damage rotor or stator. Place hoisting eyes of alternator to the top.

4. Raise the alternator assembly as necessary to align the alternator adapter to the flywheel housing. Install the hardware and torque to value given in Section 1, Specifications.

5. Align drive discs to flywheel. Turn the flywheel as necessary to align holes. Install hardware attaching drive discs to flywheel. Do not final tighten hardware at this time.

6. Hoist alternator and engine slightly to remove wood block(s) from under flywheel housing. Align alternator assembly and vibromounts. Lower alternator and tighten vibromount mounting bolts.

7. Remove chains or slings used for suspending alternator. Final tighten drive discs to flywheel. Torque hardware to values given in Section 1, Specifications.

8. Install fan guard.

9. Reinstall controller. Reconnect all controller-to-engine and engine-to-alternator harnesses and wiring. Refer to wiring diagram manual as required.

10. Reconnect fuel, cooling, and exhaust systems that were disconnected during disassembly. Reconnect output leads or load circuit cables at alternator. Refer to wiring diagram manual as required. Open fuel supply valve.

11. Reconnect starting batteries, negative lead last. Connect any AC-powered accessories such as battery charger, block heater, fuel transfer pump, etc.

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3.3 Reassembly, Rigid Mount Models

Rigid mount models do not use rubber cushion mounts between the generator set and skid. The alternator is mounted directly to the skid. This reassembly procedure is intended to minimize bending at the rear face of the engine block and to ensure correct engagement of the generator set drive discs into the pilot bore of the flywheel. To provide complete reassembly information, this procedure includes installation of the engine to the generator set skid.

The shimming procedure will only apply to engines attached rigidly to the generator set skid. Shims are available as service parts, see Figure 3-4.

Qty.	Description	Part No.
As required	Shim, 16 ga.	290743
As required	Shim, 7 ga.	290744
As required	Shim, 0.25 mm (0.01 in.)	291191

Figure 3-4 Generator Set Shims

Use the torque values given in Section 1, Specifications, for torquing alternator adapter to flywheel housing and drive discs to flywheel. Use Appendix C, General Torque Specifications, when no specific values are shown in the reassembly procedure.

1. Use the appropriate technical manual for alternator reassembly.
2. If studs are used, apply Loctite® No. 271 red to stud threads and install into flywheel as shown in Figure 3-3. Install studs completely into flywheel. Apply Loctite® No. 242 blue to stud threads on nut side.
3. Lift engine with hoist.
4. Position engine over skid and lower front of engine to skid.
5. Assemble mounting hardware to front engine mounting supports.
6. Attach rear engine mounting supports to engine (if used), install the hardware tight enough to hold the mounting plate to the flywheel housing.
7. Position and lower rear of engine to skid.
8. Assemble mounting hardware to rear engine mounts and skid. Do not tighten at this time.
9. Clean all preservative materials from machined surfaces of the flywheel and flywheel housing.
10. Install alternator drive discs guide pin(s), if used, to flywheel.

    Note: Use a stud as a drive disc guide pin or fabricate one by removing the hex head from a bolt. Remove any burrs.

11. Clean all dust and debris from the alternator drive disc.
12. Position the alternator behind the engine. Lower the alternator behind the engine and engage flex drive with guide pin(s), align as necessary. Do not force the alignment of the components. Shift the alternator from side to side or raise or lower with a hoist, as necessary.
13. Install mounting bolts between the alternator adapter and flywheel housing. Do not final tighten at this time.
14. Tighten the extreme bottom four bolts to seat adapter plate to the flywheel housing.
15. Place a 0.13 mm (0.005 in.) feeler gauge between the adapter plate and flywheel housing at the extreme top position. Raise the alternator until the gauge is snug. Reduce tension enough to remove the feeler gauge. Tighten and torque all the alternator adapter bolts to the flywheel housing. Torque hardware to values given in Section 1, Specifications.
16. Align drive discs to flywheel. Turn the flywheel as necessary to align holes. Install hardware attaching drive discs to flywheel. Do not final tighten hardware at this time.
17. Check for complete drive disc engagement of the pilot diameter of the flywheel. If the drive discs are not completely engaged into the pilot diameter, note location of improper engagement and go to step 26, Prestart Test Sequence.
18. At this point in the assembly procedure, the weight of the rear portion of the engine and alternator can be supported by a single hoist.
19. Install shims at the front alternator crossmember to support the engine/alternator at the present height. Lower the alternator down onto the shims.
20. Install shims at the rear alternator crossmember. Place shims so that the force is equally distributed to all shim stacks.
21. Install alternator mounting bolts through all shim stacks, tighten and torque the hardware.

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22. Tighten and torque the hardware that retains the rear engine supports to the skid and flywheel housing.

23. Remove chains or slings used for suspending alternator.

24. Tighten and torque engine front mounting bolts.

25. Do not install the alternator fan guard at this time.

26. **Prestart Test Sequence.** Use the following steps to assure complete seating of the alternator drive discs in the pilot diameter of the flywheel.

27. Verify that the fuel rack is closed. Refer to the engine literature as needed.

28. Disconnect the DC power leads to the governor actuator. Tape to insulate the DC power lead terminals.

29. Connect the starting batteries to the engine, negative lead last.

30. Place the generator set master switch to the RUN position to crank the engine for approximately 5 seconds or long enough to provide at least 10 engine revolutions. Return the generator set switch to the OFF/RESET position.

31. Disconnect the starting batteries, negative lead first.

32. Torque the drive disc bolts using the values given in Section 1, Specifications, and in the sequence shown in Figure 3-5. Recheck the bolt torque.

33. Check the torque on all engine mounting hardware.

34. Install the fan guard.

35. Reinstall controller. Reconnect all controller-to-engine and engine-to-alternator harnesses and wiring. Refer to wiring diagram manual as required.

36. Reconnect fuel, cooling, and exhaust systems that were disconnected during disassembly. Reconnect output leads or load circuit cables at alternator. Refer to wiring diagram manual as required. Open the fuel supply valve.

37. Reconnect starting batteries, negative lead last. Connect any AC-powered accessories such as battery charger, block heater, fuel transfer pump, etc.

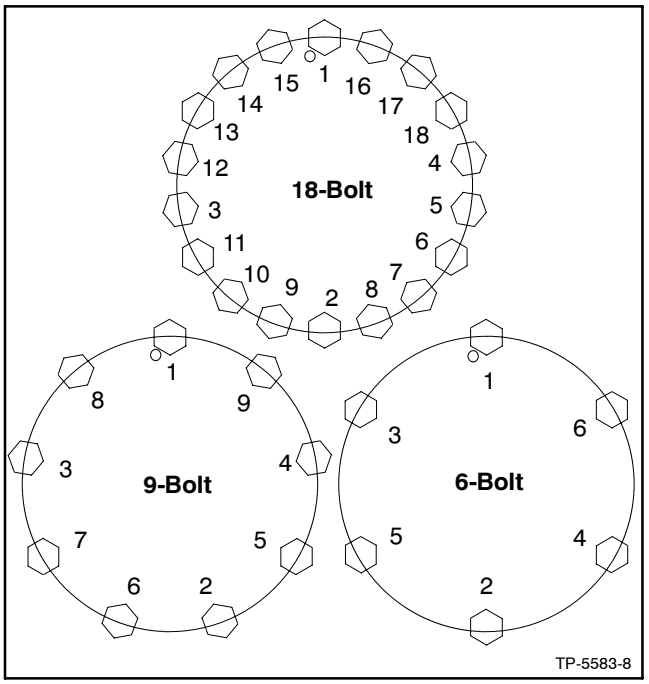


Figure 3-5 Drive Disc Bolt Tightening Sequence

3.4 Dual Bearing Alternator Installation and Alignment

Adapted from Service Bulletin SB-566 9/04a.

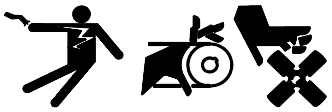
Perform the following procedure before operating the generator set to 1) prevent alternator failure and 2) maintain the warranty coverage.

Align the alternator to the engine to ensure proper alternator bearing operation and long life. Excessive misalignment causes vibration, noisy operation, coupling wear, and premature bearing failure.

Check and adjust, if necessary, the angular, axial, and parallel alignment of the coupling any time the generator set is moved. Insert dowels into the generator set frame through the mounting base to ensure that no movement in the alignment occurs during operation after generator set installation and coupling alignment. Follow the general recommendations provided to ensure correct alignment of the alternator to the engine.

3.4.1 Safety Precautions

⚠ 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.

High voltage test. Hazardous voltage can cause severe injury or death. Follow the instructions of the test equipment manufacturer when performing high-voltage tests on the rotor or stator. An improper test procedure can damage equipment or lead to generator set failure.

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.

NOTICE

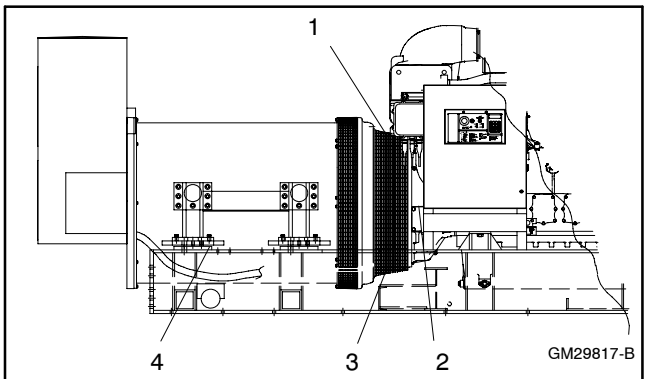
Hardware damage. The engine and generator set may use both American Standard and metric hardware. Use the correct size tools to prevent rounding of the bolt heads and nuts.

3.4.2 Required Tools

- Assorted combination wrenches
- Assorted socket wrenches and ratchet
- Torque wrench and/or torque multiplier capable of 1060 Nm (782 ft. lb.)
- Straight edge (to measure axial gap)
- 12 in. ruler graduated in 1/32 in. (to measure axial gap)
- Two dial indicators (measure parallel and angular alignment)
- Magnetic bases, posts, and clamps for indicators (to measure parallel and angular alignment)
- Feeler gauges
- Mirror with extended handle to read indicator in tight spots (to measure parallel and angular alignment)
- Engine barring tool (F6 555 766 DDC/MTU Series 4000, J22582 DDC Series 4000)
- Drill
- Reamer
- Sledge hammer
- Brass drift

3.4.3 Procedure

1. Disable generator set.
   a. Place the generator set master switch in the OFF/RESET position.
   b. Disconnect the power to the battery charger, if equipped.
   c. Disconnect the generator set engine starting battery(ies), negative (-) lead first.
2. Prepare for alignment.
   a. Locate and level the alternator and engine on the mounting pad. Install spring isolators using the location shown in the dimension drawing. See the generator set installation manual for more information on mounting and vibration isolation.
   b. Remove both the top and bottom coupling guards. See Figure 3-6.
   c. Remove right side flywheel cover plate from the engine. See Figure 3-6.
   d. Mount the engine barring tool where the cover plate was removed.



1. Top half coupling guard
2. Right side flywheel cover plate
3. Bottom half coupling guard
4. Screw jack

Figure 3-6 2000–2800 kW Assembly Drawing, Typical

e. Remove or reposition the following items (as necessary) on the generator set to provide better access to the coupling:

- Air cleaner and supports (D2000 engine)
- Battery charger (DDC/MTU Series 4000 engine)
- Fuel filter mounting (DDC Series 4000 engine)
- Fuel line mounting (DDC Series 4000 engine)

3. Attach and setup dial.

a. Attach the dial indicator bases to one of the coupling halves and locate the dial indicators for measurements as shown in Figure 3-7 for RB couplings and Figure 3-8 for HTB couplings.

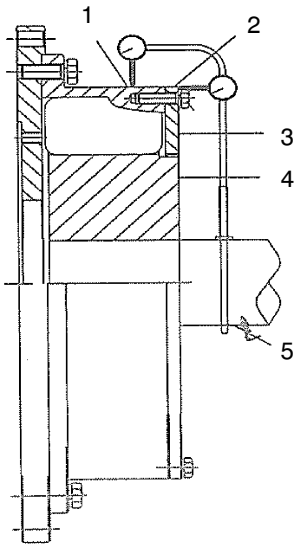
b. Place one dial indicator with the tip on the outside diameter and perpendicular to the shaft (parallel alignment).

c. Place the other dial indicator with the tip located on the coupling face as close to the outside diameter as possible (angular alignment).

d. Set each plunger at the midpoint of travel. Rotate the indicators so that they are at the top location and *zero* the indicator.

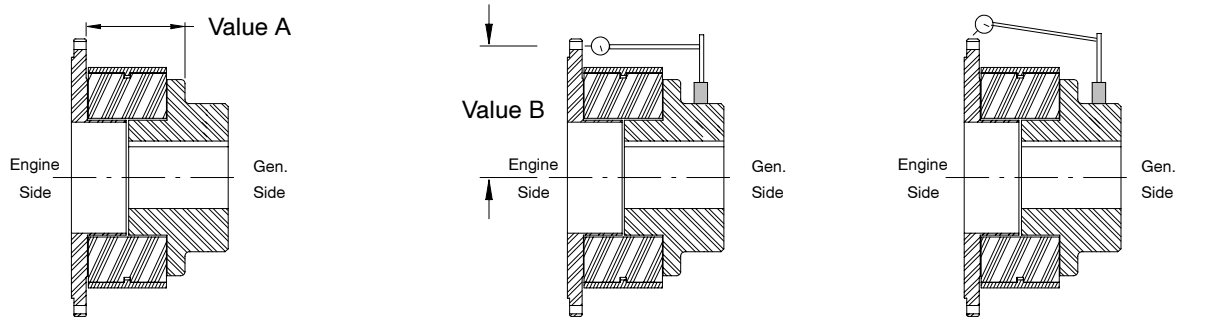
e. Mark the coupling hub at 0°, 90°, 180°, and 270° and make a reference mark on the stationary portion of the unit.

Note: If flexible coupling requires replacement, mark the engine-mounted coupling and the alternator-mounted coupling so that the set is recoupled exactly as it was uncoupled.



1. Locate dial indicator pointer at D for radial alignment
2. Locate dial indicator pointer at E for angular alignment
3. Face B minus Face A = average axial gap
4. Face A
5. Mount dial indicator on shaft at C

Figure 3-7 Dial Indicator Setup (RB Coupling)



1. Axial Gap Measurement
2. Angular Alignment Setup
3. Parallel Alignment Setup

A. Average Axial Gap: _____ B. Radius of Angular Measurement Point: _____

Figure 3-8 Dial Indicator Setup (HTB Coupling)

4. Types of coupling alignment.

   The coupling has three basic alignment dimensions—axial, angular, and parallel. Misalignment of any one or more of the above can cause coupling misalignment. See Figure 3-9. Figure 3-10 shows a typical set of measurements and their corresponding Total Indicator Readings (TIR).

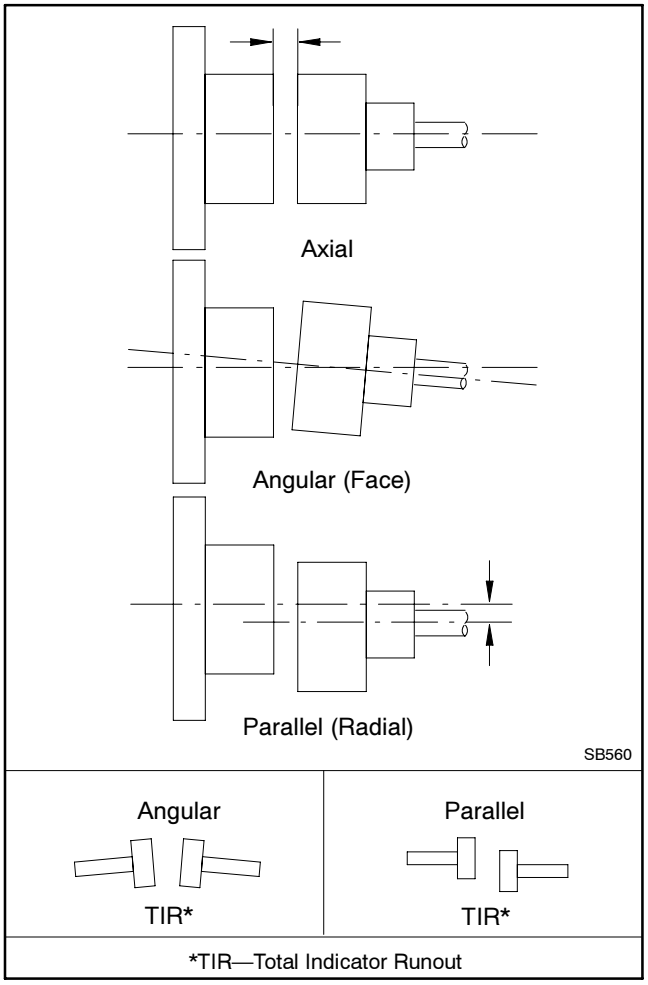


Figure 3-9 Alignment Types

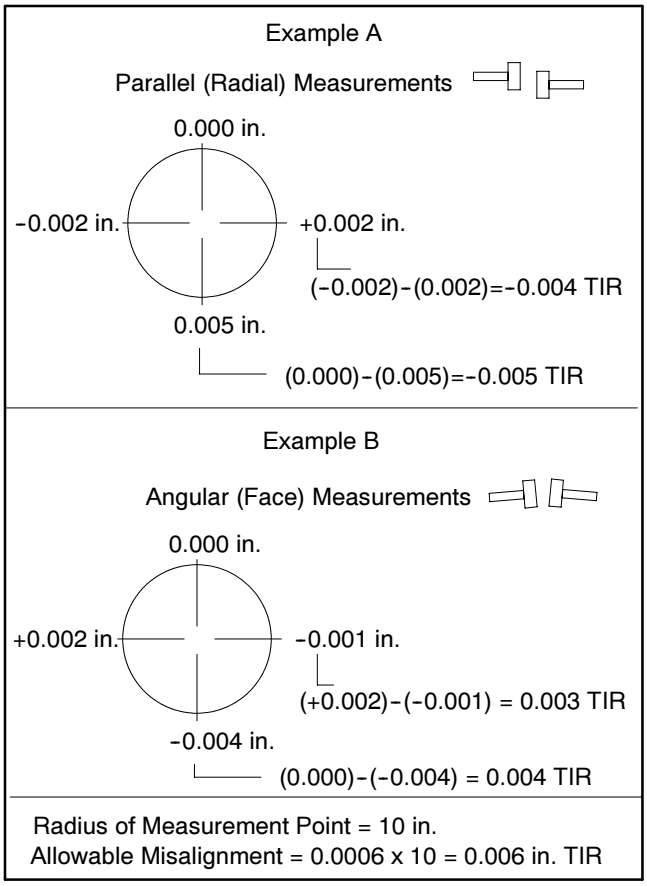


Figure 3-10 Sample Measurements

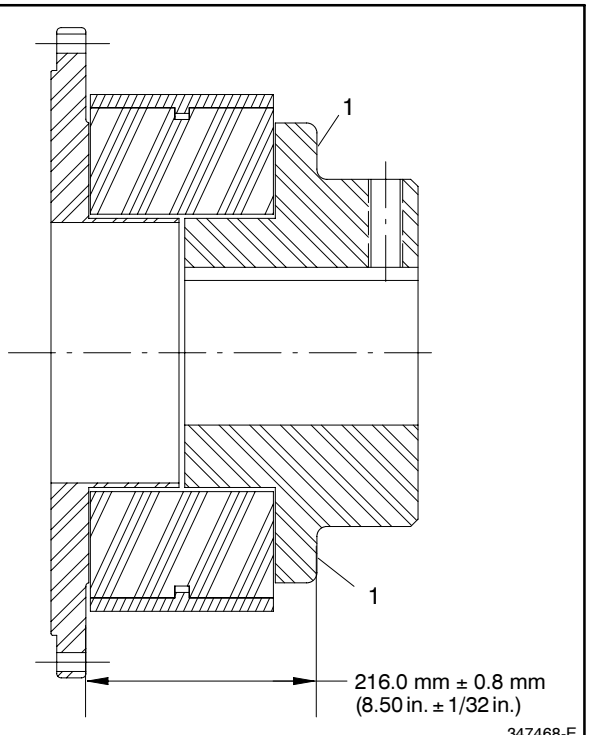
5. Align.

   a. Inspect axial alignment. Use a graduated ruler or inside caliper and straight edge to measure axial alignment. See Figure 3-7, Figure 3-11, or Figure 3-12. Keep straight edge away from the inside radius.

   b. Inspect angular and parallel alignment. See Figure 3-14 for documenting alignment data. Make copies of Alignment Worksheet, as necessary.

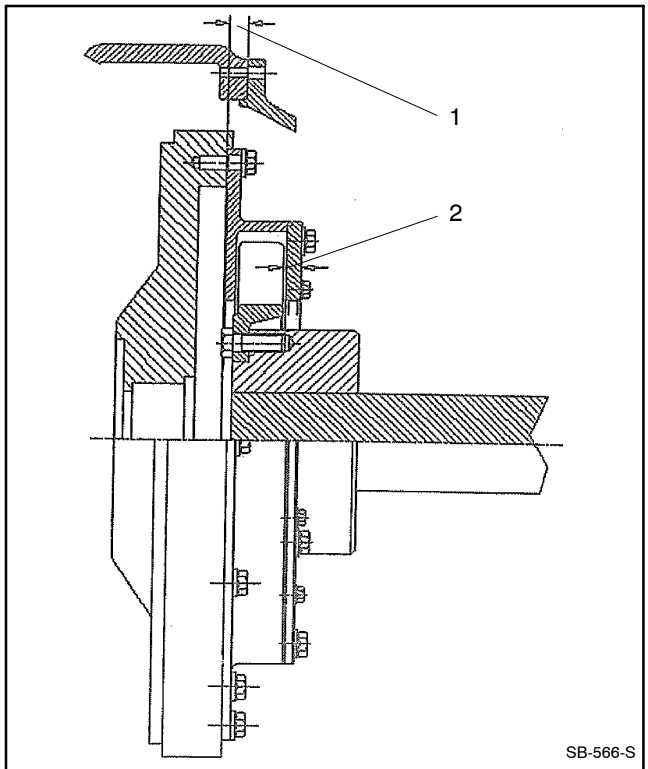
      Rotate both shafts together when taking measurements. Take measurements at 90° increments and return coupling to initial position to check that indicators are at zero. If indicators are not at zero, reset indicators and repeat alignment measurement.

      Make parallel and angular alignment measurements at the same time from the same position, if possible. If measurements are not made at the same time, mark the coupling and take measurements from the same position (degrees) for each measurement.



1. Straight edge location

Figure 3-11 Axial Alignment Measurement with Atraflex Coupling (2000 kW)



1. Angular (face)
2. Axial

Figure 3-12 Axial Alignment Measurement with HTB Coupling (2500/2800 kW)

   c. Compare the measurement values to the maximum allowable shaft misalignment values shown in Figure 3-13.

Model	Axial Measurement, mm (in.)	Angular (Face), mm (in.)	Parallel (Radial), mm (in.)
2000 kW (Atraflex Coupling)	216.0 ±0.8 (8.5 ±1/32)	0.015 (0.0006)	0.13 (0.005)
2000 kW (RB Coupling)	0.61 (0.024)	0.30 (0.012)	2.54 (0.10)
2500 kW/2800 kW new (HTB Coupling)	23.11 ±1.0 (0.91 ±0.04)	0 (0)	0.41 (0.016)
2500 kW/2800 kW used * (HTB Coupling)	23.11 ±1.0 (0.91 ±0.04)	0 (0)	1.5 (0.060)
* Inspect after approximately 10000 hours.			

Figure 3-13 Maximum Allowable Shaft Misalignment

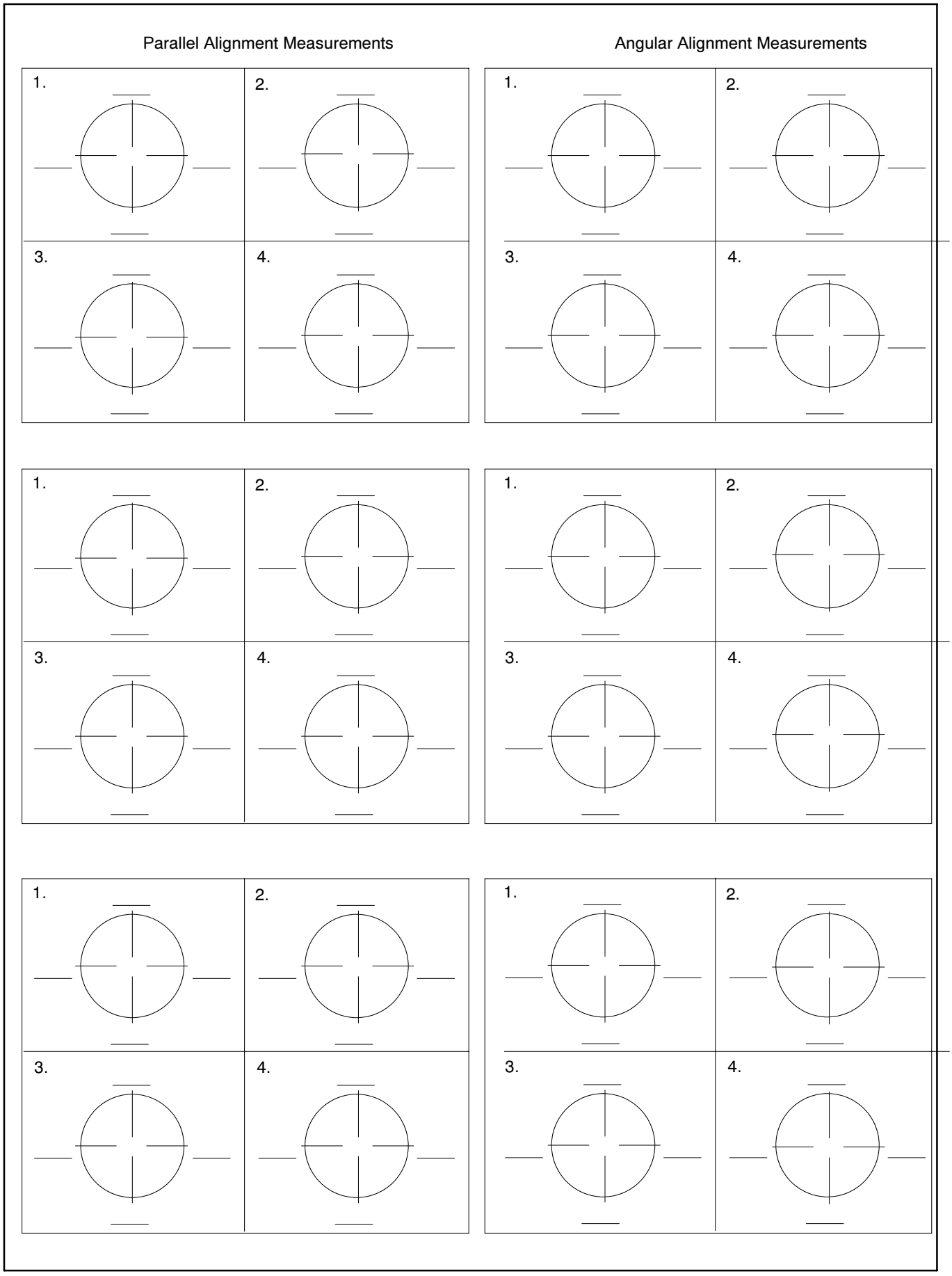


Figure 3-14 Alignment Worksheet (photocopy as necessary)

6. Correct alignment.

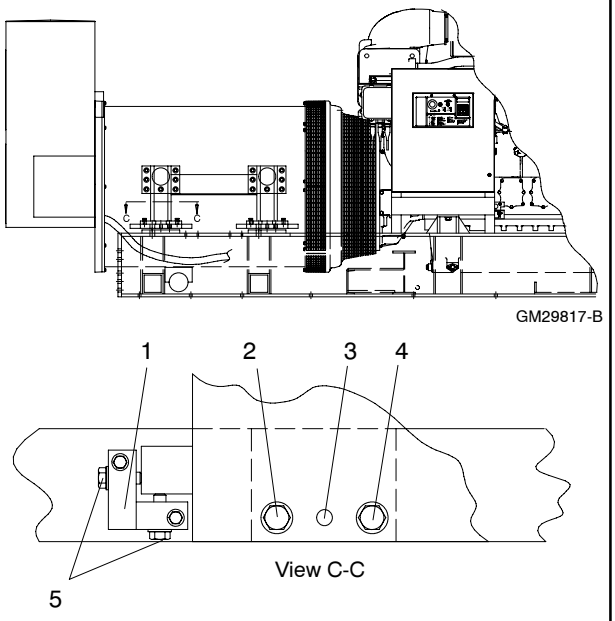
   a. Go to step 7.a. if measurements meet the specifications. Go to the next step if the measurements do not meet the specifications.

      It is good practice to first correct the parallel and angular misalignment in the horizontal plane. Jack screws attached to the skid can be used to adjust the location in the horizontal plane. After following the alignment corrections, a new set of alignment measurements should be made. If the alignment in the horizontal plane are within limits, proceed with correction in the vertical plane.

      Evaluate the measurements and determine the correction process. Corrections for parallel and angular misalignment can be made at the same time. Take new measurements after corrections are made.

      Note: The factory ships the adjustment block bolts, shims, and dowel pins loose with the generator set.

   b. Install the eight adjustment bolts into the four adjustment blocks on the generator set skid. See Figure 3-15. Keep the eight adjustment screws loose so they do not affect *soft foot* measurements. *Soft foot* exists when the alternator does not rest flat on its base and only three of the four mounting points support the alternator.



1. Adjustment blocks (4)
2. Alternator mounting bolts (4)
3. Dowel location (4)
4. Jack screws (4)
5. Adjustment block bolts (8)

Figure 3-15 Alternator Adjustment Layout

   c. Check the alternator for *soft foot* condition.

      If no *soft foot* exists, go to step 6.d. If *soft foot* needs correction, perform the following steps.

      - Tighten the eight alignment bolts to 136 Nm (100 ft. lb.) against the alternator to prevent it from moving.
      - Loosen the four alternator mounting bolts one at a time and measure the relative movement with a dial indicator.
      - Shim the alternator for *soft foot* using jack screws and supplied shims to eliminate that relative movement. The relative movement should not exceed 0.13 mm (0.005 in.). Shims with burrs on the edges can contribute to the *soft foot* condition.
      - Tighten the alternator mounting bolts.

   d. Check angular, axial, and parallel alignments. See Figure 3-15. Use the jack screws and shims to adjust the height of the alternator. Use adjustment bolts to adjust horizontal position of the alternator. Loosen opposing adjustment bolt prior to tightening an adjustment bolt.

      Note: Replace all damaged hardware. Do not reuse crushed, cupped, or otherwise distorted washers or shims.

      - Loosen the alternator mounting bolts.
      - Make adjustments to the horizontal plane.
      - Tighten alternator mounting bolts.
      - Reinspect alignment.
      - Loosen alternator mounting bolts.
      - Make adjustments to the vertical plane.
      - Tighten alternator mounting bolts.
      - Reinspect alignment.

   e. Verify that alignment meets specifications.

   f. Tighten all adjustment blocks to 136 Nm (100 ft. lb.) to prevent movement during torquing.

   g. Torque mounting bolts to 407 Nm (300 ft. lb.) in a clockwise bolt pattern sequence. Then torque mounting bolts to 1060 Nm ±10% (782 ft. lb. ±10%) in a clockwise bolt pattern sequence.

   h. Recheck all alignment measurements after torquing. Repeat alignment procedure if measurements do not meet specifications.

7. Assemble components.

   a. Record the final alignment measurements for reference purposes.

   b. Remove engine barring tool from the starter mounting location.

   c. Reinstall engine starter motor.

   d. Reposition or reinstall any items moved during the alignment procedure.

   e. Reinstall the top and bottom coupling guards. See Figure 3-6.

8. Install dowel pin.

   a. Select opposite corner dowel pin mounting locations. See Figure 3-15.

   b. Drill and ream the existing 22.22 mm (0.875 in.) hole in the skid to 25.30–25.32 mm (0.996–0.997 in.).

   c. Drive in the supplied dowel pins using a brass drift and sledge hammer within 12.70–15.87 mm (0.50–0.63 in.) from the alternator base.

9. Place generator set back in service.

   a. Place the generator set master switch in the OFF/RESET position.

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

   c. Reconnect the power to the battery charger, if equipped.

   d. Move the generator set master switch to AUTO for startup by remote transfer switch or remote start/stop switch.

3.4.4 Electrical Test/Long Term Storage

If the generator set is exposed to extreme dampness during shipment or storage, an initial period of operation may be necessary to dry all windings. Determine the need for drying out by measuring the stator insulation resistance with a megohmmeter. Connect the megohmmeter between the stator terminal and generator set frame. The one-minute test of the stator resistance at an ambient temperature of 40°C (104°F) must be at least:

Rated voltage of unit/1000 +1 = Minimum resistance value (megohms)

If the stator insulation resistance measures less than specified for the generator set voltage rating, the unit must be dried out until at least the minimum recommended resistance value is obtained. Dry out the unit by applying an external heat to obtain an end-winding temperature of 75°C (167°F) using a thermometer. Apply heat evenly and slowly to avoid excessive vapor or gas pressure harmful to insulation. Do not exceed a temperature rise of 10°C (18°F) per hour.

The easiest and most convenient method of drying out the alternator is by placing the complete or partially disassembled alternator in an oven. Apply external heat using space heaters beneath the alternator to obtain an even distribution of heat along the length of the unit. Be sure to provide adequate air circulation to ensure a complete and thorough drying out process.

When the generator set is placed in storage or not in use, the alternator strip heaters should be energized unless the unit is in a humidity controlled environment. When in storage, the unit should have adequate air circulation for moisture removal and prevention of overheating.

3.5 Fan Pulley Alignment with Pillow Block Idler Pulley Design, 1250–2000 kW with DDC Series 4000 Engines

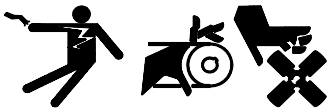
Adapted from Service Bulletin SB-582 10/06a.

Use this service bulletin when aligning the fan pulley and engine drive pulley. Perform the alignment procedure at initial startup or when reassembling the generator set after component replacement. Failure to perform this procedure may cause generator set cooling system problems and/or premature pulley belt failure.

3.5.1 Safety Precautions

Observe the following safety precautions while performing the fan pulley alignment procedure.

⚠ WARNING

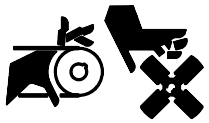


Accidental starting.
Can cause severe injury or death.

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



Rotating parts.
Can cause severe injury or death.

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

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.

3.5.2 Required Tools

- Straight edge (machinist's ruler), 610 mm (24 in.)
- Belt tension gauge (Kent-Moore BT-3384 or equivalent)

3.5.3 Procedure

1. Disable the generator set.
   a. Place the generator set master switch in the OFF position.
   b. Disconnect the power to the battery charger and block heater, if equipped.
   c. Disconnect the generator set engine starting battery(ies), negative (-) lead first.
   d. Remove the belt guards, as necessary, to access the poly-V belt and the pulleys if not already removed.

2. Pulley alignment.

   a. Align the fan pulley with the engine drive pulley. The second groove of the engine drive pulley must align with the first groove of the fan pulley. See Figure 3-16.

      - Place a straight edge (machinist's ruler) on the left side, as viewed from the radiator end, of the fan shaft along the face of the engine drive pulley and adjust the fan shaft so that the measurement between the straight edge and the first groove of the fan pulley is 13.5 mm (0.53 in.).

        Adjust the front-to-back pulley alignment by loosening the fan shaft set screws. See Figure 3-17. Adjust the left-to-right pulley alignment by loosening the fan shaft pillow block mounting hardware. See Figure 3-16.

      - Repeat above procedure using the straight edge on the right side, as viewed from the radiator end, of the fan shaft.

        The pulley alignment measurement on both the left and the right side of the fan pulley must be 13.5 mm (0.53 in.) as viewed from the radiator end. Adjust the fan shaft pillow block as required so that both the left and right measurements are 13.5 mm (0.53 in.).

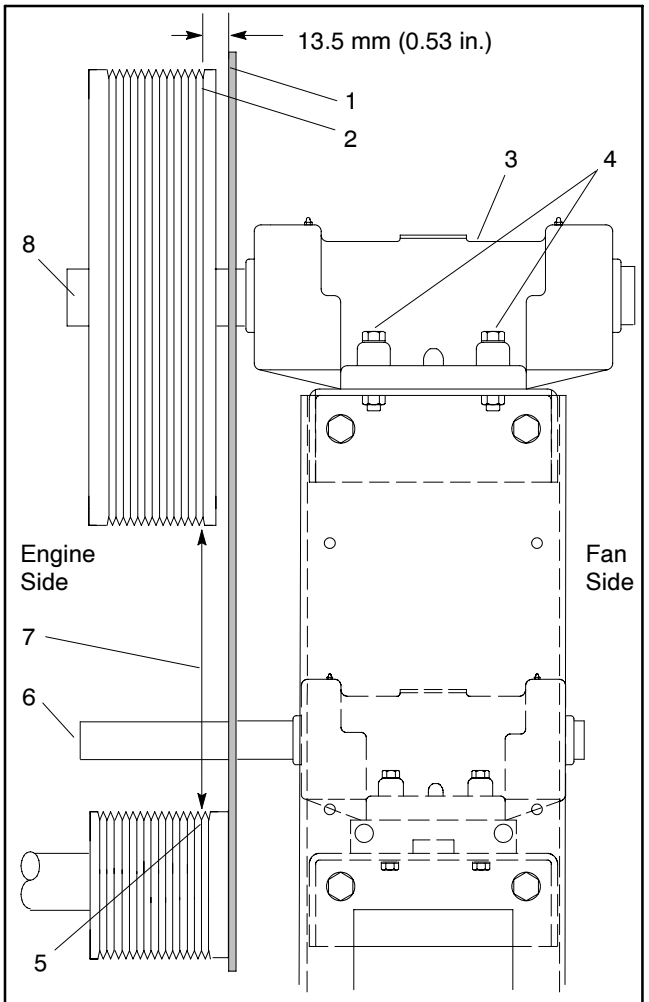
      - Make sure the fan shaft pillow block mounting hardware is tight. Hold the bolts while tightening the nuts. Torque the mounting hardware to 325 Nm (240 ft. lb.).

      - Verify the pulley alignment by measuring the distance from the straight edge to the first groove on the fan pulley and from the straight edge to the second groove on the engine drive pulley. Measure the distance on both the left and right sides of the fan shaft.

        The measurement from the straight edge to the first groove on the fan pulley and the measurement from the straight edge to the second groove on the engine drive pulley *must* be 13.5 mm (0.53 in.) on both sides.

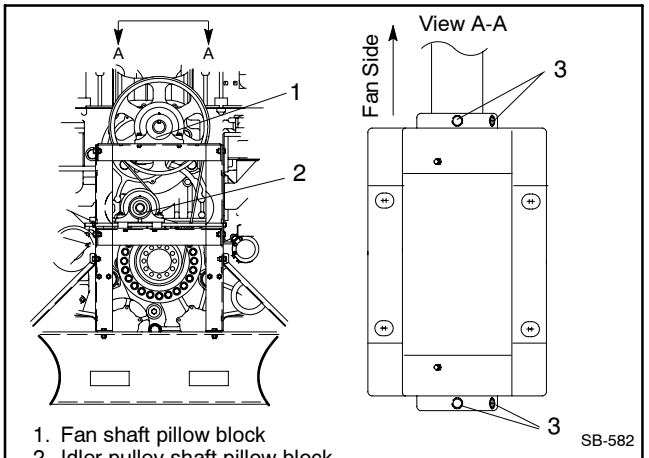
        If the measurements are not 13.5 mm (0.53 in.), adjust the fan shaft as required to achieve 13.5 mm (0.53 in.) measurement.

        Note: The fan and engine drive pulleys must be parallel with the grooves aligned.



1. Straight edge (machinist's ruler)
2. Fan pulley **(use first groove for item 7)**
3. Fan shaft pillow block
4. Fan shaft pillow block mounting hardware
5. Engine drive pulley **(use second groove for item 7)**
6. Idler pulley shaft
7. Groove alignment (align first groove of fan pulley with second groove of engine drive pulley)
8. Fan shaft

Figure 3-16 Pulley Alignment, Side View



1. Fan shaft pillow block
2. Idler pulley shaft pillow block
3. Set screws

Figure 3-17 Fan Shaft Set Screws

b. Verify that the idler pulley shaft set screws are torqued to 19 Nm (14 ft. lb.).

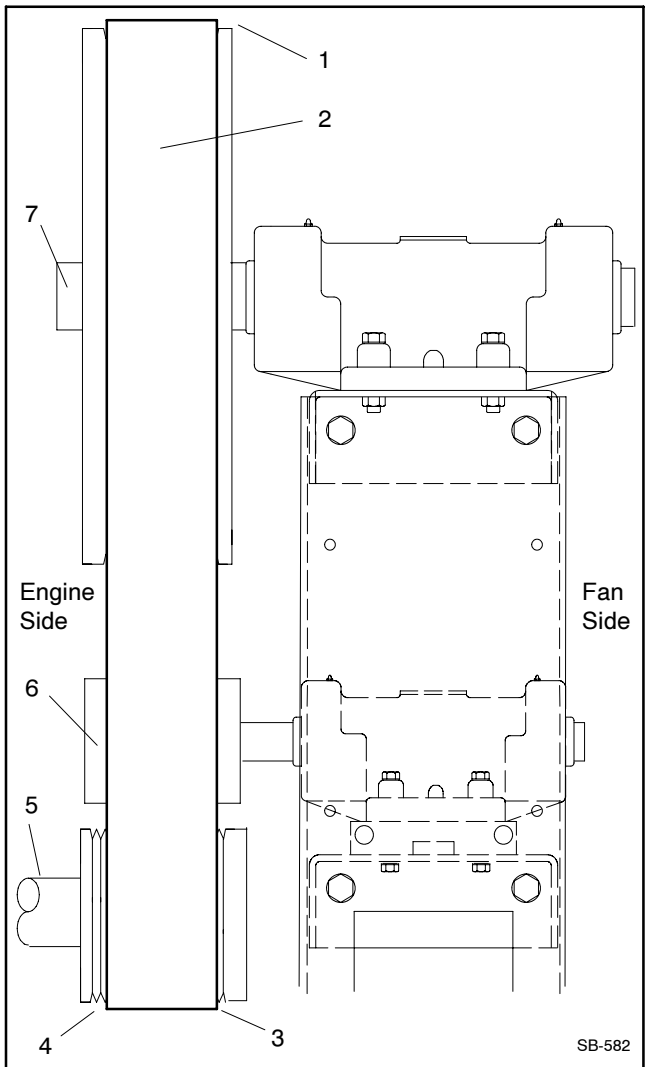
c. Verify that the fan shaft set screws are torqued to 33 Nm (24 ft. lb.). See Figure 3-17.

d. Recheck the alignment of the fan and engine pulleys as described in step 2.a.

3. Inspect drive belt.

a. Inspect the fan drive belt for damage or wear. Replace the belt if it is damaged or worn.

b. Install the poly-V belt. Align the poly-V belt with the second groove on the engine drive pulley and the first groove on the fan pulley from the fan side. See Figure 3-16 and Figure 3-18.



1. Fan pulley (use first groove for poly-V belt)
2. Poly-V belt
3. Engine drive pulley (use second groove for poly-V belt)
4. Engine drive pulley with two grooves open
5. Engine drive shaft
6. Idler pulley
7. Fan shaft

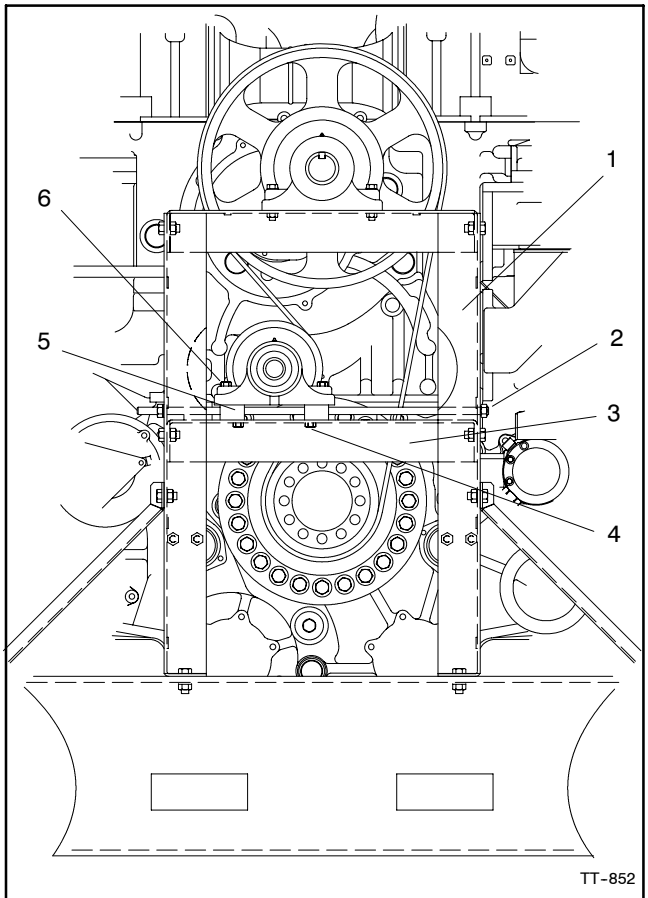
Figure 3-18 Belt Installation

Note: The engine drive pulley will have two open grooves on the *engine side.*

c. Center the idler pulley on the poly-V belt.

4. Adjust the idler slide block.

a. Verify that the idler pulley pillow block to idler slide block mounting bolts (topside) are torqued to 92 Nm (68 ft. lb.) See Figure 3-19.



1. Vertical bearing support
2. Idler pulley adjusting bolts (belt tension)
3. Idler bearing support
4. Idler slide block locking bolts
5. Idler slide block
6. Idler pulley pillow block mounting bolts

Figure 3-19 Idler Pulley Pillow Block Mounting on Fan-Bearing Support, Rear View

b. Loosen the idler slide block to idler bearing support locking bolts (underside).

c. Adjust the idler pulley by turning the two adjusting bolts located on the side of the vertical fan bearing support.

d. Verify that the fan belt is seated in the second groove on the engine drive pulley and the first groove on the fan pulley from the fan side.

e. Check the fan belt tension using a poly-V (serpentine) belt tension gauge. See Figure 3-20 for belt tension specifications. Adjust the belt tension by turning the two idler pulley adjusting bolts. See Figure 3-19 for location.

Generator Set Model	New Belt, N (lbf.)	Used Belt,* N (lbf.)
1250-2000 kW	2450-2890 (550-650)	1650-1910 (370-430)
* A belt is considered used after 50 hours of service.		

Figure 3-20 Poly-V Belt Tension Specifications

f. Tighten the idler slide block to idler bearing support locking bolts (underside) after reaching the specified belt tension. Torque the bolts to 92 Nm (68 ft. lb.).

g. Reinstall belt guards using original hardware.

5. Place the unit back in service.

a. Reconnect the generator set engine starting battery(ies), negative (-) lead last.

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

c. Listen for a squeaking or squealing noise from the fan belt, which indicates a slipping belt. Stop the generator set.

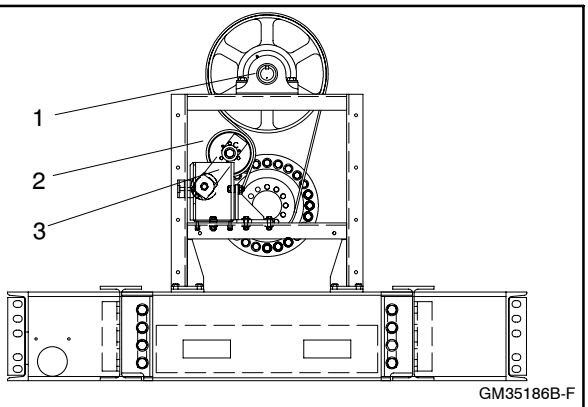
If the fan belt slips, disconnect the engine starting battery(ies). Increase the belt tension to eliminate slippage using the procedure starting with step 4.b.

d. Reconnect the power to the battery charger and block heater, if equipped.

3.6 Fan Pulley Alignment with Tensioning Arm Idler Pulley Design, 1350-2800 kW with DDC Series 4000 Engines

Adapted from Service Bulletin SB-663 10/06.

Use this service bulletin when aligning the fan pulley and engine drive pulley with the tensioning arm design; see Figure 3-21. Perform the alignment procedure at initial startup or when reassembling the generator set after component replacement. Failure to perform this procedure may cause generator set cooling system problems and/or premature poly-V belt failure.

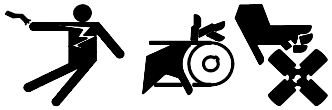


1. Fan shaft pillow block
2. Idler pulley
3. Idler pulley tensioning arm

Figure 3-21 Tensioning Arm Design

3.6.1 Safety Precautions

⚠ WARNING

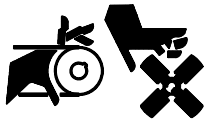


Accidental starting.
Can cause severe injury or death.

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



Rotating parts.
Can cause severe injury or death.

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

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.

3.6.2 Required Tools and Supplies

- Straight edge (machinist's ruler), 610 mm (24 in.)
- Poly-V belt tension gauge (Kent-Moore BT-3384 or equivalent)
- PERMA-LOC® MM-115 (blue) or equivalent thread locking compound (PERMA-LOC® is a registered trademark of Permabond, a National Starch and Chemical Company)

Observe the safety precautions while performing the fan pulley alignment procedure.

3.6.3 Procedure

1. Remove the generator set from service.

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

   b. Disconnect the power to the battery charger and block heater, if equipped.

   c. Disconnect the generator set engine starting battery(ies), negative (-) lead first.

2. Align the idler pulley.

   a. Remove the belt guards, as necessary, to access the poly-V belt and pulleys, if not already removed.

   b. Check the alignment of the idler pulley to the engine drive pulley.

      Place a straight edge (machinist's ruler) on the engine drive pulley and check the distance that the idler pulley is set back from the front of the engine drive pulley at four opposing points (rotate the idler pulley 90° per check). See Figure 3-22. **The offset should be 7 mm (0.275 in.) and the difference between each measurement should not exceed 4 mm (0.015 in.).**

      If the alignment is correct, go to step 3.

      If the alignment is incorrect, go to step 2.c. and/or step 2.d.

   c. Adjust the idler pulley parallel alignment. Use this adjustment to correct for nonparallel alignment with the engine drive pulley.

      (1) Adjust the idler pulley assembly using the adjusting screws shown in Figure 3-23.

      (2) Check that the inside and outside left-to-right screws are tight.

      (3) Loosen the pivot screw on the idler arm mounting bracket.

      (4) Loosen the pivot screw on the 3-hole mounting plate.

      (5) Loosen the front-to-back adjusting screws.

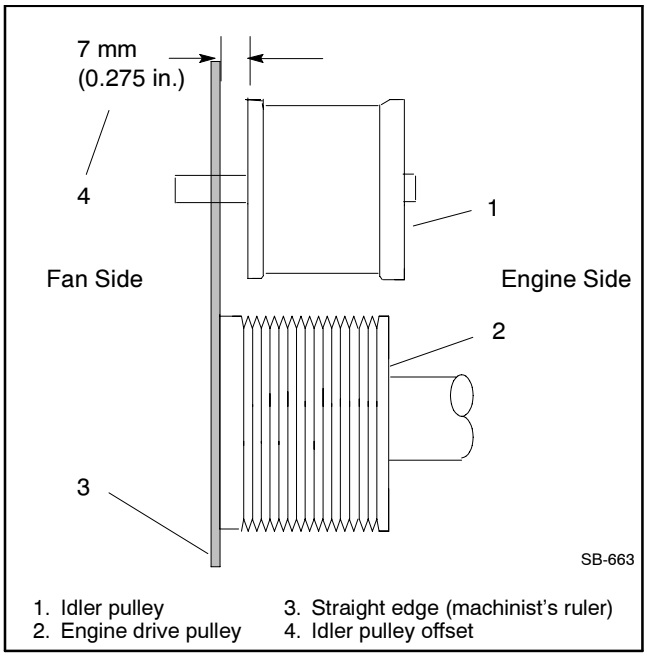


Figure 3-22 Pulley Alignment, Side View

      (6) Loosen the two adjusting screws and mounting bracket screw.

      (7) Adjust, as necessary, the idler pulley horizontal parallel alignment to the engine drive pulley. This adjustment is made by lightly tapping the idler arm mounting bracket and 3-hole mounting plate with a hammer.

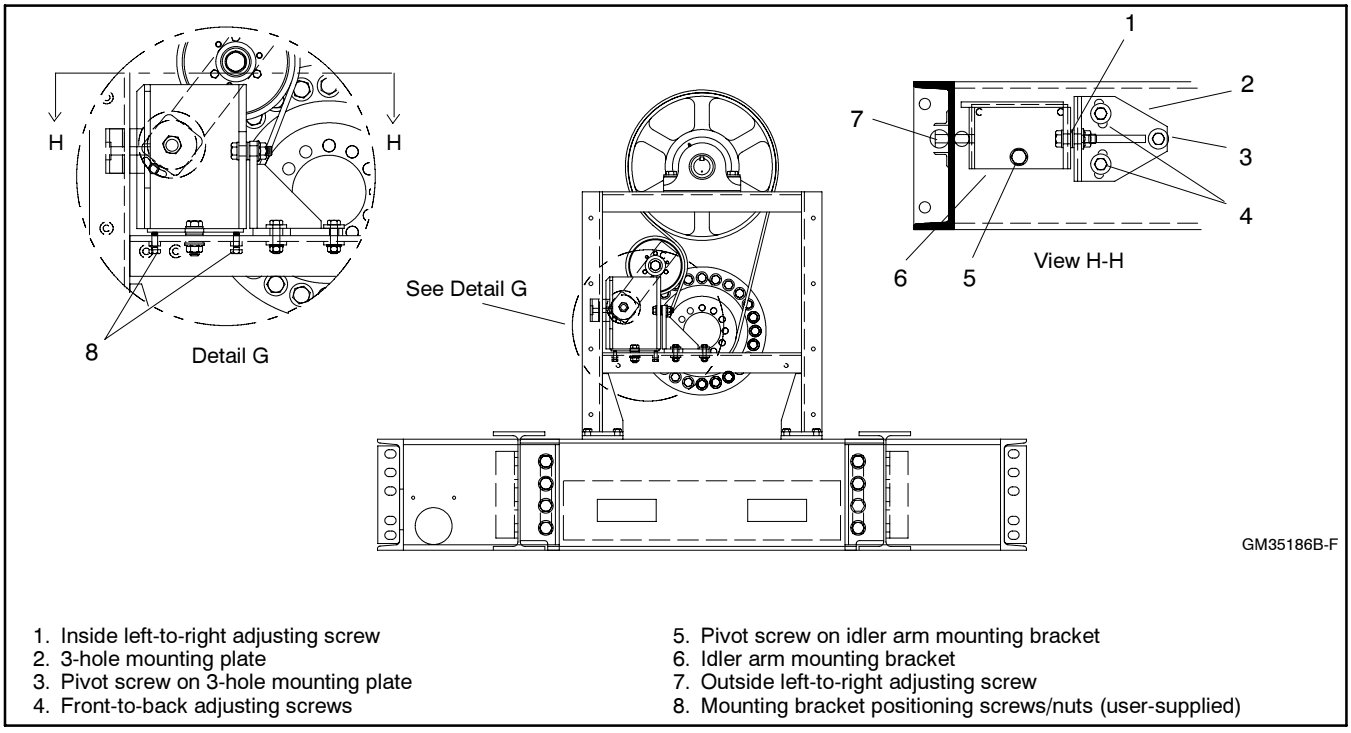
      (8) Tighten the two front-to-back adjusting screws and pivot screw on the 3-hole mounting plate.

      (9) Loosen the inside and outside left-to-right adjusting screws.

(10) Temporarily install (user-supplied) two screws M10-1.5 x 30, grade 8.8 (M933-10030-60) with nuts M10-1.5 as shown in Figure 3-23. Use these two screws to adjust the vertical parallel alignment of the idler arm mounting bracket. Use the nuts to lock to screw positions.

Keep these screws/nuts installed until instructed to remove them later in the belt tension procedure.

(11) Tighten the pivot screw on the idler arm mounting bracket.



1. Inside left-to-right adjusting screw
2. 3-hole mounting plate
3. Pivot screw on 3-hole mounting plate
4. Front-to-back adjusting screws
5. Pivot screw on idler arm mounting bracket
6. Idler arm mounting bracket
7. Outside left-to-right adjusting screw
8. Mounting bracket positioning screws/nuts (user-supplied)

Figure 3-23 Idler Pulley Arm Bracket and Plate Adjustment

(12) Tighten the inside and outside left-to-right adjusting screws.

(13) Recheck that the idler pulley is parallel to the engine drive pulley.

(14) Recheck the idler pulley offset.

(15) If the alignment is correct, go to step 3. If the idler pulley offset is incorrect, go to step 2.d. to change the offset.

d. Adjust the idler pulley offset alignment. Use this adjustment to change the offset of the idler pulley from the engine drive pulley.

Adding a washer decreases the offset and removing a washer increases the offset. Use at least one washer and do not exceed three washers.

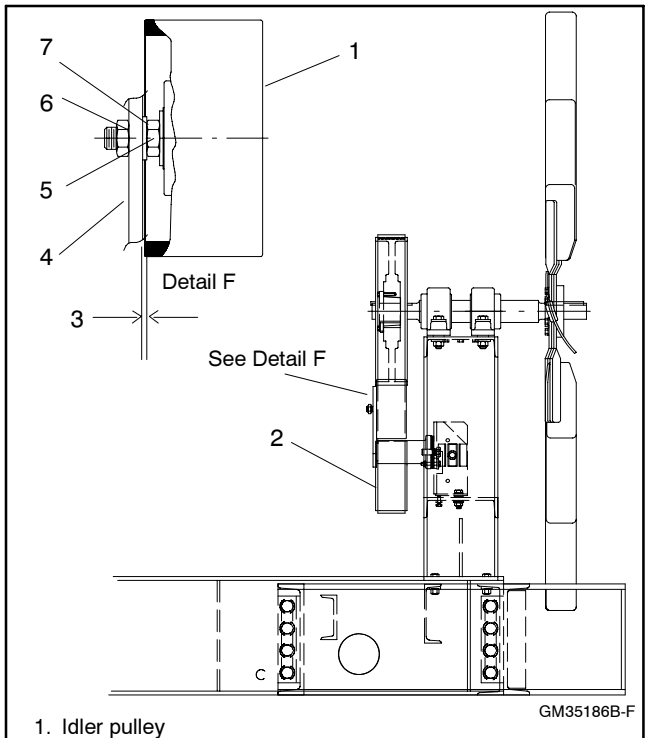
(1) Remove the tensioner arm nut. See Figure 3-24.

(2) Remove the idler pulley and hardware from the tensioner arm.

Note: Mark the hole in the tensioner arm that mounts the idler pulley.

(3) Add one plain washer X-25-29, 20.62 x 37.31 x 3.4 mm (0.812 x 1.469 x 0.134 in.), to the tensioner arm bolt for a total of three washers to decrease the offset.

If three washers are already present, one can be removed to increase the offset.



1. Idler pulley
2. Engine pulley
3. 1.5 mm ((0.06 in.) clearance required between tensioner arm and pulley
4. Tensioner arm
5. Tighten nut finger tight against the bearing, 6.8 Nm (60 in. lb.) max. torque
6. Tensioner arm nut
7. Washer

Figure 3-24 Idler Pulley Arm and Pulley Assembly

(4) The nut between the idler arm and pulley must be only finger tight against bearing. **Do not exceed 6.8 Nm (60 in. lb.) or bearing failure may result.**

(5) Mount the idler pulley and hardware to the tensioner arm in the original hole as noted in step 2.d.(2).

(6) Install the tensioner arm nut and tighten.

(7) Repeat step 2.b.

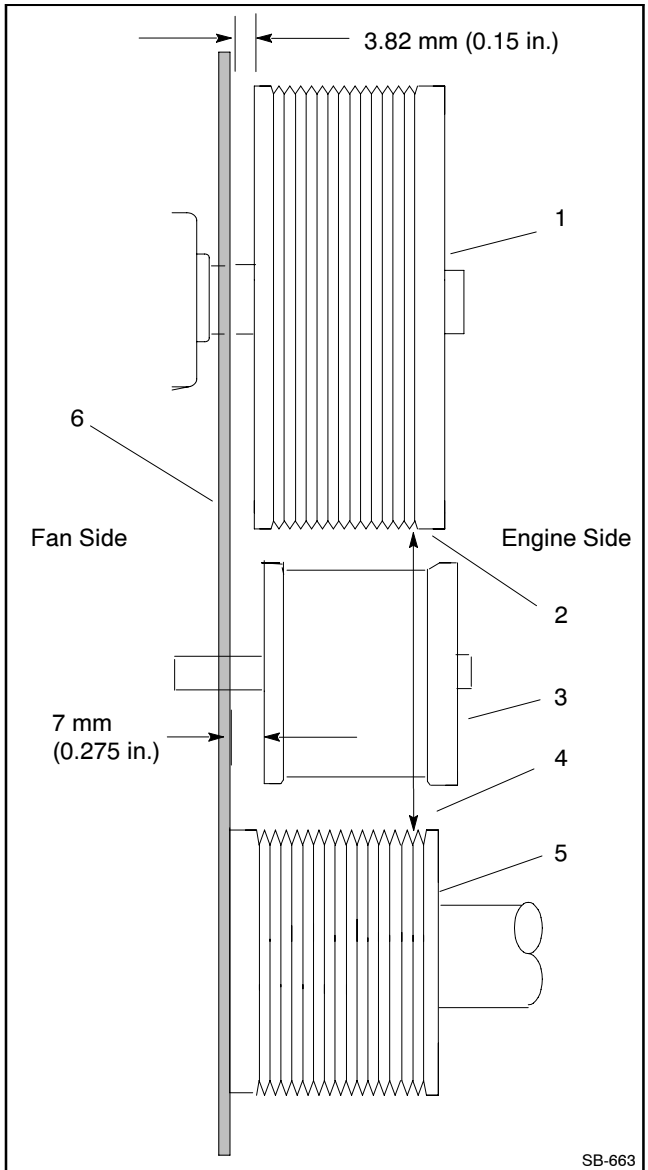
3. Align the fan pulley.

   a. Check the alignment of the fan pulley with the engine drive pulley by placing a straight edge (machinist's ruler) on the engine drive pulley left side as viewed from the radiator end. The second groove of the engine drive pulley must align with first groove of the fan pulley. See Figure 3-25 for the straight edge position and for clearance specifications.

   b. Repeat step 3.a. using the straight edge on the engine drive pulley right side as viewed from the radiator end.

      If the alignment is incorrect, go to step 3.c.

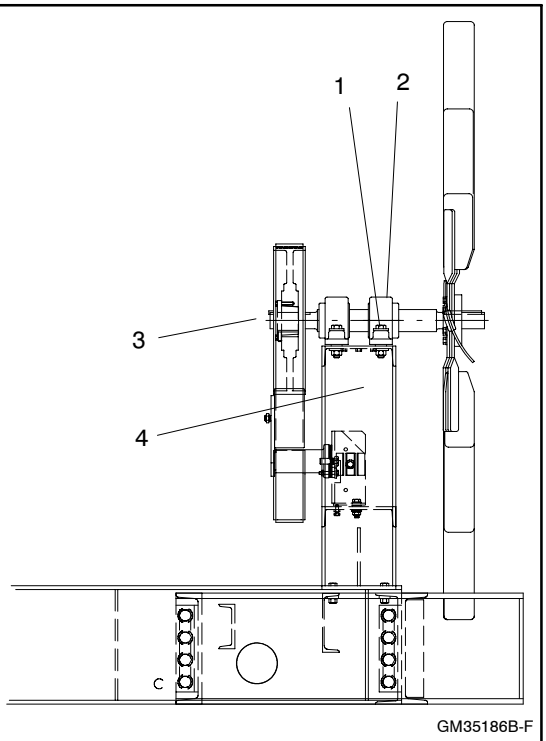
      If the alignment is correct, go to step 4.



1. Fan pulley
2. Groove alignment (first groove of fan pulley)
3. Idler pulley
4. Groove alignment (second groove of engine drive pulley)
5. Engine drive pulley
6. Straight edge (machinist's ruler)

Figure 3-25 Pulley Alignment, Side View

c. Adjust the fan pulley shaft so that it extends 209 mm (8.23 in.) behind fan tower. See Figure 3-26.



1. Fan shaft pillow block adjusting bolts (qty. 4)
2. Fan shaft pillow block (qty. 2)
   (each pillow block has two set screws located on top)
3. Fan shaft
4. Fan tower

Figure 3-26 Idler Pulley Arm and Pulley Assembly

d. Loosen the four fan shaft pillow block adjusting bolts.

Note: If the fan shaft pillow block is replaced, use GM30510 shims (16 ga.) as needed.

e. Loosen and remove set screws from the fan shaft pillow blocks. See Figure 3-26.

f. Remove thread-locking compound from set screws using solvent (lacquer thinner) or use new set screws.

g. Tighten the fan shaft pillow block adjusting bolts sufficiently to check alignment and prevent unwanted movement.

h. Check that the fan pulley is parallel to the engine drive pulley by measuring the fan pulley distance from an engine machined surface. Rotate the fan pulley 180° and measure again. The two values should not differ by more than 0.4 mm (1/64 in.).

Adjust the fan shaft pillow blocks as needed to meet the specification and to center the fan blades within the radiator shroud opening.

i. Torque the four fan shaft pillow block adjusting bolts to 375 Nm (276 ft. lb.).

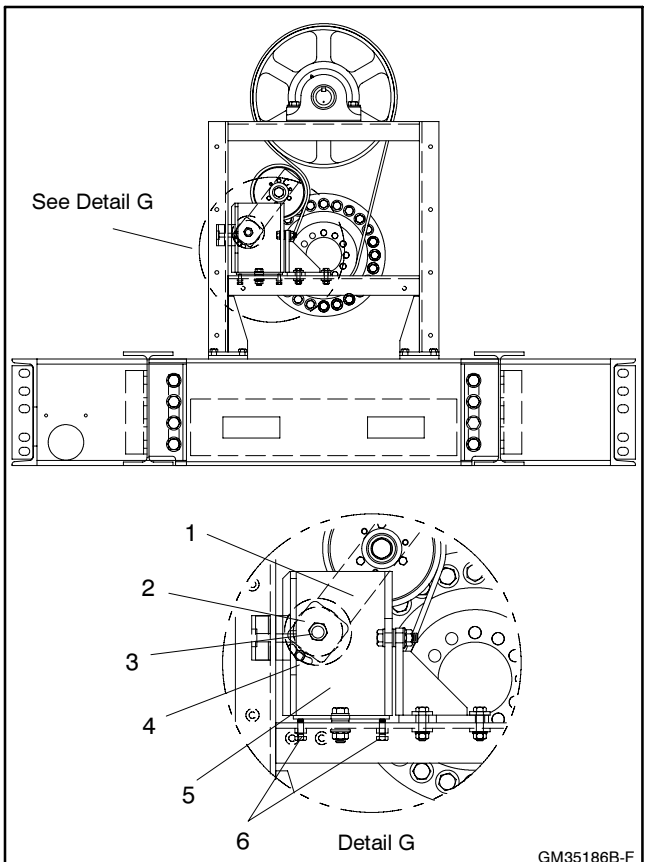
j. With set screws clean and dry, apply PERMA-LOC® MM-115 (blue) or equivalent to the set screws and install in the fan shaft pillow blocks.

k. Torque the set screws to 33 Nm (24 ft. lb.).

4. Adjust the belt tension.

a. Inspect the poly-V belt for damage or wear. Replace the poly-V belt if it is damaged or worn.

b. Loosen the belt tensioner M20 screw and tension adjustment M10 screw/nut to remove the tension on the idler arm if not already done. See Figure 3-27.



1. Idler arm
2. Square body of belt tensioner (use pipe wrench to adjust tension)
3. Belt tensioner M20 screw
4. Tension adjustment M10 screw/nut (tighten to lock tension)
5. Idler arm mounting bracket
6. Mounting bracket positioning screws/nuts (user-supplied)

Figure 3-27 Belt Tension Adjustment

c. Install the poly-V belt. Align the poly-V belt with the second groove on the engine drive pulley and the first groove on the fan pulley from the fan side. See Figure 3-25.

d. Center the idler pulley on the poly-V belt so the poly-V belt is approximately vertical.

e. Set the belt tension by placing a long-handled (24 in. min.) pipe wrench on the square body of the belt tensioner and turning inward toward the center of the drive and fan pulleys.

Note: It is recommended that the adjustment procedure have two technicians present; one to set the belt tension and one to check the belt tension and then tighten the screws.

f. Check the fan belt tension using a poly-V (serpentine) belt tension gauge. See Figure 3-28 for belt tension specifications.

g. Tighten the tension adjustment M10 screw/nut.

h. Tighten the belt tensioner M20 screw.

Generator Set Model	New Belt, N (lbf.)	Used Belt*, N (lbf.)
1350-2800 kW	1334 ±111 (300 ±25)	1112 ±111 (250 ±25)
* A belt is considered used after 50 hours of service.		

Figure 3-28 Poly-V Belt Tension Specifications

i. Verify that the fan belt is seated in the second groove on the engine drive pulley and the first groove on the fan pulley from the fan side.

j. Recheck the fan belt tension using a poly-V (serpentine) belt tension gauge. See Figure 3-28 for belt tension specifications.

If the belt tension is correct, go to step 4.k.

If the belt tension is incorrect, go back to step 4.e.

k. Final tighten the tension adjustment M10 screw/nut to lock the belt tension.

l. Torque the belt tensioner M20 screw to 410 Nm (302 ft. lb.).

m. Remove the user-supplied positioning screws and nuts installed in the bottom of the mounting bracket. See Figure 3-27.

n. Reinstall the belt guards using the original hardware.

5. Restore the generator set to service.

a. Reconnect the generator set engine starting battery(ies), negative (-) lead last.

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

c. Listen for a squeaking or squealing noise from the fan belt, which indicates a slipping belt. Stop the generator set.

If the fan belt slips, disconnect the engine starting battery(ies). Increase the belt tension to eliminate slippage using the procedure starting with step 4.e.

d. Reconnect the power to the battery charger and block heater, if equipped.

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
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. lb.	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. 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)
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.

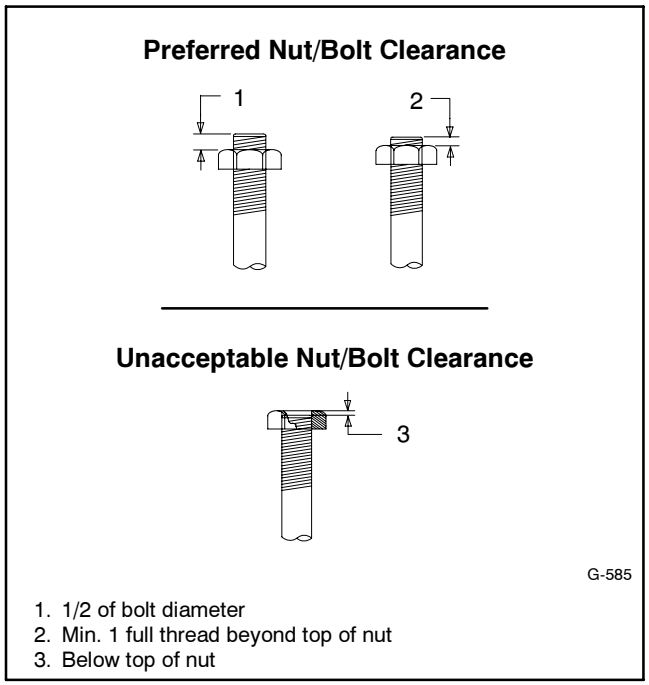


Figure 1 Acceptable Bolt Lengths

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.

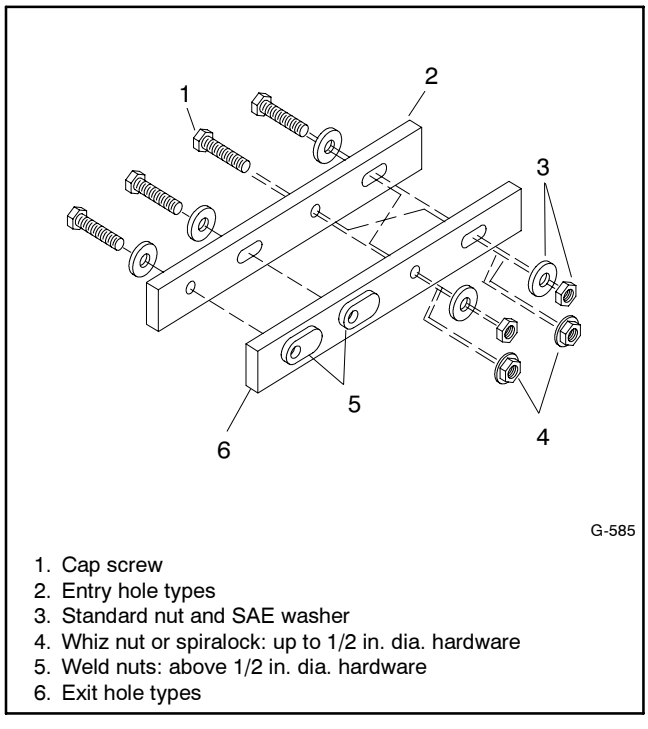


Figure 2 Acceptable Hardware Combinations

Appendix C General Torque Specifications

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)	

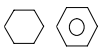
Notes:

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.

Appendix D Common Hardware Identification

Screw/Bolts/Studs	
Head Styles	
Hex Head or Machine Head	
Hex Head or Machine Head with Washer	
Flat Head (FHM)	
Round Head (RHM)	
Pan Head	
Hex Socket Head Cap or Allen™ Head Cap	
Hex Socket Head or Allen™ Head Shoulder Bolt	
Sheet Metal Screw	
Stud	
Drive Styles	
Hex	
Hex and Slotted	
Phillips®	
Slotted	
Hex Socket	

Nuts	
Nut Styles	
Hex Head	
Lock or Elastic	
Square	
Cap or Acorn	
Wing	
Washers	
Washer Styles	
Plain	
Split Lock or Spring	
Spring or Wave	
External Tooth Lock	
Internal Tooth Lock	
Internal-External Tooth Lock	

Hardness Grades	
American Standard	
Grade 2	
Grade 5	
Grade 8	
Grade 8/9 (Hex Socket Head)	
Metric	
Number stamped on hardware; 5.8 shown	

Allen™ head screw is a trademark of Holo-Krome Co.

Phillips® screw is a registered trademark of Phillips Screw Company.

Sample Dimensions

American Standard (Screws, Bolts, Studs, and Nuts)

1/4-20 x 1

- Length In Inches (Screws and Bolts)
- Threads Per Inch
- Major Thread Diameter In Fractional Inches Or Screw Number Size

Metric (Screws, Bolts, Studs, and Nuts)

M8-1.25 x 20

- Length In Millimeters (Screws and Bolts)
- Distance Between Threads In Millimeters
- Major Thread Diameter In Millimeters

Plain Washers

9/32 x 5/8 x 1/16

- Thickness
- External Dimension
- Internal Dimension

Lock Washers

5/8

- Internal Dimension

Notes

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