KOHLER. Power Systems **SB-675 5/17c**

SERVICE BULETIN

Original Issue Date: **9/07**
Model: **10-150 kW (GM 1.6, 3.0, 4.3, 5.0, 5.7, 8.1 L Engines)**
Market: **Industrial, Residential/Commercial, and Mobile**
Subject: **Fuel Mixture Adjustment Service Kit GM58035**

1 Introduction

This bulletin details NG and LP fuel mixture adjustment for General Motors 1.6 - 8.1 L engine-powered generator sets. The fuel mixture must be verified during the commissioning startup or when troubleshooting these units. Units built prior to 2010 require fuel mixture adjustment. Since 2010, fuel systems on these units have migrated to electronic fuel systems that do not require fuel mixture adjustment. Use the unit specification number to verify the build date. Figure 1 lists specification numbers for generator sets and engine models.

Model	Engine	Spec. No.
10 kW	1.6 L	GM39948-GA23
13 kW	1.6 L	GM39948-GA25
15 kW	1.6 L	GM32850-GA1, 3, 5
		GM39949-GA1, 3, 5, 7, 9, 11, 13, 15, 20, 21, SA-1, 4
25 kW	3.0 L	GM22316-GA5, 7, 9
30 kW	1.6 L	GM32850-GA2, 4, 6
		GM39949-GA2, 4, 6, 8, 10, 12, 14, 16, 17, 18, 19, 22, 23, 24, SA-2, 3, 5
	4.3 L	GM22383-GA1, 7, 10
		GM39370-GA1, 7, 10, 13, 14*
		GM60227-GA1, 2, 7, 10
	3.0 L	GM22316-GA1, 4, 8, 10
35 kW	4.3 L	GM32950-GA2, 4, 6
		GM39370-GA2, 8, 11, 15, 16*
		GM60227-GA3, 4, 8, 11
45 kW	4.3 L	GM22383-GA3, 9, 12
		GM39370-GA3, 9, 12, 17, 18*
		GM60227-GA5, 6, 9, 12
50 kW	5.7 L	GM13686-GA1, 3, 5, 7
	5.0 L	GM21302-GA1, 5, 7
		GM39374-GA1, 5, 7*
		GM60230-GA1, 2, 5, 9
60 kW	5.7 L	GM21302-GA2, 6, 8
		GM39374-GA2, 6, 8*
		GM60230-GA3, 4, 6, 10
80 kW	8.1 L	GM22407-GA1, 2, 3, 4
		GM34436-GA1, 2, 3, 4, 13
100 kW	8.1 L	GM22407-GA5, 6, 7, 8
		GM34436-GA5, 6, 7, 8, 9, 10, 11, 12, 14
125 kW	8.1 L	GM20568-GA1, 2
		GM25339-GA1, 2, 3, 4
		GM34464-GA1, 2, 3, 4, 5, 6, 7, 8, 9
150 kW	8.1 L	GM49978-GA1, 2, 3, 4
* L-series throttle body models		

Figure 1 Specification Numbers

Routing	Service Manager	Sales Manager	Parts Manager	Technician No. 1	Technician No. 2	Technician No. 3	Return This to
Initial Here							

Figure 2 provides the differences in engine components and the optimum air/fuel mixture measured with an oxygen sensor in volts.

kW	Engine	Fuel Mixer Type	Electronic Control Unit (ECU) Type	Air/Fuel Mixture in λ
10/13/15/30	1.6 L	Woodward	E-Controls	0.95-1.02
25/30	3.0 L	Nolff/Impco	E-Controls	0.94-0.98
30-45	4.3 L	Woodward	PSI/ E-Controls	0.99-1.01
50/60	5.0, 5.7 L	Woodward	PSI/ E-Controls	0.91-0.95
80/100	8.1 L	Nolff/Impco	E-Controls	0.94-0.98
125/150	8.1 L Turbo (Single Fuel)	Nolff/Impco	E-Controls	0.94-0.98
125	8.1 L Turbo (Dual Fuel)	Nolff/Impco	E-Controls	0.94-1.00

Figure 2 Engine Components and Optimum Air/Fuel Mixture Values

Use the following procedure to field-adjust fuel mixture on generator sets that are not California Air Resources Board (CARB) or United States Environmental Protection Agency (EPA) certified. Correct fuel metering valve adjustment provides both reliable cold starting and overall generator set performance.

The adjustment procedure requires:

- Engine oxygen sensor service kit GM58035 that contains:
  - Oxygen Sensor (UEGO - Universal Exhaust Gas Oxygen Sensor) GM49621
  - Digital Air/Fuel Ratio Meter (LM-2)
  - 12V accessory adapter (cigarette lighter) power plug harness (Customer will need to provide automotive-type power adapter to this harness. Supplier discontinued automotive-type power adapter connection)

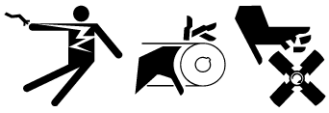
    Note: The engine starting battery is used to power the Engine Oxygen Sensor Service Kit.

  - CD (Instructions and Software)

    Note: For troubleshooting and additional items listed, see the LM-2 instruction manual included on the kit CD.
- Load bank capable of rated kW for the fuel being used.
- Manometer with range of 0-15 inches of water.
- Laptop computer with CD drive.
- For 125 kW with dual fuel model only, E-Controls interface kit GM42033 and engine control module (ECM) service manual TP-6724.

2 Safety Precautions

Observe the following safety precautions while installing the kit

⚠ 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 equipment connected to the set, 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.

DANGER	Hazardous voltage. Moving parts. **Will cause severe injury or death.** Operate the generator set only when all guards and electrical enclosures are in place.

Servicing the generator set when it is operating. Exposed moving parts will 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.

Read the entire installation procedure before adjusting the fuel mixture. Perform the steps in the order shown.

3 Installation Procedure

Note: Read all safety precautions at the beginning of this publication before performing any work on the generator set.

3.1 Remove the Generator Set from Service

1. Place the generator set master switch in the OFF position.
2. Disconnect power to the battery charger, if equipped.
3. Disconnect the generator set engine starting battery, negative (–) lead first.

3.2 Install the Manometer

1. Remove the 1/8” NPT pipe plug from the solenoid fuel valve located at the generator set fuel inlet connection. See Figure 3.
2. Connect the manometer to the solenoid fuel valve port.

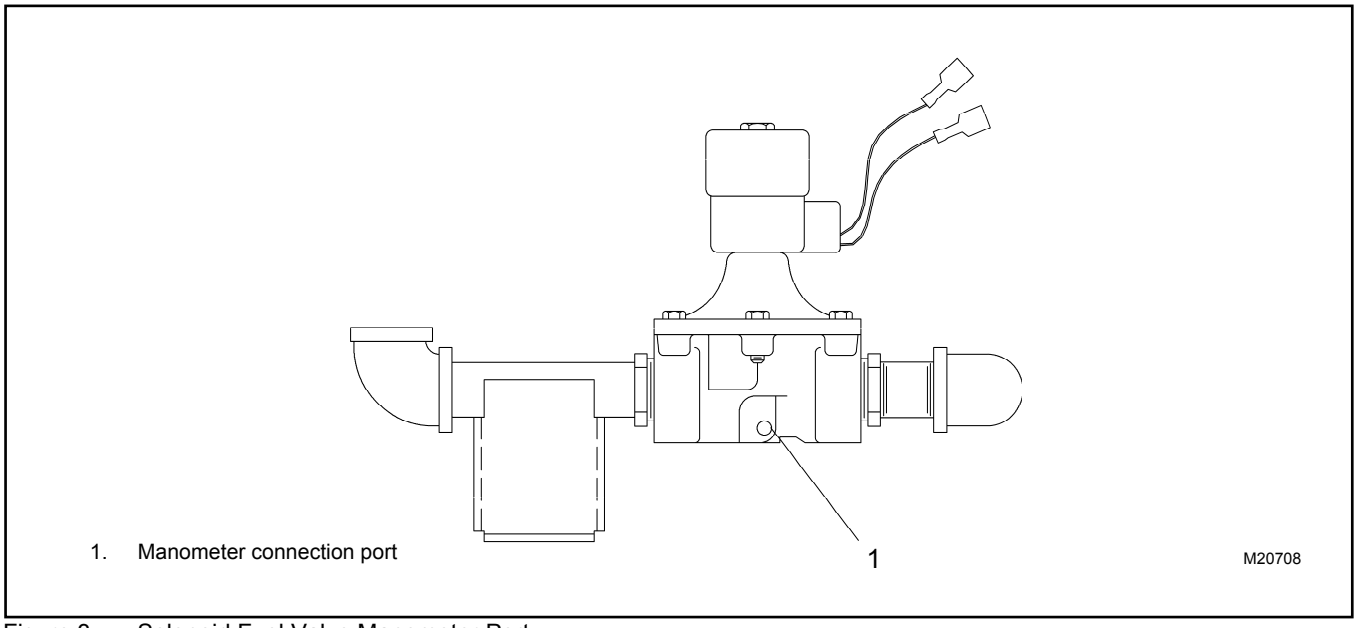


Figure 3 Solenoid Fuel Valve Manometer Port

3.3 Oxygen Sensor Calibration

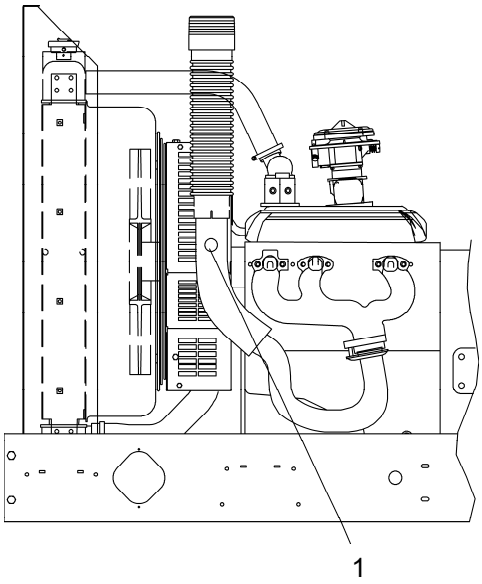
Note: The calibration procedure requires that the oxygen sensor be in free air (removed from the exhaust system completely).

Perform this step when using the kit for the first time that day or after an extended time of non-use during the day.

1. With the Digital Air/Fuel Ratio Meter powered off, connect the oxygen sensor to the sensor cable and the other end to the sensor input on the Digital Air/Fuel Ratio Meter.
2. Connect the Digital Air/Fuel Ratio Meter to the cigarette power plug with a customer provided cigarette power adapter.
3. Also, reference LM-2 User Manual on the included CD or manufacturer’s website, www.tuneyourengine.com

3.4 Install the Oxygen Sensor and Interface Harness

1. Remove the oxygen sensor pipe plug from the exhaust pipe. See Figure 4 or Figure 5 for the location.



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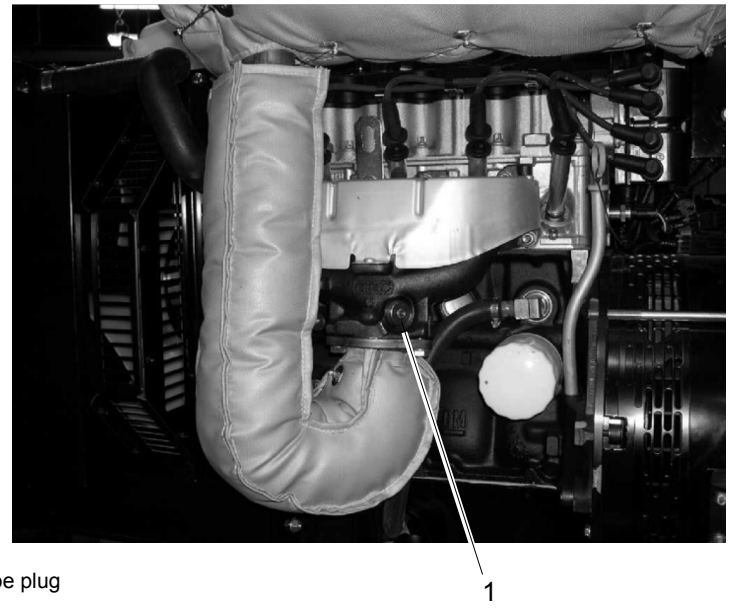
1. Exhaust tube pipe plug

Figure 4 Oxygen Sensor Mounting Location, Typical (30 kW model shown)



1. Exhaust manifold pipe plug

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Figure 5 Oxygen Sensor Mounting Location, 15/30 kW with GM1.6 L Engine

2. Install the oxygen sensor in the exhaust tube where the plug was removed.
3. Connect the power supply harness and oxygen sensor to the Digital Air/Fuel Ratio Meter.

   Note: Ensure that the oxygen sensor is only powered when the engine is in operation. An un-powered oxygen sensor will be damaged in a short period of time when exposed to exhaust gas.

4. Do not pre-warm the oxygen sensor before starting the engine; simply start the engine as normal. Allowing the oxygen sensor to pre-warm before starting the engine will increase the possibility of damaging the oxygen sensor from shock cooling.

   Note: Exhaust leaks will cause false lean readings at light engine loads. Typically, once the engine is under load and the exhaust gas volume increases, oxygen sensor readings are more accurate.

3.5 Adjust the Fuel Mixture

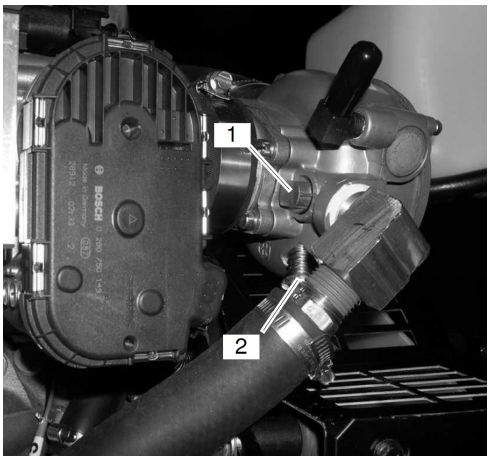
Choose the procedure based on the type of fuel mixer on the generator set. See Figure 6.

kW	Engine/Fuel Mixer	Go to
10/13/15/30	1.6 L	3.5.1
30-60	Woodward Venturi style	3.5.2
30-80	Nolff and early Woodward style	3.5.3
100/125	Nolff style (single fuel)	3.5.4
125	Nolff style (dual fuel)	3.5.5

Figure 6 Fuel Mixture Sections

3.5.1 10/13ERG and 15/30RES Generator Sets with GM 1.6 L engine

10/13ERG and 15/30RES generator sets with GM 1.6 L engine. See Figure 7.



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

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Figure 7 Fuel Mixture Adjustment Screw Location

1. Reconnect the generator set engine starting battery and place the controller master switch in the RUN position to start generator set.
2. Allow the generator set to run until the generator set reaches normal operating temperature. The time required to reach normal operating temperature depends primarily on the ambient temperature and the size of the engine.
3. With the generator set at normal operating temperature, apply 90%–100% of rated load. If a load bank is not available, apply a load at least comparable to what is generally connected to the generator set.
4. Verify that the fuel pressure is within 7-11 inches of water at full load. Adjust the primary fuel regulator as necessary to achieve the fuel pressure of 7-11 inches of water as measured at the inlet side of the generator set fuel solenoid valve.
5. Adjust the fuel mixture adjustment screw (on the mixer, see Figure 7) to obtain a full load oxygen sensor reading in the range specified in Figure 2.

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

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

6. Disconnect the load.
7. Adjust the idle screw (see Figure 7) to obtain a no-load oxygen sensor reading in the range specified in Figure 2.
8. Repeat steps 3 through 6 to verify the settings.
9. Remove the load and allow the generator set to run unloaded to cool for at least 5–10 minutes.
10. Place the generator set master switch in the OFF position to stop generator set.

3.5.2 For 30-60 kW generator sets

Venturi style fuel mixer used with an integrated throttle body governor on 4.3 L, 5.0 L, and 5.7 L GM engines. Also similar to the IMPCO model 100 used on the 30 kW with 3.0 L GM engine. See Figure 8.

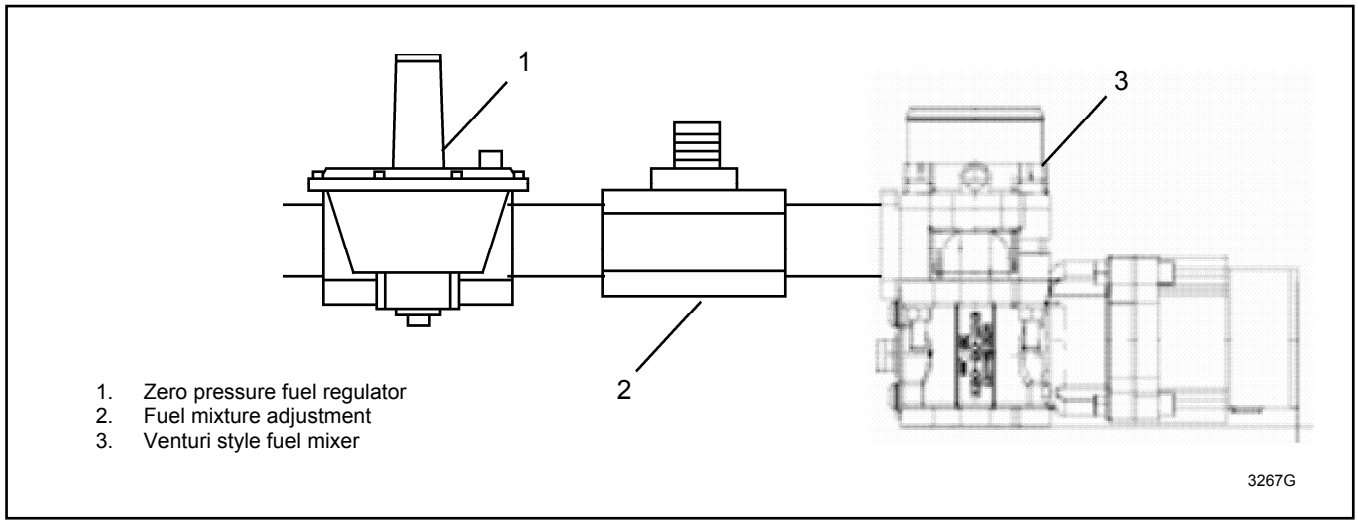


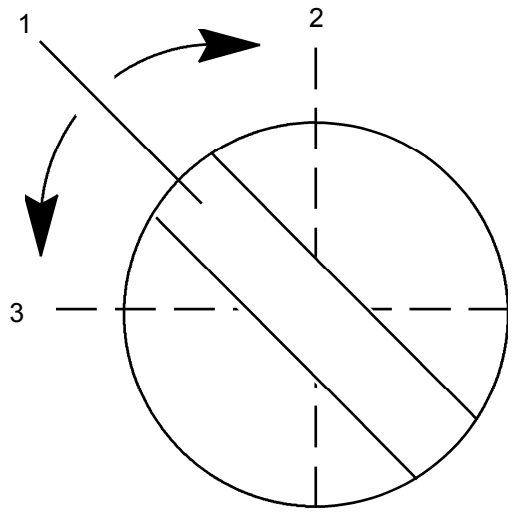
Figure 8 30-60 kW with Venturi Style Fuel Mixer

Note: The pressure regulator should be set to between 12 and 14mm (1/2" to 5/8"). The zero pressure regulator settings are measured from the top of the spring adjustment screw to the top of the spring tower. Every venturi is factory flowed and the load adjustment valve set. There should be no need to adjust the load valve before startup. These initial settings should get the engine up and running for final adjustment with an oxygen sensor or exhaust analyzer. Before starting the engine, ensure that the inlet side of the pressure regulator has between 7 and 11 inches of water column fuel pressure.

1. Reconnect the generator set engine starting battery and place the generator set master switch in the RUN position to start the unit using factory setting or by making minor adjustment to pressure regulator.
2. Once unit is running set distributor using an adjustable timing light. The distributor must be set before continuing the fuel system setup. Using an adjustable timing light set the timing between 30 and 32 degrees before top dead center (BTDC) for NG and between 26 and 28 degrees BTDC for LP. Reference timing specs in Engine Operation Manual TP-6101.
3. Allow the generator set to run until the generator set reaches normal operating temperature.
4. Apply 90%–100% of full rated load.
5. Connect the oxygen sensor to the Digital Air/Fuel Ratio Meter.

   Note: Ensure that the oxygen sensor is only powered when the engine is in operation. An un-powered oxygen sensor will be damaged in a short period of time when exposed to exhaust gas.

6. If no load point is between phi (1.00-1.071) or lambda (1.00-.933). Run engine at no load until warm.
7. Raise engine load to 100%. Adjust load adjust valve to achieve phi (1.00-1.071) or lambda (1.00-.933) on the Digital Air/Fuel Ratio meter. Turning the load adjust valve clockwise will cause the mixture to become rich and counterclockwise to become more lean.
8. Return engine to no load. Adjust the pressure regulator to achieve phi (1.00-1.071) or lambda (1.00-.933). Clockwise rotation of the adjustment screw causes the mixture to become richer. Make sure the adjustment tower cap is reinstalled prior to final reading.
9. Raise engine load again to 100%. Re-verify Digital Air/Fuel Ratio meter to be between phi (1.00-1.071) or lambda (1.00-.933). Re-adjust load adjust valve as necessary. Return to no load and re-verify the Digital Air/Fuel Ratio meter.
10. Repeat steps 7–9 until fuel setting are between phi (1.00-1.071) or lambda (1.00-.933). See Figure 8and Figure 9 to obtain a full-load oxygen sensor reading in the range specified in Figure 2. Adjust the zero pressure regulator (see Figure 8 and Figure 10) to obtain a no-load oxygen sensor reading in the range specified in Figure 2.



1. Fuel adjusting screw
2. Lean
3. Rich

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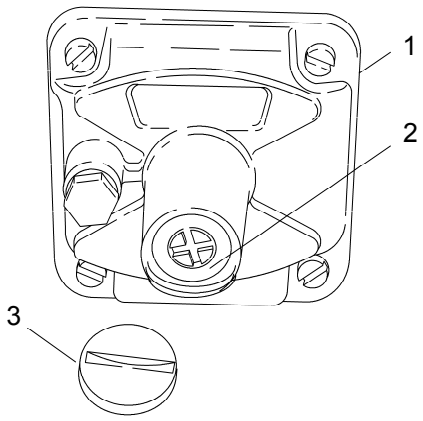
Figure 9 Fuel Mixture Adjustment, Typical



1. Fuel Regulator
2. Adjustment screw
3. Cover plug

TP-5750-3

Figure 10 Fuel Regulator, Typical

11. Disconnect the load.
12. Remove the load and allow the generator set to run unloaded to cool for at least 5–10 minutes.
13. Place the generator set master switch in the OFF position to stop generator set.

3.5.3 For 30-80 kW generator sets

Nolff NCA-225M and NCA-125M style fuel mixers used on early versions of 30-60 kW 4.3 L and 5.7 L GM engines, 30-60 kW LP liquid withdrawal systems, and 80 kW 8.1 L GM engines. See Figure 11.

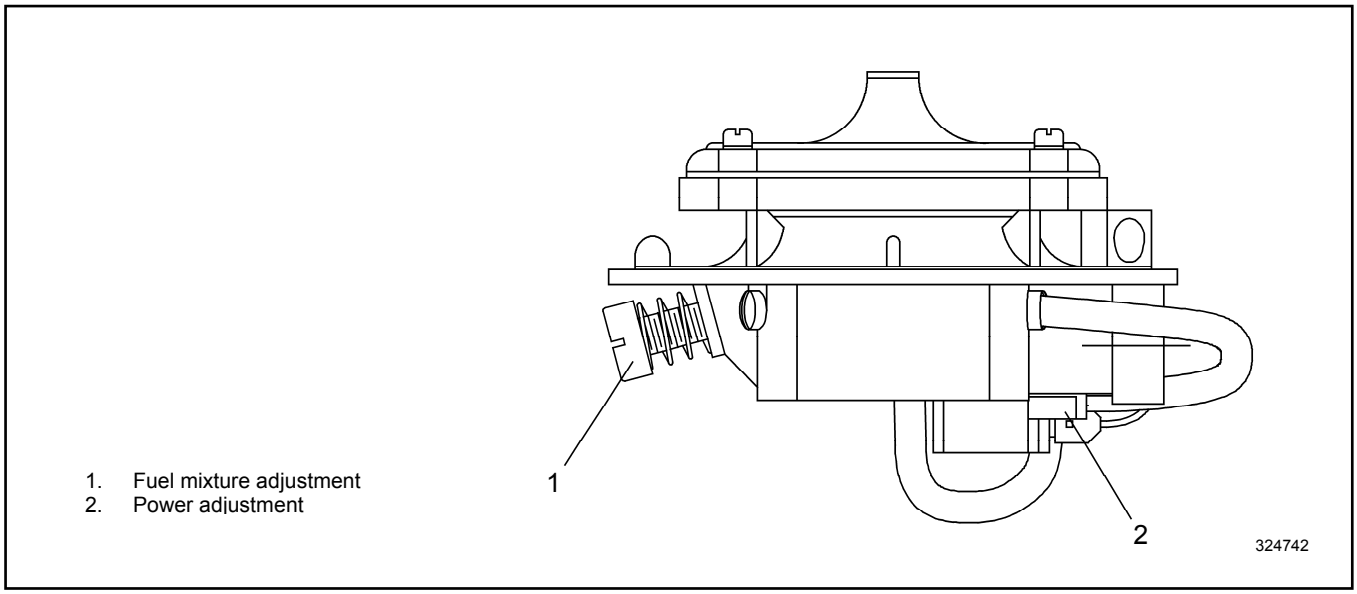


Figure 11 30-80 kW with Nolff NCA-225M and NCA-125M Style Fuel Mixers

1. Adjust the fuel regulator adjustment screw to the approximate midpoint of its adjustment range. See Figure 10.
2. Reconnect the generator set engine starting battery and place the generator set master switch in the RUN position to start generator set.

   Note: If the generator set fails to start, turn the fuel regulator adjustment screw slightly in or out while the engine cranks.

3. Allow the generator set to run until the generator set reaches normal operating temperature.
4. Apply 90%-100% of full rated load.
5. Adjust the fuel mixture adjustment (Figure 11) to obtain a full-load oxygen sensor reading in the range specified in Figure 2.

   Note: If the oxygen sensor reading is too high with the fuel mixture adjustment in the richest position (turned in clockwise), turn fuel regulator adjustment screw clockwise to richen the fuel mixture. Readjust the fuel mixture adjustment as needed to obtain an oxygen sensor reading within specifications.

   Note: If the oxygen sensor reading is too low with the fuel mixture adjustment in the leanest position (turned out counterclockwise), turn fuel regulator adjustment screw counterclockwise to lean the fuel mixture. Readjust the fuel mixture adjustment as needed to obtain an oxygen sensor reading within specifications.

6. Disconnect the load.
7. Adjust the fuel mixture adjustment to obtain a no-load oxygen sensor reading within the specifications shown in Figure 2.

   Note: If the oxygen sensor specification cannot be met at no-load, turn the idle mixture screw in to the richest possible setting.

8. Repeat steps 4 through 7 to verify the settings.
9. Remove the load and allow the generator set to run unloaded to cool for at least 5–10 minutes.
10. Place the generator set master switch in the OFF position to stop generator set.

3.5.4 For 100-125 kW generator sets

Nolff N16-475-5A and N16-475-9A style fuel mixers used on 100 kW 8.1 L GM and 125 kW 8.1 L GM turbocharged engines. See Figure 12. This fuel mixer style does not have a fuel mixture adjustment.

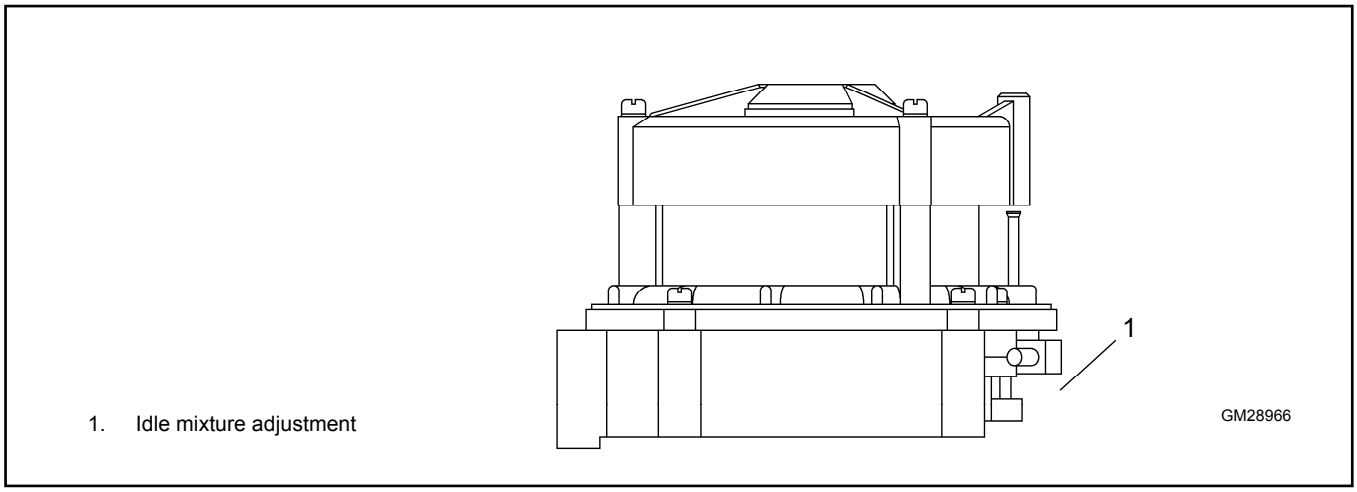


Figure 12 100/125 kW with Nolff 475 Style Fuel Mixer

1. Adjust the fuel regulator adjustment screw to the approximate midpoint of its adjustment range. See Figure 10.
2. Reconnect the generator set engine starting battery and place the generator set master switch in the RUN position to start the generator set.
3. Allow the generator set to run until the generator set reaches normal operating temperature.
4. Apply 90%–100% of full rated load.
5. Adjust the fuel regulator adjustment screw to obtain a full-load oxygen sensor reading in the range specified in Figure 2.
6. Disconnect the load.
7. Adjust the idle mixture adjustment (Figure 12) to obtain a no-load oxygen sensor reading within specifications.

   Note: If the oxygen sensor specification cannot be met at no-load, turn the idle mixture screw out to the richest possible setting (2-2.5 turns).

8. Repeat steps 4 through 7 to verify the settings.
9. Remove the load and allow the generator set to run unloaded to cool for at least 5–10 minutes.
10. Place the generator set master switch in the OFF position to stop generator set.

3.5.5 For 125 kW (dual fuel) generator sets

Dual fuel units have a closed loop fuel control system that will automatically make adjustments in order to maintain a fuel/air mixture reading of approximately λ = 1.0 using the UEGO oxygen sensor.

1. Connect a laptop computer with ECM monitoring software (PSI Display). Reference SB-750 and TP-6724 for instructions on how to use the software.
2. Adjust the fuel regulator adjustment screw to the approximate midpoint of its adjustment range. See Figure 10.
3. Reconnect the generator set engine starting battery and place the generator set master switch in the RUN position to start the generator set.
4. Allow the generator set to run until the generator set reaches normal operating temperature.
5. Apply 90%–100% of full rated load.
6. On the laptop computer with PSI Display, go to the Faults page and locate the Primary Trim Valve (FTV) parameter shown in the middle of the page to the right. Adjust the fuel regulator adjustment screw until the FTV indicates between 30% and 60%.
7. Disconnect the load.
8. Adjust the idle mixture adjustment (Figure 12) to obtain a no-load oxygen sensor reading within specifications. See Figure 2.

   Note: If the oxygen sensor specification cannot be met at no-load, turn the idle mixture screw out to the richest possible setting (2-2.5 turns).

9. Repeat steps 5 through 8 to verify the settings.
10. Remove the load and allow the generator set to run unloaded to cool for at least 5–10 minutes.
11. Place the generator set master switch in the OFF position to stop generator set.

4 Stop the Generator Set

1. Place the generator set master switch in the OFF position, if not already done.
2. Disconnect the generator set engine starting battery(ies), negative (–) lead first.

5 Remove the Oxygen Sensor and Interface Harness

1. Allow the generator set exhaust system to cool.
2. Disconnect the generator set engine starting battery.
3. Disconnect the interface harness from the oxygen sensor.
4. Remove the oxygen sensor from the exhaust tube.
5. Apply a small amount of antiseize compound to the pipe plug and reinstall the pipe plug into the exhaust tube.
6. Remove the manometer hose fitting from the solenoid fuel valve.
7. Apply a small amount of antiseize compound to the pipe plug and reinstall the pipe plug into the solenoid fuel valve.

6 Restore the Generator Set to Service

1. Check that the generator set master switch is in the OFF position.
2. Reconnect the generator set engine starting battery, negative (–) lead last.
3. Reconnect the power to the battery charger, if equipped.

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