

Special Instruction

i03617941

Installation and Initial Start-Up Procedure for G3516B A3 Engines

SMCS Code: 1000

Engine
G3516B (S/N: JEF1-Up)

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- Required information
- Requirements for the electrical system
- Grounding practices
- Proper welding practices
- Service tools
- Wiring connections
- Initial start-up procedures
- Governor adjustment procedures

Reference: The following information is required in order to perform the installation and initial start-up:

- Complete analysis of the fuel
- Data from a complete fuel analysis that is entered into Caterpillar Software, LEKQ6378, "Methane Number Program"
- The engines performance data sheet from the engines Technical Marketing Information (TMI)
- Engine Operation and Maintenance Manual, SEBU8099
- Systems Operation/Testing and Adjusting, RENR9352
- Troubleshooting Manual, RENR9353
- Service Manual, RENR4911, "Exhaust Temperature Scanner"

Introduction

Do not perform any procedure in this Special Instruction until you read this information and you understand this information.

This Special Instruction provides the following information for G3516B A3 Engines:

Required Information

Ignition Timing

A complete fuel analysis must be conducted prior to putting the engine into service. Obtain a fuel analysis in order to determine the fuel energy content and calculate the methane number. The methane number indicates the ability of the fuel to be ignited. The methane number is determined when you input the data from the fuel analysis into the Methane Number Program, LEKQ6378. Use the methane number and the Engine Performance, "Fuel Usage Guide" in order to determine the ignition timing.

Obtain several samples of fuel if the quality is expected to change. If the methane number will vary during engine operation, use the lowest expected value in order to determine ignition timing.

Maximum Load

Refer to the Data Sheet on the engine performance from the engines Technical Marketing Information (TMI) in order to determine the engine power level for the altitude, the temperature, and the methane number. Use the information in the Engine Performance, LEBQ6117 in order to determine the maximum engine load. The desired engine load must not exceed the maximum engine load.

Inlet Manifold Pressure at Full Load

Use the inlet manifold pressure to estimate the engines load. The inlet manifold pressure may be used if the engine timing and the exhaust NO_x are set properly. Refer to the Data Sheet on the engine performance from the engines TMI in order to determine the inlet manifold pressures for specific settings of timing and of emissions. If the engine power is derated, interpolate the desired inlet manifold pressure between the 100 percent and the 75 percent load ratings.

Level of Exhaust Emissions

The 156-1060 Emissions Analyzer Gp or another emissions analyzer is required to set up a gas engine. The engines performance Data Sheet gives the levels of emissions for engine loads of 50 percent, of 75 percent, and of 100 percent. Set up the engine in accordance with the Data Sheet at the desired full load with the data that was taken at 100 percent load.

Note: Use NO_x levels to set up the engine, when possible.

Gas Pressure Regulator

The gas pressure regulator requires adjustment when the engine is installed. Use only Caterpillar approved regulators in order to avoid problems with performance. A balance line for the regulator is required on all gas engines. This line compensates for changes in boost pressure or in air filter restriction.

Note: The supply line to the gas pressure regulator must be of adequate diameter to provide constant pressure to the regulator from idle to full load. Do not use supply lines that are smaller than the inlet to the pressure regulator.

Requirements for the Electrical System

All of the wiring must conform to the requirements of CSA Class 1 Division 2 Group C,D. The wiring must also conform to all other codes that are applicable to the site.

When you route the wiring, avoid acute bends and sharp edges. To protect the wiring harnesses, route the harnesses through the metal conduit. A liquid tight conduit is recommended. Use proper support and alignment in order to avoid strain on the conduit.

The engine control system requires a clean 24 VDC power supply. The maximum allowable AC ripple voltage is 150 mV AC peak to peak. For the wiring, the maximum allowable voltage drop is 1 VDC from the power supply to the Electronic Control Module (ECM) or to an actuator. The power supply can supply 20 amp of continuous power.

The circuit for the engine control system must be separate from the circuit for the electric starting motor.

Grounding Practices

Proper grounding is necessary for optimum engine performance and reliability. Improper grounding will result in electrical current paths that are uncontrolled and unreliable.

Uncontrolled electrical circuit paths can result in damage to main bearings, to crankshaft bearing journal surfaces, and to aluminum components. Uncontrolled electrical circuit paths can also cause electrical activity that may degrade the engine electronics and communications.

- For the starting motor, do not attach the battery negative terminal to the cylinder block.
- Use an electrical ground strap to connect all metal cases that contain electrical components or electronic components to the cylinder block.

- Do not connect the negative terminal from the electrical power supply directly to the cylinder block. Connect the negative terminal from the electrical power supply to the negative terminal “-” on the interface box.
- Ground the cylinder block with a ground strap that is furnished by the customer. Connect this ground strap to the ground plane.
- Use a separate ground strap to ground the battery negative terminal for the control system to the ground plane or to earth ground.
- Rubber couplings may connect the steel piping of the cooling system and the radiator. This action causes the piping and the radiator to be electrically isolated. Ensure that the piping and the radiator are continuously grounded to the cylinder block. Use ground straps that bypass the rubber couplings.
- Ensure that all grounds are secure and free of corrosion.

Proper Welding Procedures

Proper welding procedures are necessary in order to avoid damage to electronic controls. Perform welding on the engine according to the following procedure.

1. Set the engine control to the “STOP” mode.
2. Turn OFF the fuel supply to the engine.
3. Disconnect the negative terminal from the power supply.
4. Disconnect the following electronic components from the wiring harnesses: ECM, throttle actuator, fuel actuator, and sensors.
5. Protect the wiring harnesses from welding debris and/or from the welding spatter.

NOTICE

Do NOT use electrical components (ECM or ECM sensors) or electronic component grounding points for grounding the welder.

6. Connect the welders ground cable directly to the engine component that will be welded. Place the clamp as close as possible to the weld to reduce the possibility of welding current damage to the engine bearings, electrical components, and to other engine components.
7. Use standard welding procedures to weld the materials together.

Service Tools

The tools that are listed in Table 1 are required in order to perform the electrical installation and the initial start-up.

Table 1

Service Tools		
Pt. No.	Description	Functions
N/A	Personal Computer (PC)	The PC is required for the use of Cat ET.
"JERD2124"	Software	Single user license for Cat ET Use the most recent version of this software.
"JERD2129"	Software	Data subscription for all engines
275 - 5120 ⁽¹⁾	Communication Adapter Gp	This group provides the communication between the PC and the engine.
344 - 2650	Wiring Harness	Wiring harness (turbo speed sensor)
343 - 3320	Speed Sensor	Speed sensor (turbo)
237 - 7547	Adapter Cable As	This cable connects to the USB port on computers that are not equipped with a serial port.
225 - 5985	Parallel Port Cable (COMMUNICATION ADAPTER)	This cable connects to the parallel port on the computer.
8T - 8726	Adapter Cable As	This cable is for use between the jacks and the plugs of the sensors.
121 - 9588	Wire Removal Tool (Blue)	These tools are used for the removal of pins and of sockets from Deutsch connectors and AMP connectors.
151 - 6320	Wire Removal Tool (Red)	
1U - 5805	Wire Removal Tool (Green)	
1U - 5804	Crimp Tool	This tool is used for crimping sockets and pins.
139 - 2788	Ferrule Crimp Tool	This tool is for crimping 24 gauge to 12 gauge wire ends. This tool is for connections to the terminal block and the terminal strip.
139 - 2789	Ferrule Crimp Tool	This tool is for crimping 10 gauge and 6 gauge wire ends. This tool is for terminating the wiring for the battery at the interface box.
146 - 4080	Digital Multimeter	The multimeter is used for the testing and for the adjusting of electronic circuits.
7X - 1710	Multimeter Probes	The probes are used with the multimeter to measure voltage in wiring harnesses without disconnecting the harnesses.

(continued)

(Table 1, contd)

Service Tools		
Pt. No.	Description	Functions
156-1060 or 156-1070	Emission Analyzer Tool	This tool is used to measure the level of emissions in the engines exhaust. The 156-1060 measures the levels of four different compounds. The 156-1070 measures the levels of six different compounds. Either tool may be used.

(1) The 7X-1700 Communication Adapter Gp or the 171-4400 Communication Adapter Gp may also be used.

Connect the Wiring From the Battery

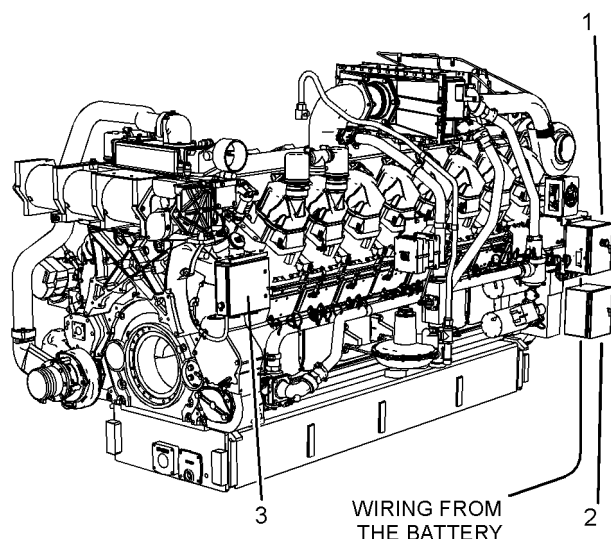


Illustration 1

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Typical view of the engine

- (1) Interface box
- (2) The customer will provide the Canadian Standards Association (CSA) enclosure.
- (3) ECM control box

Requirements for Engines That are Not Equipped With an Alternator

The customer is responsible for providing overcurrent protection for the battery circuit. The battery circuit must be protected by a CSA approved fuse. The maximum allowable rating of the fuse is 20 amp.

Install the fuse in a fuse holder that is CSA approved. Mount the fuse holder in a CSA approved enclosure (2), if necessary. Mount the fuse holder or the enclosure as close as practical to interface box (1).

Requirements for Engines That are Equipped With an Alternator

The customer is responsible for providing overcurrent protection for the charging circuit. The charging circuit includes the wiring from the battery and the wiring from the alternator. This wiring is connected at terminal 12 inside interface box (1). The circuit must be protected by a CSA approved fuse. The maximum allowable rating of the fuse is 60 amp. This rating limits the charging current between the alternator and the battery. The gauge of the wiring from the battery may require a fuse rating that is lower than 60 amp.

Install the fuse in a fuse holder that is CSA approved. Mount the fuse holder in a CSA approved enclosure (2), if necessary. Mount the fuse holder or the enclosure as close as practical to interface box (1).

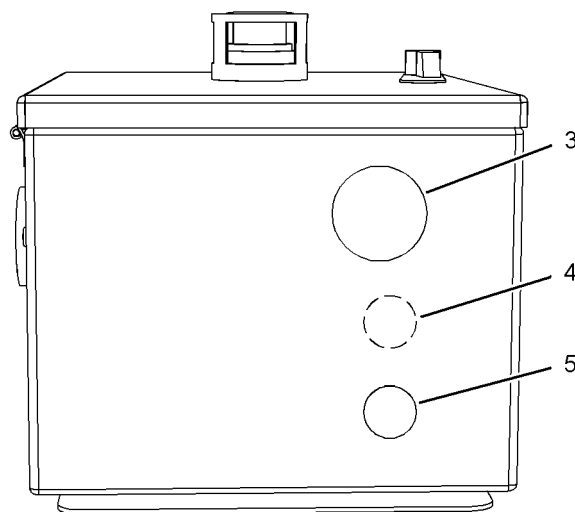


Illustration 2

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Bottom view of the interface box

- (3) 50 mm (1.9685 inch) hole
- (4) 28 mm (1.1024 inch) hole
- (5) 28 mm (1.1024 inch) hole

Refer to Illustration 2. The bottom of the interface box has two holes (3) and (5) when the engine is shipped from the factory. Fabricate hole (4) if the engine is equipped with an alternator. Refer to Table 2.

Table 2

Holes in the Bottom of the Interface Box		
Hole	Size	Purpose
(3)	50 mm (1.9685 inch)	Wiring from the driven equipment
(4)	28 mm (1.1024 inch)	Wiring from the battery when the engine is equipped with an alternator.
(5)	28 mm (1.1024 inch)	Wiring from the alternator when the engine is equipped with an alternator Route the wiring from the battery through this hole when the engine is not equipped with an alternator.

Perform the following procedure to make the connections from the battery.

1. Verify that the wiring from the battery is de-energized.

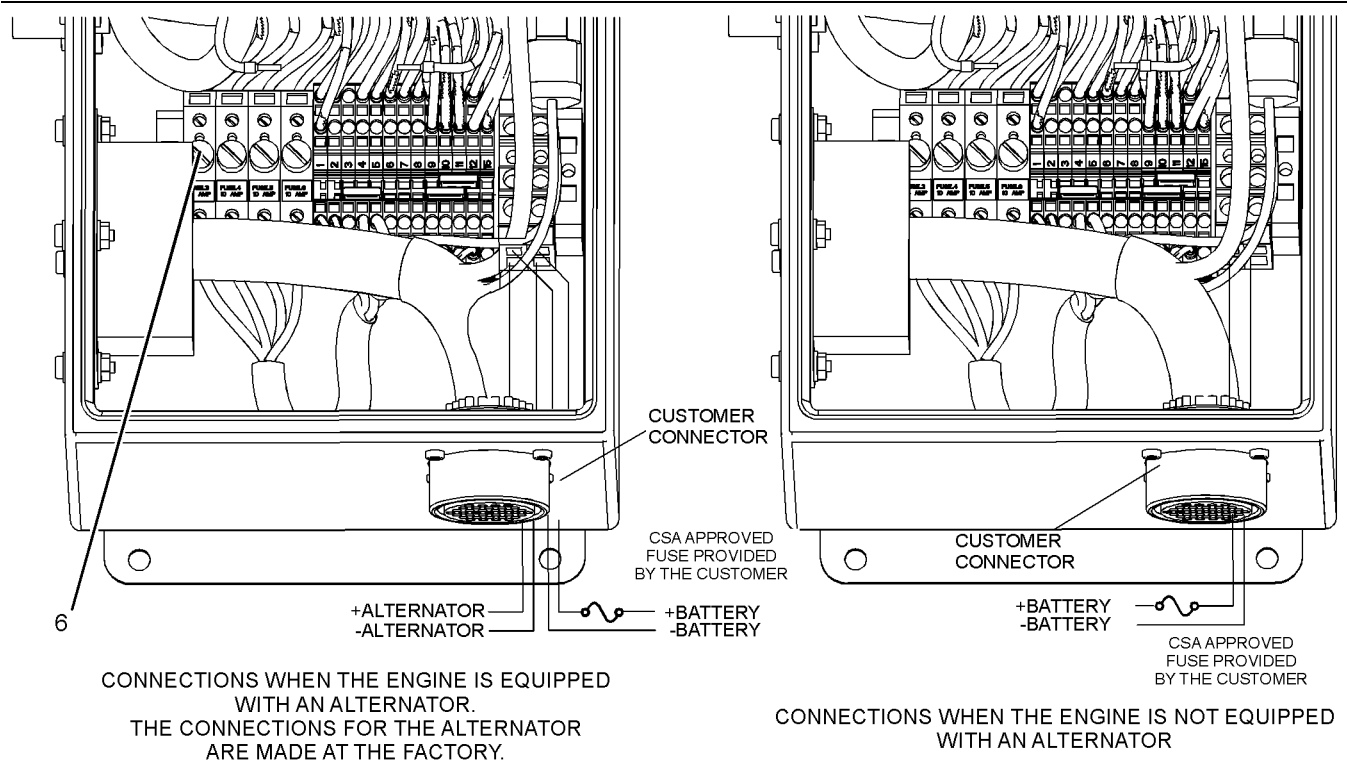


Illustration 3
Connections for the battery
(6) Main fuse

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2. Remove main fuse (6).

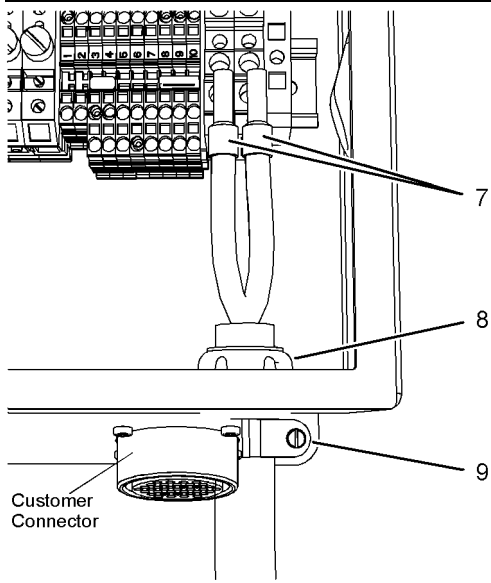


Illustration 4

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Hardware for connecting the wiring from the battery

(7) 119-8044 Wire Ends (6 Gauge)

(8) 4P-4891 Terminal Bushing

(9) 273-3127 Connector

3. Use connector (9) and terminal bushing (8) to attach the wiring from the battery to the interface box.
4. Use a 139-2789 Ferrule Crimp Tool to crimp a wire end (7) to the end of each wire.
5. Connect wire ends (7) to the appropriate locations. Be sure to observe the polarity of the connections.
6. Connect the wiring to the battery.

Note: Do not install main fuse (6) until all of the wiring from the driven equipment is connected to the engine.

Connect the Wiring From the Driven Equipment

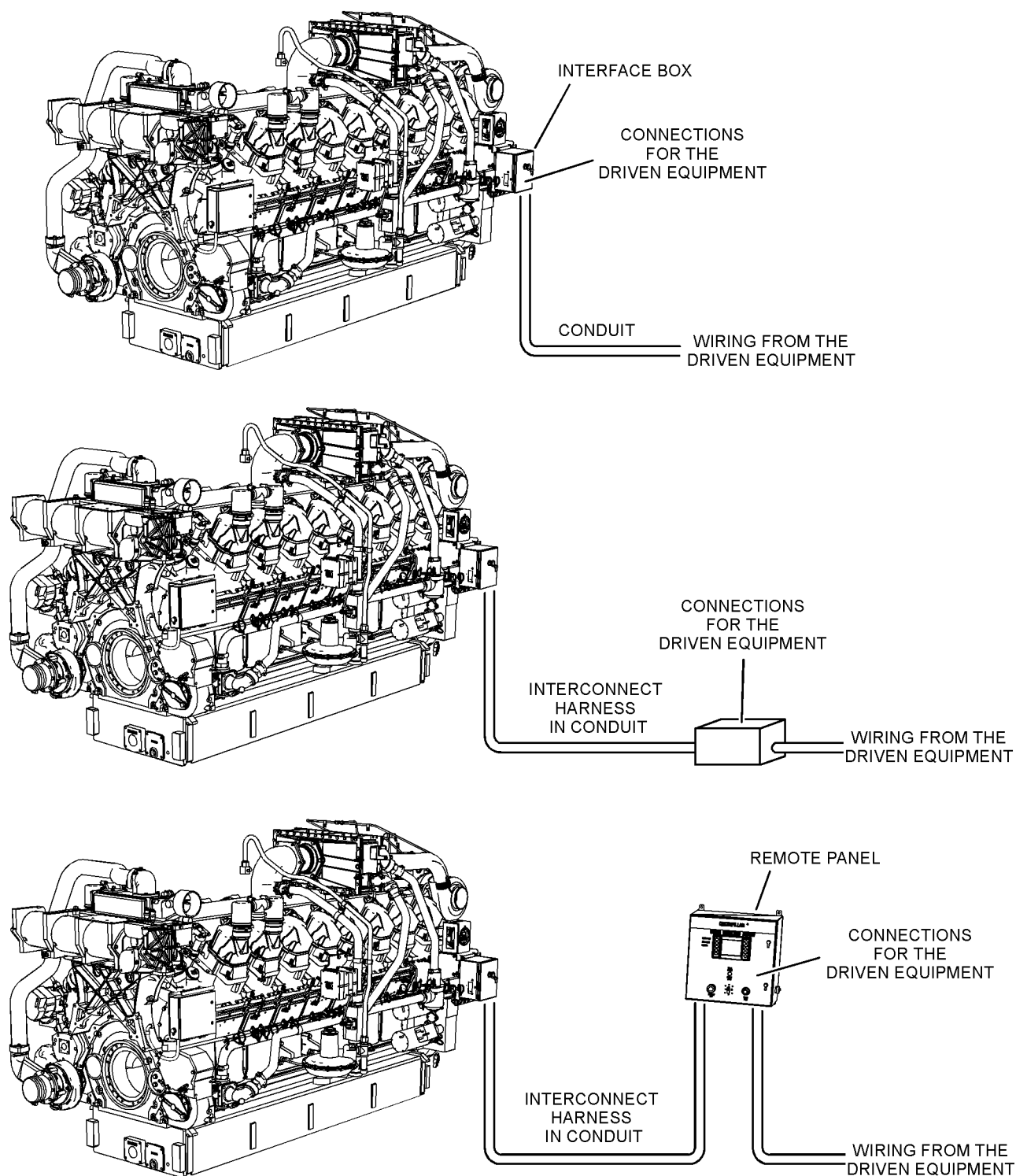


Illustration 5
Typical installations

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Refer to Illustration 5. Make the electrical connections for the driven equipment at one of the following locations:

Interface Box – All of the electrical connections for the driven equipment are made inside the interface box.

Interconnect Harness – The interconnect harness is connected to the interface box. All of the electrical connections for the driven equipment are made to the end of the interconnect harness.

Remote Panel – A remote panel is connected to the interface box via an interconnect harness. All of the electrical connections for the driven equipment are made at a terminal strip inside the remote panel.

Table 3 lists the connections that are available at each of the locations. Review the Table before making the connections.

Table 3

Connections for the Driven Equipment				
Description	Interface Box	Interconnect Harness (Wire Identification)	Remote Panel (Terminal strip)	Function and Comments
Prelube ON	Terminal 1 on the Terminal Block	A320-T33 Cable 91-Red	33	This output indicates that the prelubrication is ON. The prelube indicator on the remote panel will illuminate when the prelubrication is ON.
“Manual Prelube” Input	Terminal 2 on the Terminal Block	C293-T26 Cable 91-White	26	This input must be connected to the keyswitch input via a switch. The manual prelube switch on the remote panel provides this connection.
Unswitched +Battery	Terminal 4 on the Terminal Block	P200-T4 Cable 105-Red	4	These connections provide the electrical power to the remote panel. Current flow through these connections must be limited to 5 amp. If the remote panel is not installed.
-Battery	Terminal 8 on the Terminal Block	P300-T39 Cable 105-Black	39	
-Battery	Terminal 8 on the Terminal Block	P300-T40 Cable 91-Black	40	
Keyswitch	Terminal 7 on the Terminal Block	P600-T18 Cable 105-White	18	This connection is the keyswitch input for the ECM. This connection must be powered when the engine control is in the “COOLDOWN/STOP”, “AUTO”, or “START” when the remote panel is not installed.

(continued)

(Table 3, contd)

Connections for the Driven Equipment				
Description	Interface Box	Interconnect Harness (Wire Identification)	Remote Panel (Terminal strip)	Function and Comments
+5 VDC for the Input for the Desired Engine Speed	Terminal 6 on the Customer Connector	M170-T6 Cable 50-Red	6	An input for the desired engine speed is required. The input can be either 0 to 5 VDC or 4 to 20 mA. The method for the desired speed input must be selected with Cat ET. Terminals 6 and 8 provide a 5 VDC supply for the desired engine speed. These terminals must be connected to the potentiometer for the desired speed.
Input for the Desired Engine Speed	Terminal 7 on the Customer Connector	M170-T7 Cable 50-White	7	
Return for the Desired Engine Speed	Terminal 8 on the Customer Connector	M170-T8 Cable 50-Black	8	
Shield for the Wiring for the Desired Engine Speed	Terminal 9 on the Customer Connector	M170-T9 Cable 50-Shield	9	Terminal 7 is the input for the desired engine speed. An input of 0 VDC causes the engine rpm to equal the value of the "Minimum High Idle Speed" parameter. An input of 5 VDC causes the engine rpm to equal the value of the "Maximum High Idle Speed" parameter.
"+" Input for the 4 to 20 mA Desired Speed Signal	Terminal 10 on the Customer Connector	M180-T10	10	An input for the desired engine speed is required. The input can be either 0 to 5 VDC or 4 to 20 mA. The method for the desired speed input must be selected with Cat ET. The 4 to 20 mA is an optional method for providing the desired engine speed input. If the 4 to 20 mA method is used to control the desired speed, the 0 to 5 VDC input must be disabled. The 4 to 20 mA input is an isolated input. The "+" input must be in the same circuit as the "-" input. An input of 4 mA causes the engine rpm to equal the value of the "Minimum High Idle Speed" parameter. An input of 20 mA causes the engine rpm to equal the value of the "Maximum High Idle Speed" parameter.
"-" Input for the 4 to 20 mA Desired Speed Signal	Terminal 12 on the Customer Connector	M180-T12	12	
"Grid Status" Input	Terminal 11 on the Customer Connector	M120-T11	11	This input is not normally used in industrial applications. Primary governor gains are used when this input is not connected to the digital return. Auxiliary governor gains are used when this input is connected to the digital return.

(continued)

(Table 3, contd)

Connections for the Driven Equipment				
Description	Interface Box	Interconnect Harness (Wire Identification)	Remote Panel (Terminal strip)	Function and Comments
Cat Data Link +	Terminal 13 on the Customer Connector	D100-T13	13	These connections provide the means for communicating the status of the engine control system, of various engine components, and of sensors.
Cat Data Link -	Terminal 14 on the Customer Connector	D100-T14	14	The Advisor Monitor Display on the remote panel is connected to these terminals. The Cat Data Link can be connected to the Customer Communication Module (CCM). For information on connecting the CCM, refer to the most recent literature for the CCM. When the Caterpillar Software for the CCM is loaded on a personal computer. The program uses the CCM in order to obtain engine information via this data link.
Digital Return	Terminal 15 on the Customer Connector	P500-T15	15	This connection provides a return for various inputs.
Input for the "START" Mode	Terminal 16 on the Customer Connector	P615-T16	16	If these inputs are not wired correctly, the ECM will activate a diagnostic code.
Input for the "AUTO" Mode	Terminal 24 on the Customer Connector	P614-T24	24	Typically, these inputs are connected to an engine control switch. Refer to "Inputs for the engines Mode of Operation" for additional information on these inputs.
Input for the "COOLDOWN/ STOP" Mode	Terminal 31 on the Customer Connector	P613-T31	31	These inputs must be connected to a switch or a logic device. The switch or the logic device must be connected to the input of the digital return. When terminal 24 is connected to the digital return, the ECM is in "STANDBY" mode. The engines mode of operation is determined by the "Input for the START Mode". When the "Input for the START Mode" are connected to a digital return, the normal sequence for the start-up is initiated. When the "Input for the START Mode" are disconnected from the digital return, a normal shutdown is initiated. If the engine is running and the "Input for the Cooldown/STOP Mode" are connected to a digital return, the sequence for a normal shutdown is initiated.

(continued)

(Table 3, contd)

Connections for the Driven Equipment				
Description	Interface Box	Interconnect Harness (Wire Identification)	Remote Panel (Terminal strip)	Function and Comments
"Driven Equipment Ready" Input	Terminal 17 on the Customer Connector	M530-T17	17	This input indicates when the driven equipment is ready for operation. This input must be connected to a digital return in order for the engine to run. When this input is connected to a digital return, the engine can be started. When this input is not connected to a digital return, the engine will not crank. The ECM generates an event code if this input is not connected to a digital return within the programmed delay time. When the engine is running, this input normally continues to be connected to the digital return. If the engine is running and this input is disconnected from a digital return, the ECM immediately generates an event code. The ECM also de-energizes the GSOV. Because the cooldown is not performed, do not use this input for the normal shutdown.
Keyswitch	Terminal 7 on the Terminal Block	P600-T18	18	When this input is connected to a +Battery, the ECM will power up. The Advisor Monitor Display on the remote panel will power up.
Normal Stop	Terminal 19 on the Customer Connector	M510-T19	19	This input must be connected to a digital return in order for the engine to run. This input is not recommended for the normal shutdown. Connecting to a "Input for the COOLDOWN/STOP Mode" digital return is the recommended method for initiating a normal shutdown. If the engine is not running and this input is not connected to a digital return, the engine will not crank. No diagnostic codes or event codes are provided for this condition. If the engine is running and this input is disconnected from the digital return, the ECM will remove power from the GSOV. The cooldown does not operate.

(continued)

(Table 3, contd)

Connections for the Driven Equipment				
Description	Interface Box	Interconnect Harness (Wire Identification)	Remote Panel (Terminal strip)	Function and Comments
Output for Active Alarm	Terminal 20 on the Customer Connector	P697-T20	20	This output is activated if the ECM detects an alarm condition. When this output is activated, the output is connected to ground. This output can sink 0.3 amp.
Idle/Rated Input	Terminal 22 on the Customer Connector	M190-T22	22	When this input is not connected to a digital return, the engine will run at the idle speed that has been programmed with Cat ET. When the engine oil pressure is greater than the setpoint for the engine speed. This terminal is connected to a digital return, the engine will run at rated speed.
Emergency Stop	Terminal 2 on the 2 Terminal Connector	C256-T23	23	These terminals must be connected in order for the engine to start. These terminals must remain connected in order for the engine to run.
	Terminal 28 on the Customer Connector	C256-T28	28	If the ECM is controlling the gas shutoff valve and this circuit is opened, the ECM de-energizes the gas shutoff valve. The fuel is immediately shut off. The ignition is immediately shut off. Additional emergency stop buttons may be added to the emergency stop circuit. For details, refer to "Wiring for the Emergency Stop Circuit".
Output for Engine Failure	Terminal 25 on the Customer Connector	P698-T25	25	The ECM connects this terminal to ground when the ECM causes the engine to be shut down. This output is capable of sinking 0.3 amp.
Input for Manual Prelube	Terminal 22 on the Customer Connector	C293-T26	26	This terminal is for the manual prelube. Prelube occurs when this input is connected to the +Battery and the logic in the ECM determines that a prelubrication is required.
Gas Shutoff Valve	Terminal 5 on the Terminal Block	A330-T30 Cable 109-Red	30	These connections are part of the circuit for the Gas Shutoff Valve (GSOV).
	Terminal 1 on the 2 Terminal Connector	A330-T37 Cable 109-White	37	For details on these terminals, refer to "Wiring for the Gas Shutoff Valve (GSOV)".

(continued)

(Table 3, contd)

Connections for the Driven Equipment				
Description	Interface Box	Interconnect Harness (Wire Identification)	Remote Panel (Terminal strip)	Function and Comments
CAN Data Link +	Terminal 35 on the Customer Connector	D200-T35 Cable 45-Yellow	35	The Advisor Monitor Display on the remote panel is connected to these terminals.
CAN Data Link -	Terminal 36 on the Customer Connector	D200-T36 Cable 45-Green	36	
CAN Data Link Shield	Terminal 38 on the Customer Connector	D200-T38 Cable 45-Shield	38	
Spare	No Connection	P300-T41 Cable 109-Black	No Connection	Spare

Refer to the appropriate procedure in order to make the connections.

Interface Box

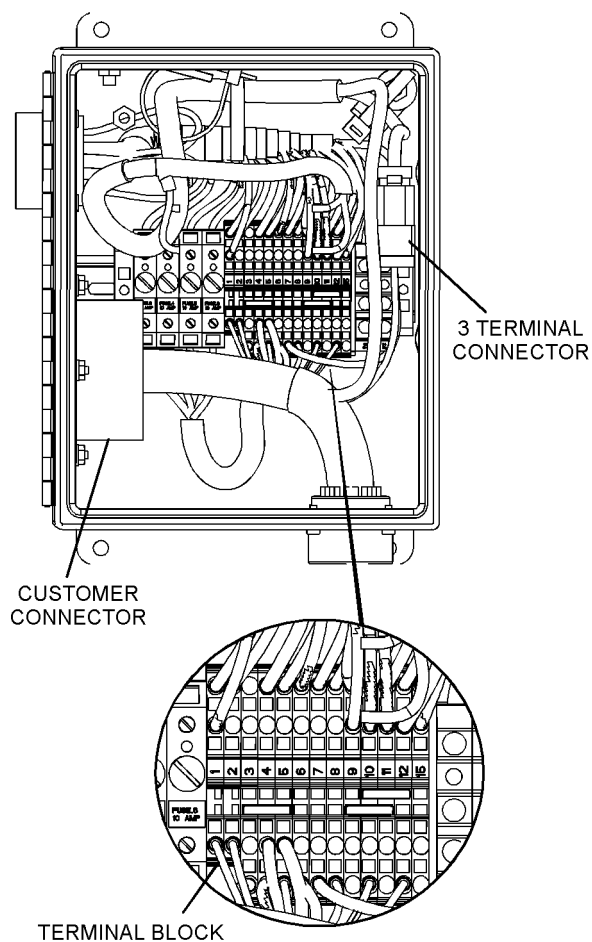


Illustration 6

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Locations for connections inside the interface box

Wiring for the Emergency Stop Circuit

The GSOV may be controlled by the engines control system or by the customers equipment. The recommended configuration is for the engines control system in order to control the GSOV. There will be fewer problems if this configuration is used. When the customers equipment controls the GSOV. The equipment must include the necessary logic in order to ensure that the GSOV opens and the GSOV closes at the appropriate times.

The ECM can supply a maximum continuous current of 1.5 amp to the GSOV. A relay must be installed if the GSOV requires a continuous current that is greater than 1.5 amp.

When the engines control system controls the GSOV, the ECM supplies voltage to the GSOV. The valve opens in order to allow fuel to flow to the engine. When voltage is removed from the GSOV, the valve closes and the fuel flow stops.

The following section describes the two configurations for the circuit for the GSOV.

The GSOV is controlled by the engines control system. The customer may supply an additional switch in the electrical circuit for the GSOV. Refer to Illustration 8 for examples of these types of installations.

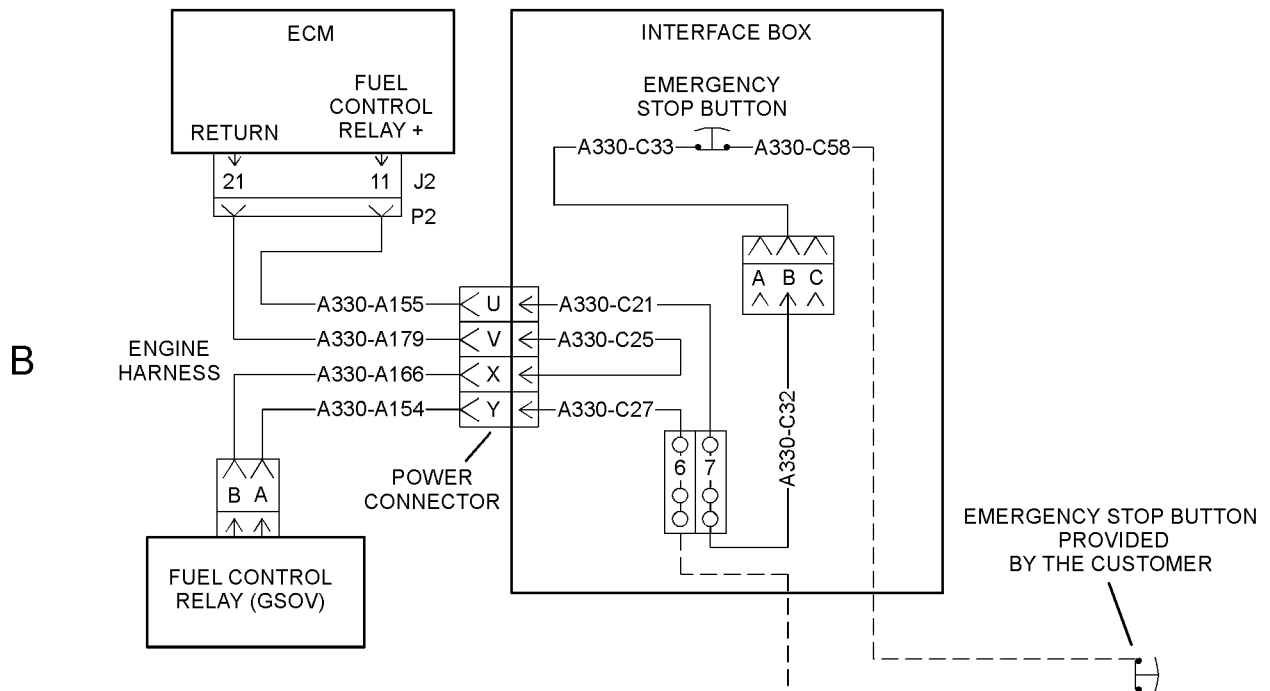
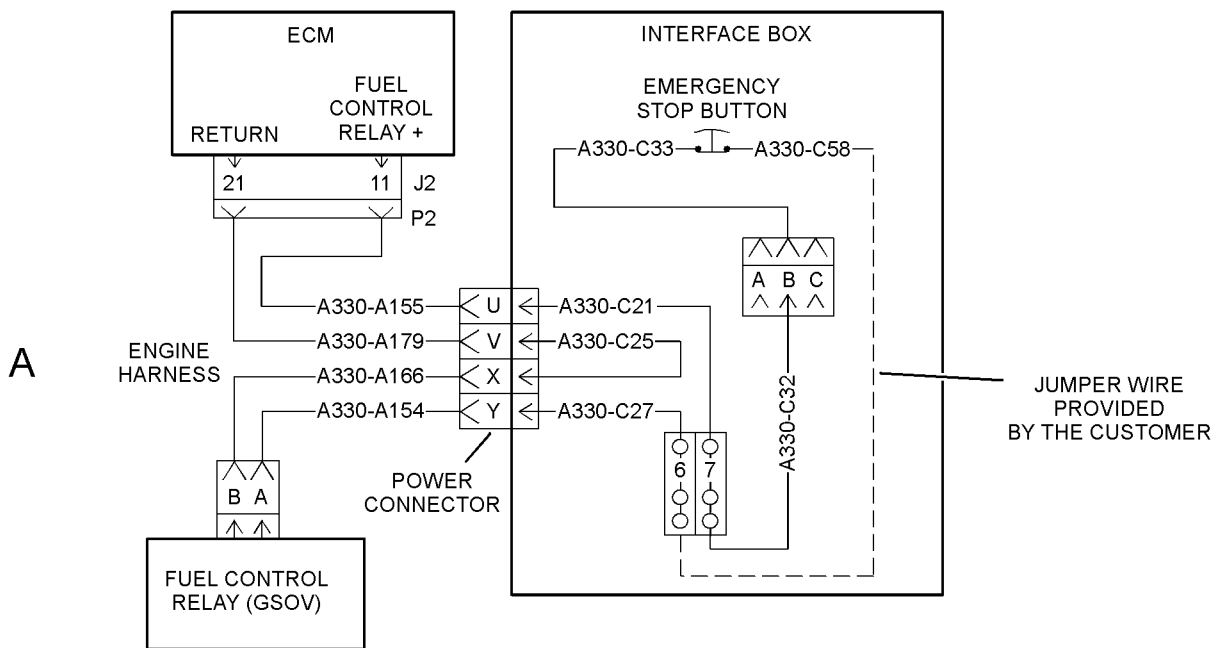


Illustration 8

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The GSOV is controlled by the engine' control system.

(A) Only the engines emergency stop button is used.

(B) The circuit contains an additional emergency stop button that is provided by the customer.

The GSOV is controlled by the customers equipment.

Refer to Illustration 9 for an example of this type of installation.

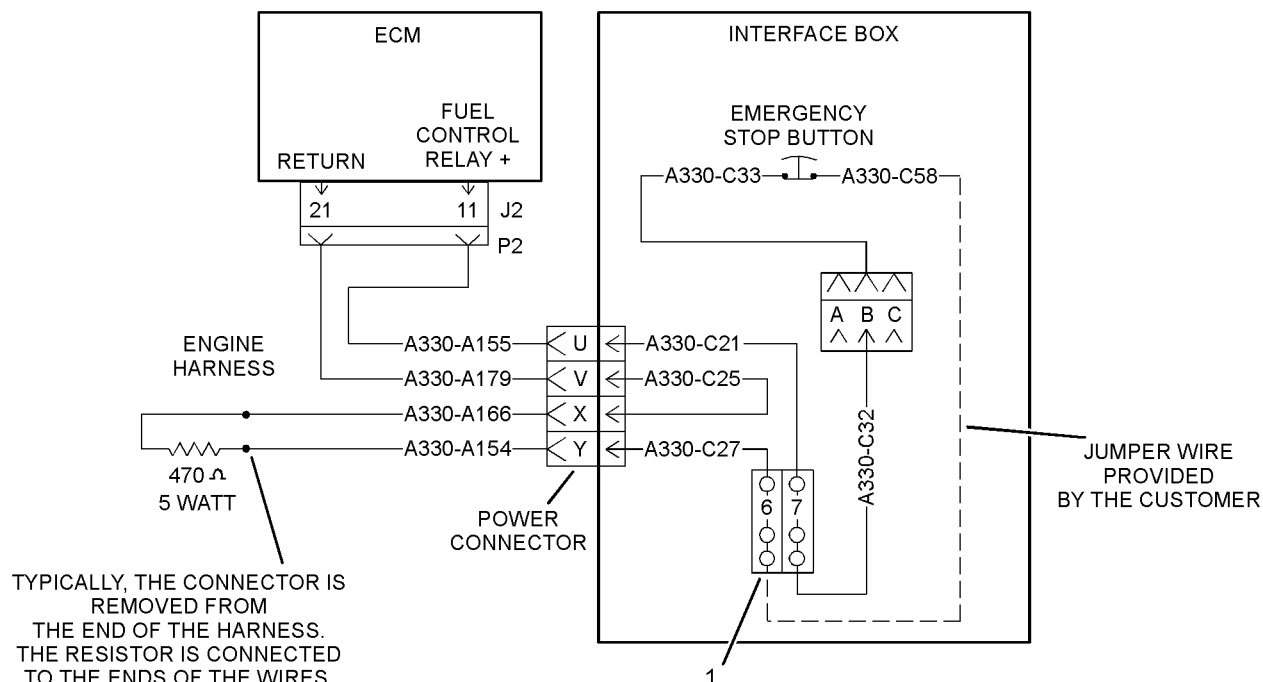


Illustration 9

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The GSOV is controlled by the customers equipment.

(1) 109 - 3038 Wire End

Wire the circuit for the gas shutoff valve according to the appropriate illustration. Use 16 gauge wiring for this circuit.

CAN Data Link

A termination resistor must be added to the CAN data link. Select one of the following locations for the resistor.

Inside of the Interface Box – Use this location when the CAN data link does not extend past the interface box.

Outside of the Interface Box – Use this location when the CAN data link extends past the interface box.

Illustration 10 describes a typical connection inside the interface box. Wire the connection according to SAE standards.

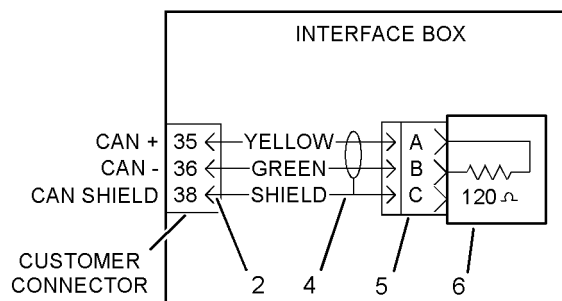


Illustration 10

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Typical installation for the termination resistor inside the interface box

- (2) 3 8T - 8729 Connector Pins
- (4) 153 - 2707 Electrical Cable
- (5) 3E - 3370 Connector Receptacle As
- (6) 174 - 3016 Plug As

Illustration 11 describes a typical connection outside the interface box. Wire the connections according to SAE standards.

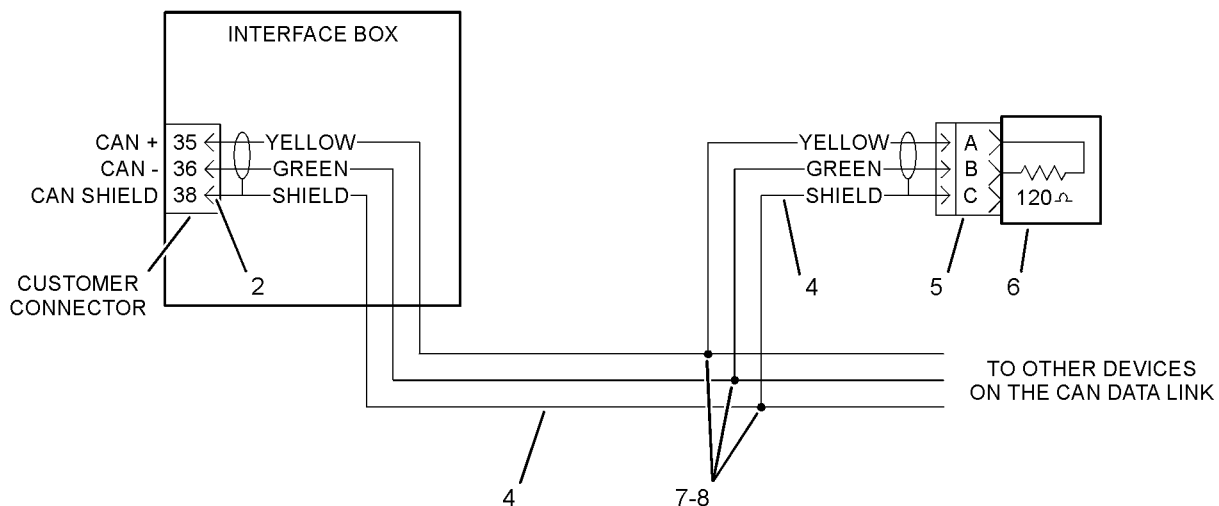


Illustration 11

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Typical installation for the termination resistor that is outside of the interface box

(2) 3 8T - 8729 Connector Pins
(4) 153 - 2707 Electrical Cable

(5) 3E - 3370 Connector Receptacle As
(6) 174 - 3016 Plug As

(7) Splice
(8) 119 - 3662 Heat Shrink Tube

Customer Connector

Make the connections to the customer connector according to the following procedure:

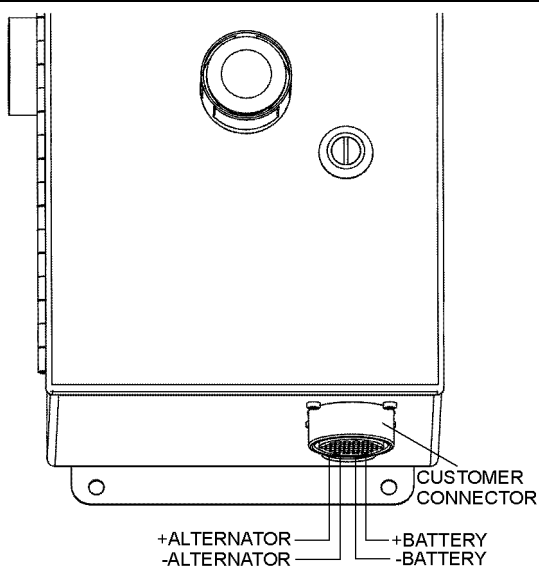


Illustration 12

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Orientation of the customer connector

Terminal Block

Interconnect Harness

Interconnect harness

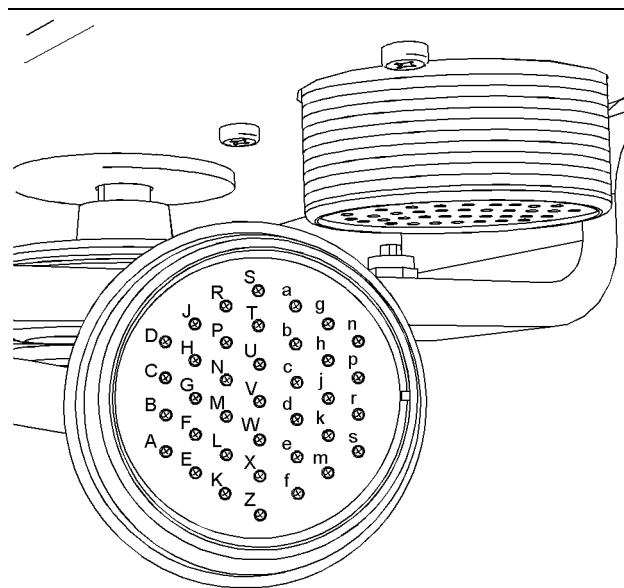


Illustration 13

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The end of the interconnect harness for the engine interface box

Refer to Illustration 13. Attach the interconnect harness to the engine interface box.

Remote Panel

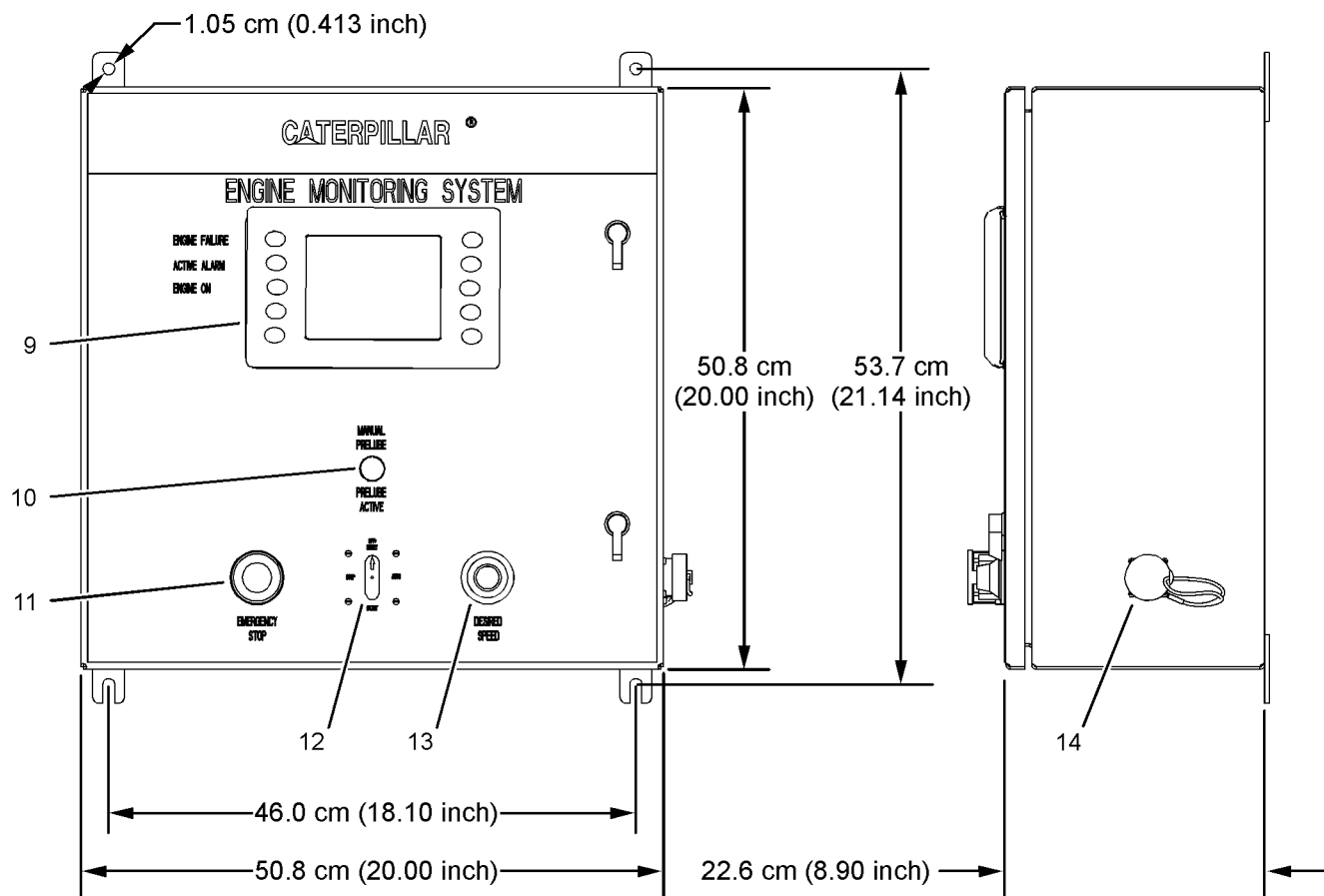


Illustration 14

g01256226

Dimensions and components of the remote panel

(9) Advisor monitor display

(10) Manual prelubrication switch and indicator

(11) Emergency stop button

(12) Engine control

(13) Desired speed potentiometer

(14) Service tool connector

The remote panel provides the following capabilities:

- Emergency stop
- Engine control
- Advisor monitor display
- Desired engine speed
- Manual prelubrication
- Indication of alarms, derates, and shutdowns via the Advisor monitor display

Make the connections to the remote panel according to the following procedure:

1. Refer to "Interconnect Harness". Route the interconnect harness from the interface box to the remote panel. Make the connections for the interconnect harness inside the interface box.

Note: The wires and the cables that make up the interconnect harness may be cut to the appropriate length, if necessary. Do not cut all of the wires and the cables at the same time. Cut one wire and connect the wire to the appropriate location on the terminal strip. This is important when a cable that contains several wires is cut. The cable does not have an external marking that identifies the cable. Cut the cable. Then slide the appropriate heat shrink tube into the end of each wire in the cable. This technique helps to ensure that each connection is made correctly.

Note: Each wire in the harness is identified with the circuit identification.

- a. Select a wire. Identify the location on the terminal strip for the wire. Refer to Table 4.
- b. Cut the wire to the appropriate length.
- c. Slide the appropriate heat shrink tube onto the end of the wire. Shrink the tube onto the wire.
- d. Attach the wire end that is the appropriate gauge onto the end of the wire.

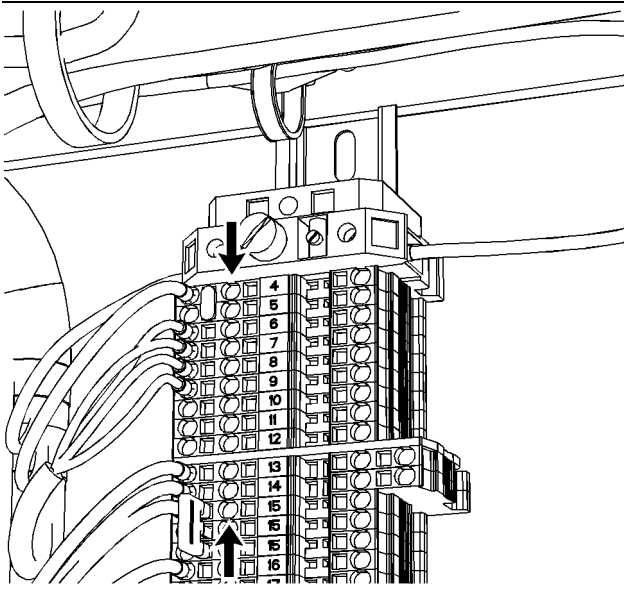


Illustration 15

g01243294

Location for the connections for the interconnect harness inside the remote panel

- e. Refer to Illustration 15. Make the connections for the interconnect harness on the left side of the terminal strip. Insert the wire end into the appropriate location on the terminal strip. Pull on the wire in order to verify that the connection is secure.

Table 4

Connections for the Interconnect Harness on the Terminal Strip			
Interconnect Harness Wire Identification	Gauge of the Wire End	Location on the Terminal Strip	Function
P200-T4 Cable 105-Red	16	4	+Battery for the operation of the remote panel
M170-T6 Cable 50-Red	16	6	Desired Engine Speed
M170-T7 Cable 50-White	16	7	Desired Engine Speed
M170-T8 Cable 50-Black	16	8	Desired Engine Speed
M170-T9 Cable 50-Shield	16	9	Shield for the Desired Engine Speed
M180-T10	16	10	Desired Engine Speed 4 to 20 mA

(continued)

(Table 4, contd)

Connections for the Interconnect Harness on the Terminal Strip			
Interconnect Harness Wire Identification	Gauge of the Wire End	Location on the Terminal Strip	Function
M120-T11	16	11	Grid Status
M180-T12	16	12	Desired Engine Speed 4 to 20 mA –
D100-T13	16	13	Cat Data Link +
D100-T14	16	14	Cat Data Link –
P500-T15	16	15	Return
P615-T16	16	16	Start Command
M530-T17	16	17	Driven Equipment
P600-T18 Cable 105-White	14	18	Keyswitch
M510-T19	16	19	Normal Stop
P697-T20	16	20	Active Alarm
SC01-T21	16	21	Spare
M190-T22	16	22	Idle/Rated Input
C256-T23	16	23	Emergency Stop
P614-T24	16	24	Auto
P698-T25	16	25	Engine Failure
C293-T26 Cable 91-White	16	26	Manual Prelube Input
P696-T27	16	27	Crank Terminate
C256-T28	16	Bottom 28	Emergency Stop
M140-T29	16	29	Run Relay
A330-T30 Cable 109-Red	16	30	Gas Shutoff Valve
P613-T31	16	31	Cooldown/Stop
M164-T32	16	32	Desired Timing
A320-T33 Cable 91-Red	16	33	Prelube ON
D200-T35 Cable 45-Yellow	18	35	CAN Data Link +
D200-T36 Cable 45-Green	18	36	CAN Data Link –
A330-T37 Cable 109-White	16	37	Gas Shutoff Valve
D200-T38 Cable 45-Shield	18	38	CAN Data Link Shield
P300-T39 Cable 105-Black	14	39	–Battery
P300-T40 Cable 91-Black	16	40	
P300-T41 Cable 109-Black	Unconnected		Spare

2. Perform the following procedure to connect the wiring from the driven equipment.

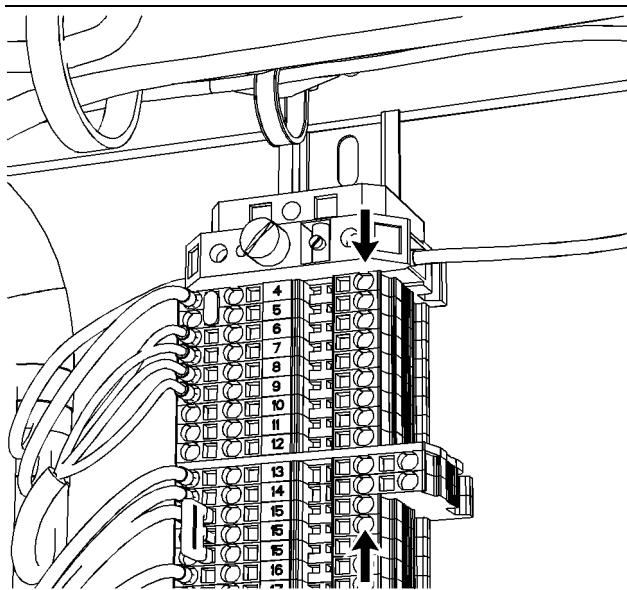


Illustration 16

g01242443

Location for the customers connection inside the remote panel

3. Refer to Illustration 16. Make the connections for the driven equipment on the right side of the terminal strip. Table 3 lists the connections that are available.

Wiring for the Emergency Stop Circuit

The circuit for the emergency stop buttons is complete when the remote panel is installed. An additional emergency stop button may be added to the circuit. Refer to Illustration 17. Remove the bridge and connect the additional button according to the Illustration.

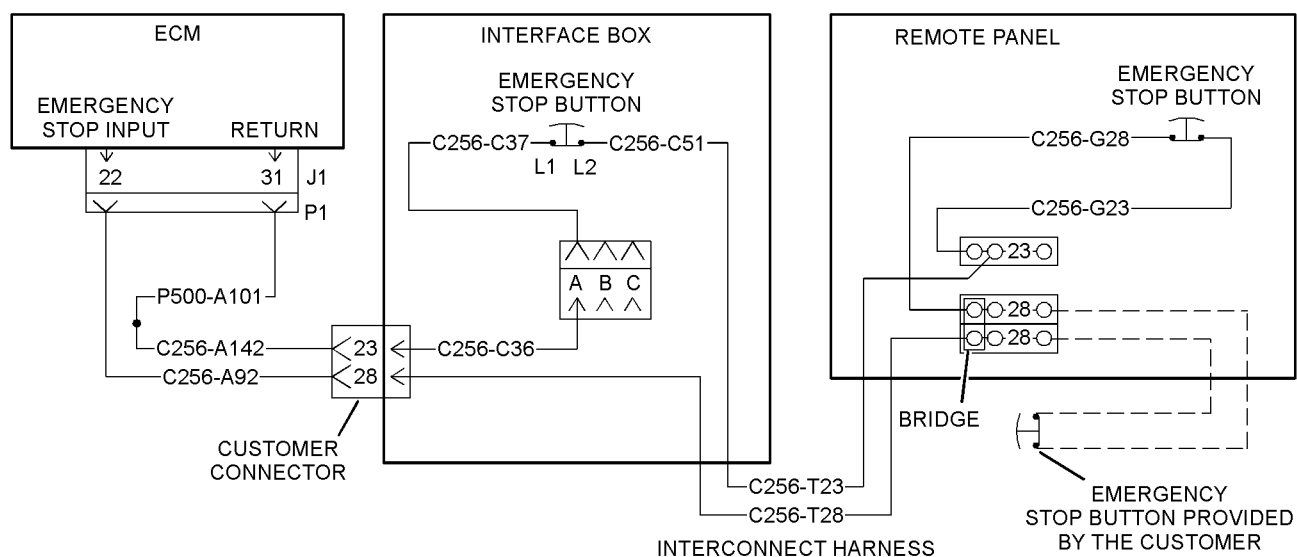


Illustration 17

g01982813

Emergency stop circuit with an additional emergency stop button

Wiring for the Gas Shutoff Valve

The circuit for the emergency stop buttons is complete when the remote panel is installed. Refer to Illustration 17.

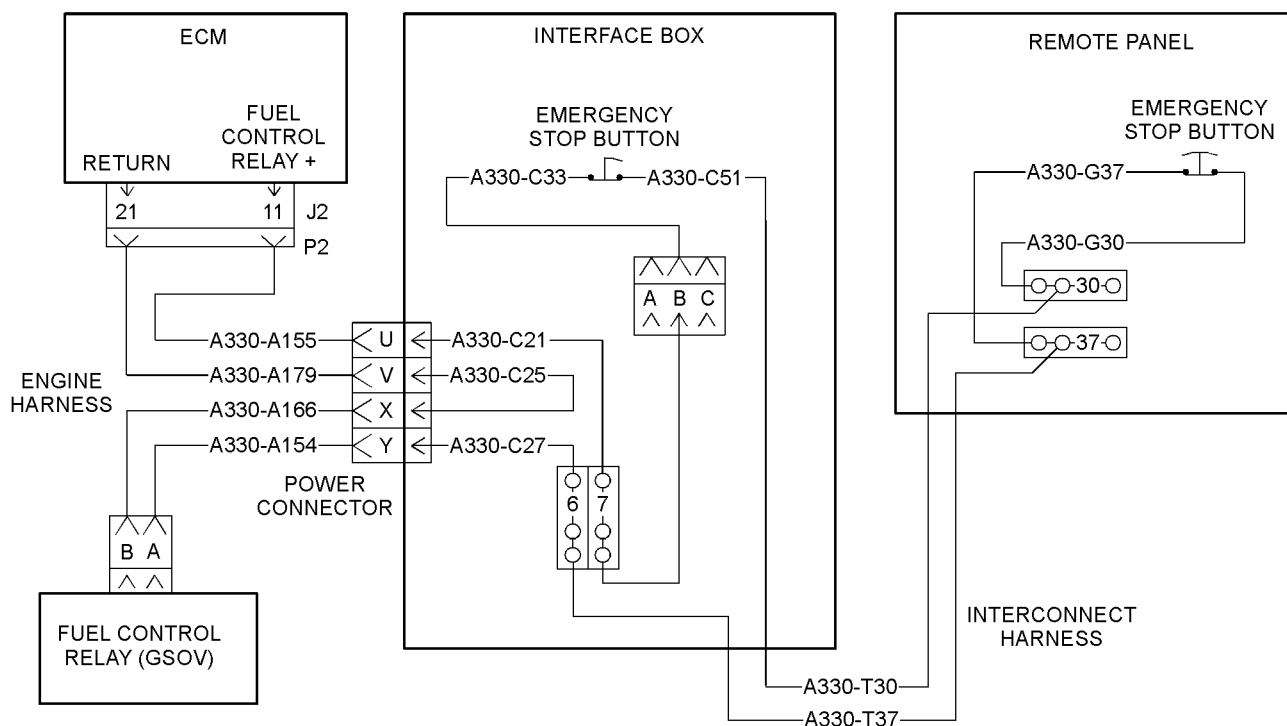


Illustration 18

Circuit for the gas shutoff valve

g01982833

Inputs for the Engines Mode of Operation

The engine has four modes of operation. The mode of operation is determined by three inputs. The valid configurations of the inputs are described in Table 5.

Table 5

Valid Configurations of the Terminals on the Customer Connector for Selection of the engines Mode of Operation			
	Terminal 24	Terminal 16	Terminal 31
"OFF/RESET" Mode	No ⁽¹⁾	No	No
"AUTO" Mode	Yes ⁽²⁾	No	No
"START" Mode	Yes	Yes	No
"START" Mode	No	Yes	No
"COOLDOWN/STOP" Mode	No	No	Yes

(1) The "No" indicates that the terminal is not connected to terminal 15.

(2) The "Yes" indicates that the terminal is connected to terminal 15.

Configurations that are not shown in Table 5 will activate a diagnostic code.

The transition between inputs must occur within 1/10 second. If the transitions do not occur within 1/10 second, a diagnostic code is activated.

“OFF/RESET” Mode

When none of the inputs are connected, the engine is in the “OFF/RESET” mode. Any active diagnostic codes are cleared.

“AUTO” Mode

When terminal 24 is connected to terminal 15, the engine is in the “AUTO” mode. The ECM is in standby. In the “AUTO” mode, terminal 16 controls both the engine start sequence and the shutdown sequence.

The engine start sequence is initiated when terminal 16 is connected to terminal 15. When terminal 16 is disconnected, the shutdown sequence is initiated.

“START” Mode

The engine start sequence begins when terminal 16 is connected to terminal 15.

“COOLDOWN/STOP” Mode

The cooldown begins when terminal 16 is disconnected from terminal 15 and terminal 31 is connected to terminal 15. The cooldown is followed by the shutdown sequence.

Connect the Caterpillar Electronic Technician (ET)

Cat ET is designed to run on a personal computer. Cat ET can display the following information:

- Parameters
- Diagnostic codes
- Event codes
- Engine configuration
- Status of the monitoring system

Cat ET can perform the following functions:

- Perform diagnostic tests.
- Calibrate sensors.
- Download flash files.
- Set parameters.

Note: For more information regarding the use of Cat ET and of the PC requirements for Cat ET, refer to the documentation that accompanies your Cat ET software.

There are two locations for connecting the communication adapter to the engines control system. One connection is on the right rear corner of the engine. The other connection is on the remote panel.

The engines power supply provides the communication adapter with 24 VDC. An indicator on the communication adapter indicates when the adapter is receiving power. Use the following procedure to connect Cat ET to the engines control system.

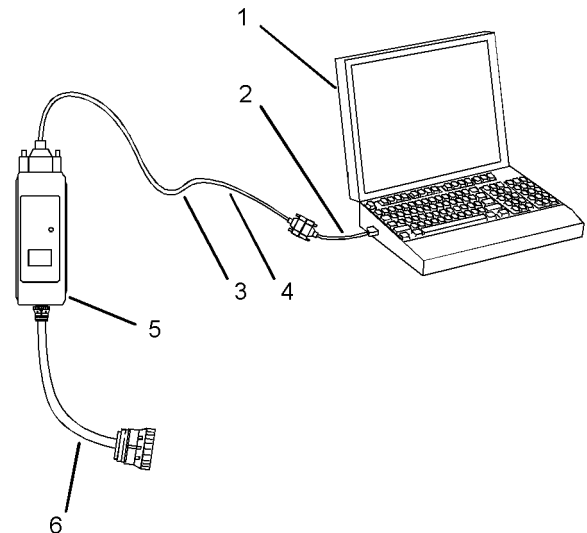


Illustration 19

g01255306

Connecting the Communication Adapter II

- (1) Personal Computer (PC)
- (2) 237 - 7547 Adapter Cable As
- (3) 196 - 0055 Adapter Cable As
- (4) 225 - 5985 Parallel Port Cable (COMMUNICATION ADAPTER)
- (5) 275 - 5121 Communication Adapter As
- (6) 207 - 6845 Adapter Cable As

Note: Items (3), (5), and (6) are part of the 275 - 5121 Communication Adapter Gp.

1. Set the engine control to the OFF/RESET mode.
2. Connect communications adapter (5) to a communications port on the PC by using one of the following methods:
 - a. Connect cable (4) between the “COMPUTER” end of communications adapter (5) and the parallel port of PC (1). Be sure to configure Cat ET for the parallel port. This configuration provides the fastest connection.
 - b. Connect cable (3) between the “COMPUTER” end of communication adapter (5) and the RS232 serial port of PC (1).

- c. Connect cables (2) and (3) between the "COMPUTER" end of communication adapter (5) and the USB port of PC (1).
3. Connect cable (6) to communication adapter (5).
4. Connect cable (6) to a service tool connector.
5. Verify that the "POWER" indicator on the communication adapter is illuminated.
6. Establish communication between Cat ET and the ECM.

Connect Gauges and Instruments

Water Manometer

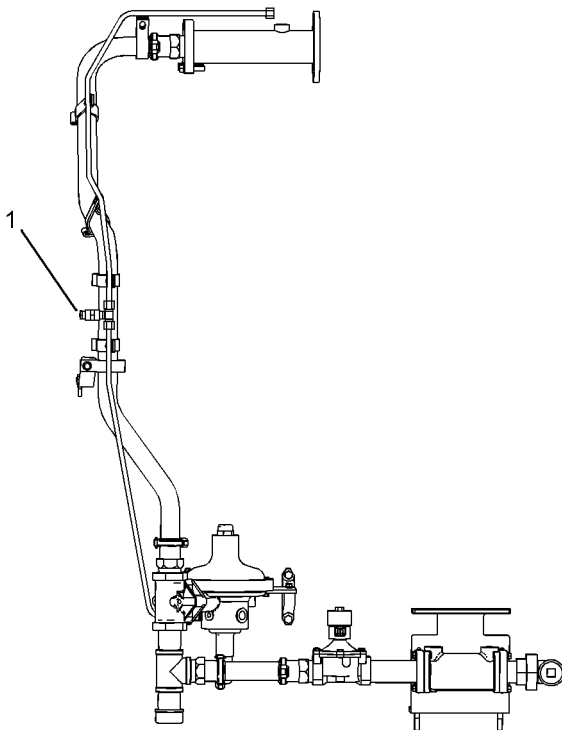


Illustration 20

g02110373

A typical configuration is shown.

(1) Tap for the manometer

The water manometer or the differential pressure gauge is not required for the Deltec mixer systems with zero pressure regulators.

1. Turn the main gas valve OFF.
2. Remove the plugs from tap (1).
3. Connect a 1U-5470 Engine Pressure Group or a water manometer between the two pressure taps with the proper adapter fittings.

Emissions Analyzer

Install the 156-1060 Emissions Analyzer in order to monitor the exhaust emissions before the turbocharger. Remove the plug that is located in the exhaust inlet of the turbocharger, or in the exhaust elbow on naturally aspirated engines. Connect the 156-1060 Emissions Analyzer in accordance with the manufacturers instructions.

Note: An emissions analyzer that can measure NO and NO² separately must be used to check the air/fuel ratio control. Use the emissions analyzer to adjust the air/fuel ratio control. The accuracy of the emissions analyzer used for engine calibration must be within 10 percent of a standard at the desired engine NO_x emissions level. Calibrate the emissions analyzer for both NO and NO² as needed to maintain this accuracy level.

Inlet Manifold Pressure

The inlet manifold pressure is measured below the throttle plate with a pressure gauge. The inlet manifold pressure is used to indicate the engine load.

Initial Start-Up Procedure

Ensure that all of these factors are in proper working condition prior to the initial start-up: engine installation, driven equipment, all of the related hardware, and electrical connections. Failure to perform the commissioning procedure could result in unsatisfactory operation.

Perform the following procedure for the initial start-up and for start-up after major maintenance and/or after repair.

Note: Use Cat ET version 2008C or later.

1. Current fuel analysis

Obtain a fuel analysis and calculate the methane number for air/fuel ratio control.

- Methane number for determining desired timing
- Fuel quality value for the engine setup
- Gas specific gravity for the engine setup
- Fuel specific heat ratio for the engine setup.

2. Connect Cat ET to the service tool connector. Establish communications with the master ECM. Go to the Air/Fuel Ratio setup screen and set the Air/Fuel Proportional and the Air/Fuel Integral input value to 0.

3. Set the first desired ignition timing by using the methane number and the fuel usage for this engine "Refer to the correct performance data sheet".

4. Set the engine speed control.

- Set the governor control to Isochronous.
- Set the Crank Terminate speed to be 50 rpm more than the cranking speed.
- Set Low idle to 1000 rpm (range 750 rpm – 1100 rpm)
- Set minimum high idle to 1050 rpm (range 900 rpm - 1300 rpm)
- Set maximum high idle to 1400 rpm (range 1100 rpm - 1500 rpm)
- Set governor gain (P) to 100 percent
- Set the governor stability (I) to 100 percent

5. Adjust the fuel supply pressure to the engine regulator to 45 to 60 (Psig).

6. Adjust the fuel supply pressure to the fuel valve between 1 and 5 Psig. The target pressure should be 2.5 psig. The fuel supply pressure on ET can be read as the fuel supply pressure minus the atmospheric pressure.

7. Calibrate the NO_x sensor.

Note: If the engine air/fuel ratio is not correct, you cannot calibrate the NO_x sensor now in step 7.

Perform the following procedure in order to calibrate the NO_x sensor :

- a. Start the engine. Before continuing, allow the engine to warm to normal operating temperature. Apply load to the engine.

Note: Recommended to set the engine to 1400 rpm with a 100 percent load. If not, set the engine to the maximum load and speed.

- b. Connect a 156-1060 Emissions Analyzer Gp or a 156-1070 Emissions Analyzer Gp (or equivalent) to the engines exhaust system. Allow the NO_x readings from the analyzer to stabilize.
- c. Access the "service/calibrations/engine exhaust NO_x level sensor calibration" screen of Cat ET. Use Cat ET to start the calibration.
- d. Follow the prompts in order to guide you through the calibration procedure.

- e. Compare the value of the NO_x that is reported from Cat ET to the value that is reported from the exhaust analyzer. Select the arrow buttons at the bottom of the calibration screen to increase or decrease the slope sensor value that is reported by Cat ET.

Note: Make small changes to the slope value during the calibration procedure. If large changes are made to the slope value, the engine operation may become unstable. Allow the engine to stabilize after each adjustment is made. When the values are comparable within ± 10 PPM, click the "Next" button at the bottom of the screen.

- f. Cat ET will prompt you to allow the engine to stabilize for three minutes in order to verify the correct settings.
- g. If necessary, perform the calibration procedure again in order to recalibrate the sensor.
- h. Stop the engine and allow the turbochargers to cool down before installing the speed sensor.

8. Turbocharger speed measurement and setup procedure

- a. Remove all debris from the threaded plug and the surrounding area. Foreign material must be kept out of the turbocharger housing.
- b. Remove the threaded plug and the o-ring seal. Store the plug in a clean place in order to be reinstalled.
- c. Check the condition of the o-ring on the 343-3320 Speed Sensor. Replace the o-ring if necessary with Parker part number 0036-6087. Install the 343-3320 Speed Sensor .
- d. By using a deep well socket to prevent damage to the speed sensor, torque the speed sensor to 12 to 15 N·m (8.85 to 11 ft lb).
- e. Once the pins are aligned correctly, attach the 344-2650 Wiring Harness by pushing down the bayonet type lock ring connector and twisting until locked.
- f. Connect the sensor harness to the Multimeter. The black plug is ground and the red plug is the signal. Set the multimeter to 60 VAC range frequency measurement.



Illustration 21

g01946115

(1) 343-3320 Speed Sensor



Illustration 22

g01946116

(2) The bayonet type lock ring is installed.

- g.** Start the engine and gradually apply a load in order to match any of the following combinations for the respective emission settings.

Note: Set the engine to 1400 rpm and 100 percent load.

For 0.5 g NO_x setting

- Engine speed of 1400 rpm with a load of 100 percent Refer to illustration 23.
- Engine speed of 1400 rpm with a load of 90 percent Refer to illustration 24.

- Engine speed of 1400 rpm with a load of 80 percent Refer to illustration 25.
- Engine speed of 1400 rpm with a load of 75 percent Refer to illustration 26.
- Engine speed of 1200 rpm with a load of 100 percent Refer to illustration 27.

For 1 g NO_x setting

- Engine speed of 1400 rpm with a load of 100 percent Refer to illustration 28.
- Engine speed of 1400 rpm with a load of 90 percent Refer to illustration 29.
- Engine speed of 1400 rpm with a load of 80 percent Refer to illustration 30.
- Engine speed of 1200 rpm with a load of 100 percent Refer to illustration 31.

- h.** Check the ambient temperature, site altitude, and emission setting.

Note: The speed of the turbocharger will increase with an increase in temperature. For a given speed, load, emission setting, and altitude.

Table 6

$$N_{\text{desired}} = N_{\text{max}} \times F_{\text{corr}}$$

N_{desired} – Desired turbocharger speed in Hz

N_{max} – Maximum turbocharger speed from setup charts in Hz

F_{corr} – Temperature correction factor from Table 7

- i.** Determine the maximum turbocharger speed (**N_{max}**) in Hz from the turbocharger speed setup charts for the particular emission settings, engine speed, load, and the altitude. Then, use Table 7 to determine the temperature correction factor (**F_{corr}**). Apply the correct formula from the table 6 in order to determine the desired turbocharger speed (**N_{desired}**).

Set the engine to run at the desired turbocharger speed (**N_{desired}**) calculated from the above equation.

- j.** Adjust the wastegate so the turbocharger speed reading from the multimeter matches with the desired turbocharger speed (**N_{desired}**).

Table 7

Temperature correction factor look-up.													
T _{current} / Current Temperature													
T _{max} / Max Temp for Month		32 -40	41 - 49	50 - 58	59 - 67	68 - 76	77 - 85	86 - 94	95 - 103	104 - 112	113 - 121	122 - 130	131
	32 -40	1.000											
	41 - 49	.986	1.000										
	50 - 58	.972	.986	1.000									
	59 - 67	.958	.973	.986	1.000								
	68 - 76	.946	.960	.973	.987	1.000							
	77 - 85	.934	.947	.961	.974	.987	1.000						
	86 - 94	.922	.935	.949	.962	.975	.987	1.000					
	95 - 103	.910	.924	.937	.950	.963	.975	.988	1.000				
	104 - 112	.899	.913	.926	.938	.951	.964	.976	.988	1.000			
	113 - 121	.889	.902	.915	.927	.940	.952	.964	.976	.988	1.000		
	122 - 130	.879	.892	.904	.917	.929	.941	.953	.965	.977	.989	1.000	
	131	.869	.882	.894	.907	.919	.931	.943	.954	.966	.977	.989	1.000

T_{max} – Maximum ambient temperature for the month in deg F

T_{current} – Current ambient temperature in deg F

G3516B ULB 0.5g NOx NTE: Turbo Frequency 1400rpm 100% Load

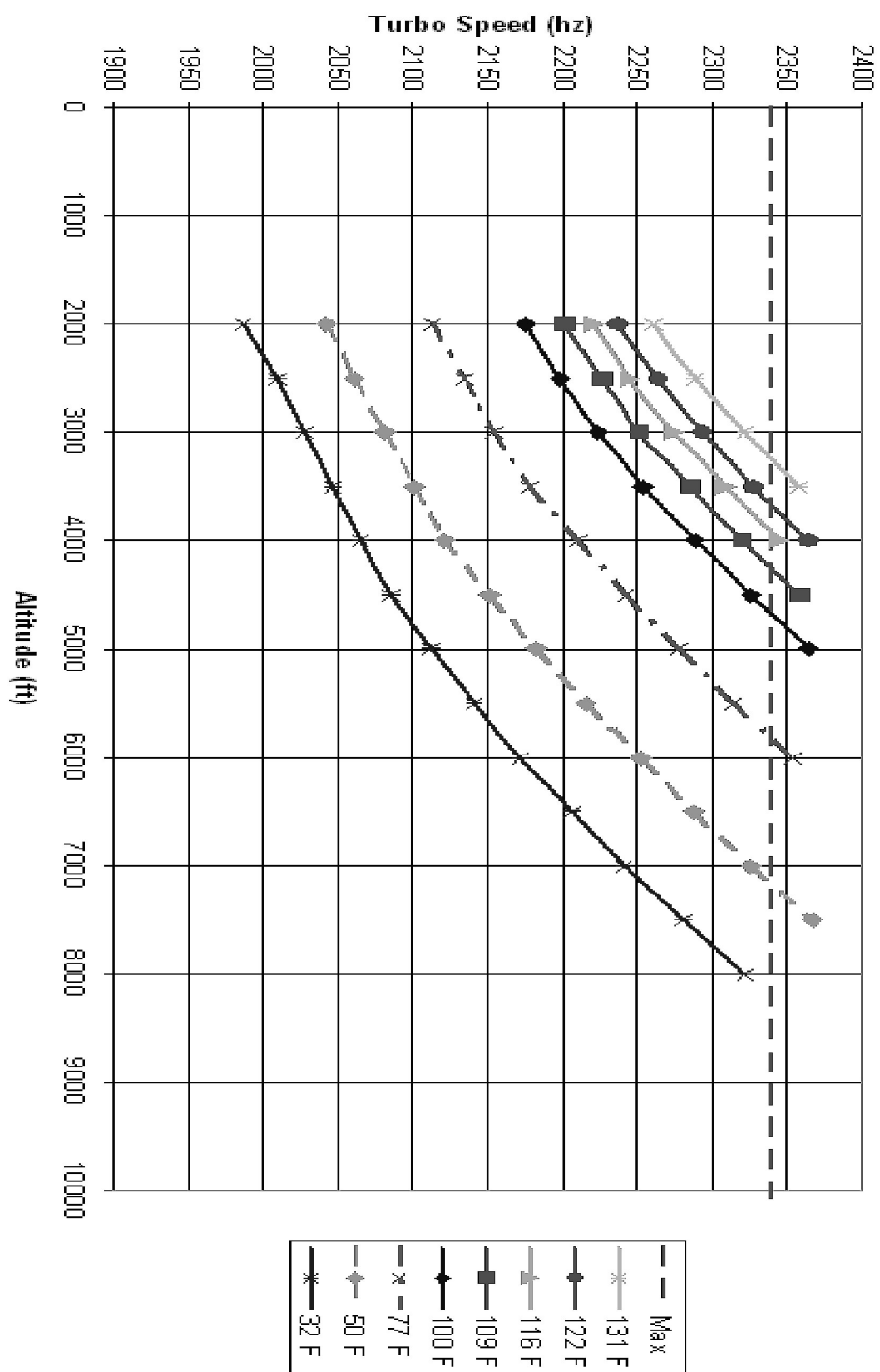


Illustration 23

g01946048

G3516B ULB 0.5g NOx NTE: Turbo Frequency **1400rpm 90% Load**

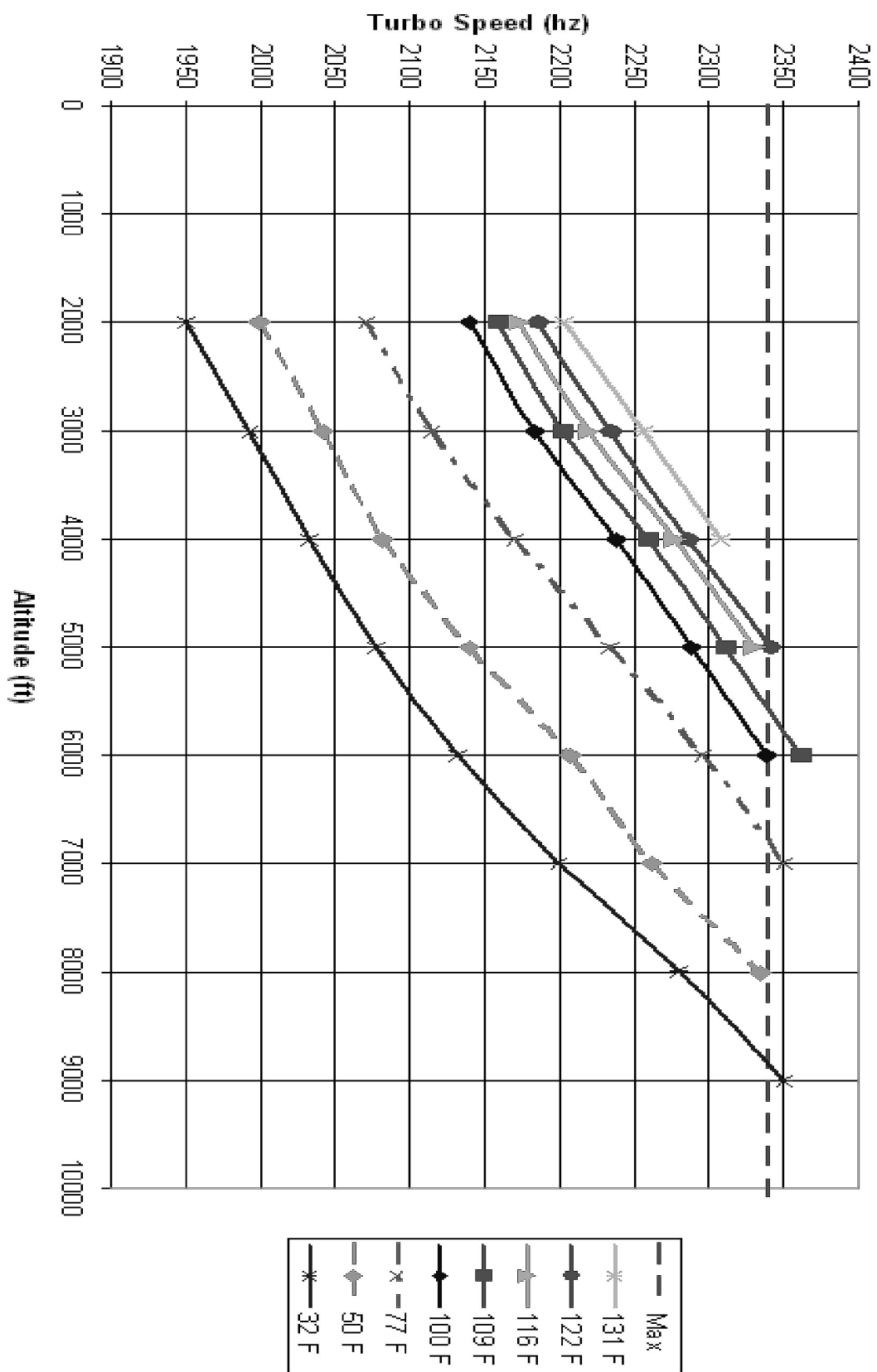
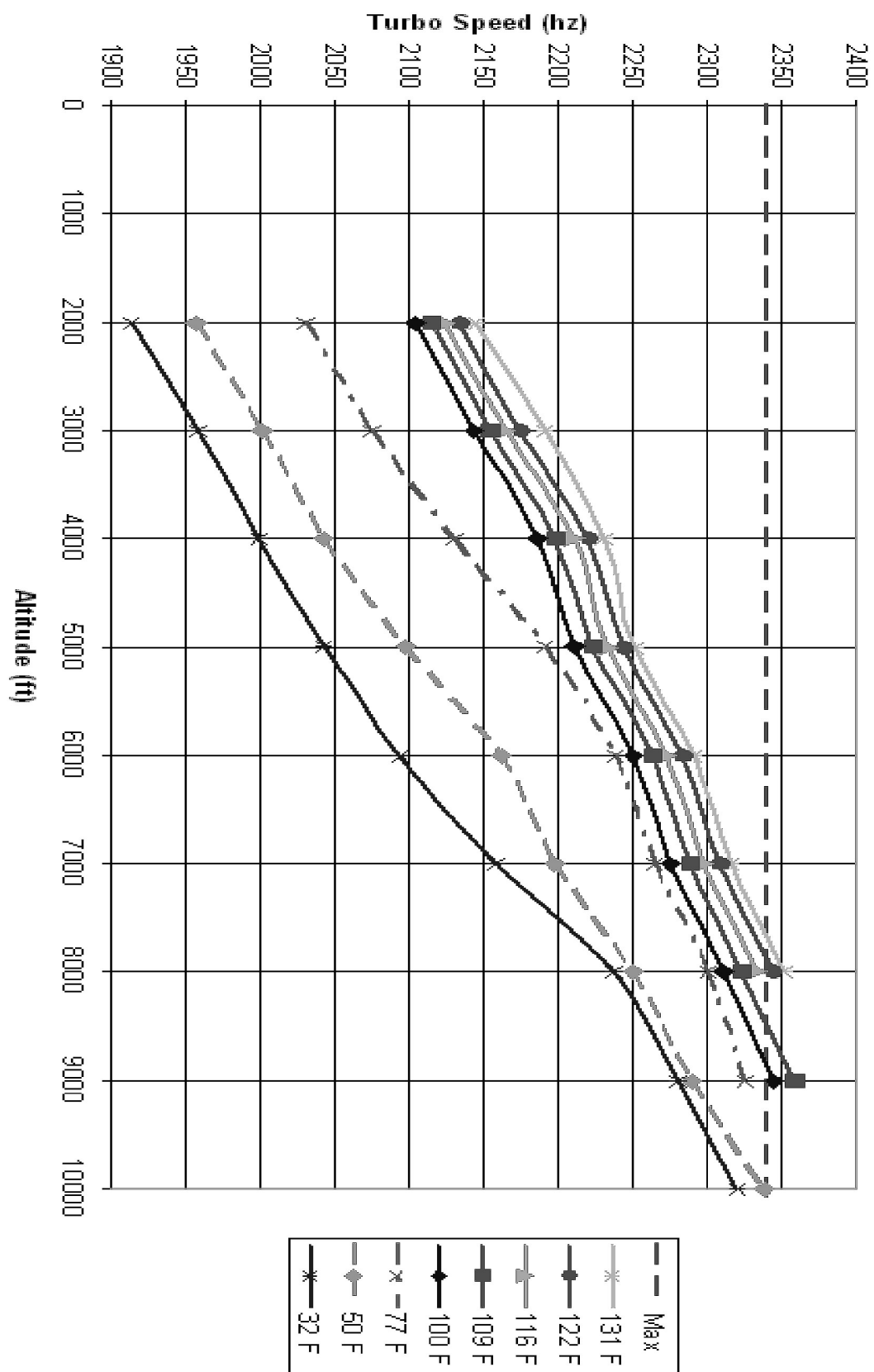


Illustration 24

g01946063

G3516B ULB 0.5g NOX NTE: Turbo Frequency **1400rpm 80% Load**



G3516B ULB 0.5g NOX NTE: Turbo Frequency **1400rpm 75% Load**

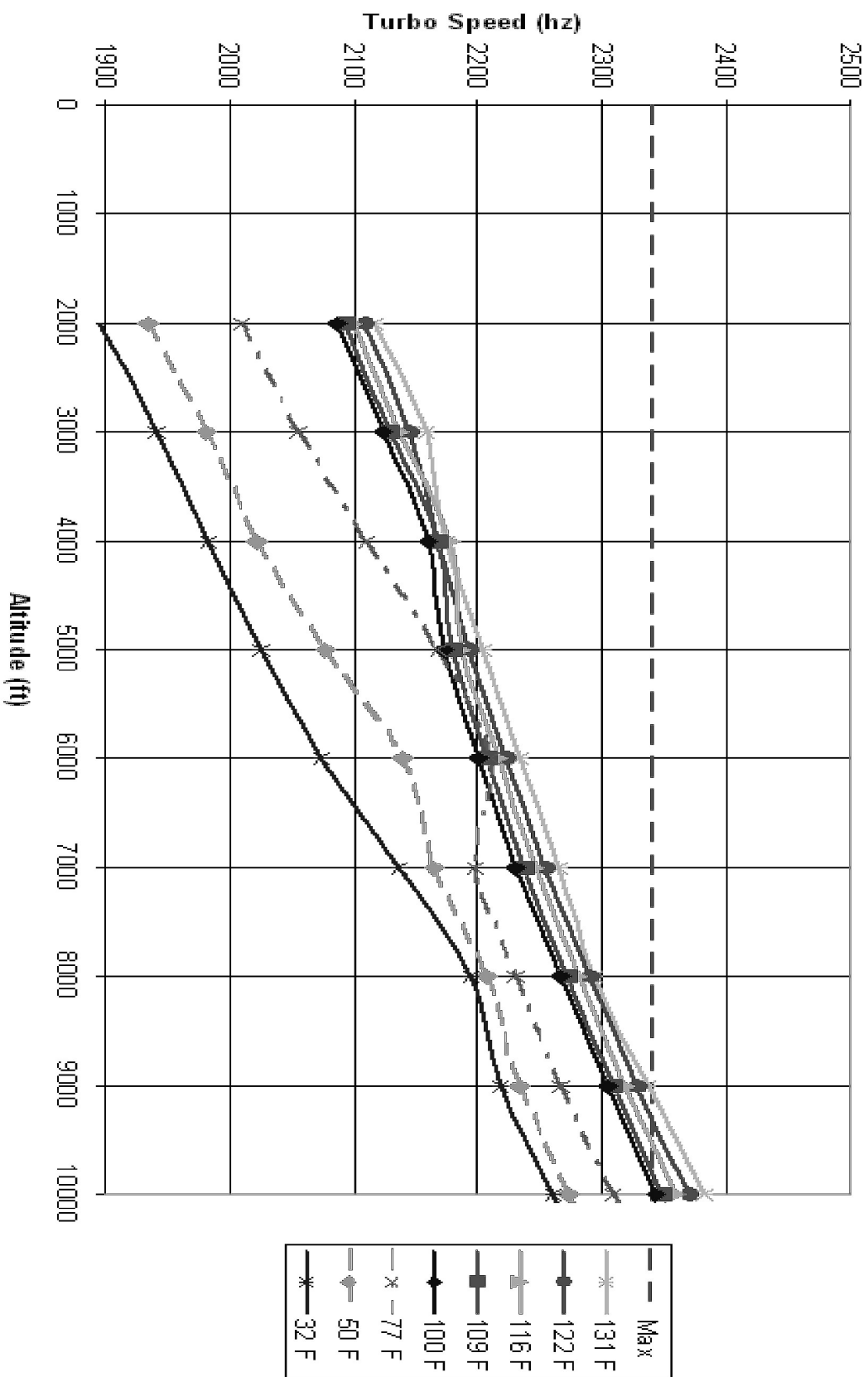


Illustration 26

g01946068

G3516B ULB 0.5g NOx NTE: Turbo Frequency **1200rpm 100% Load**

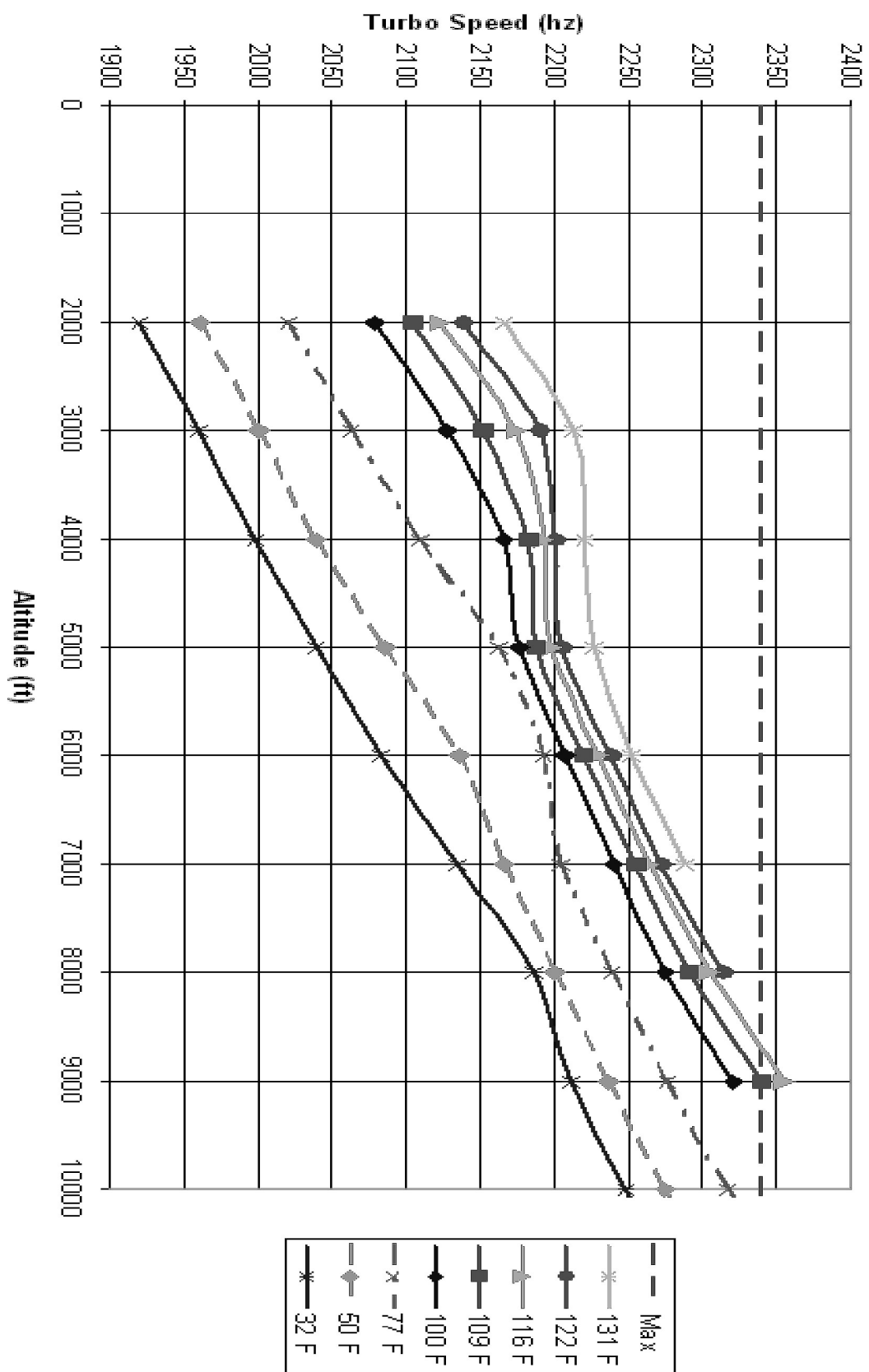
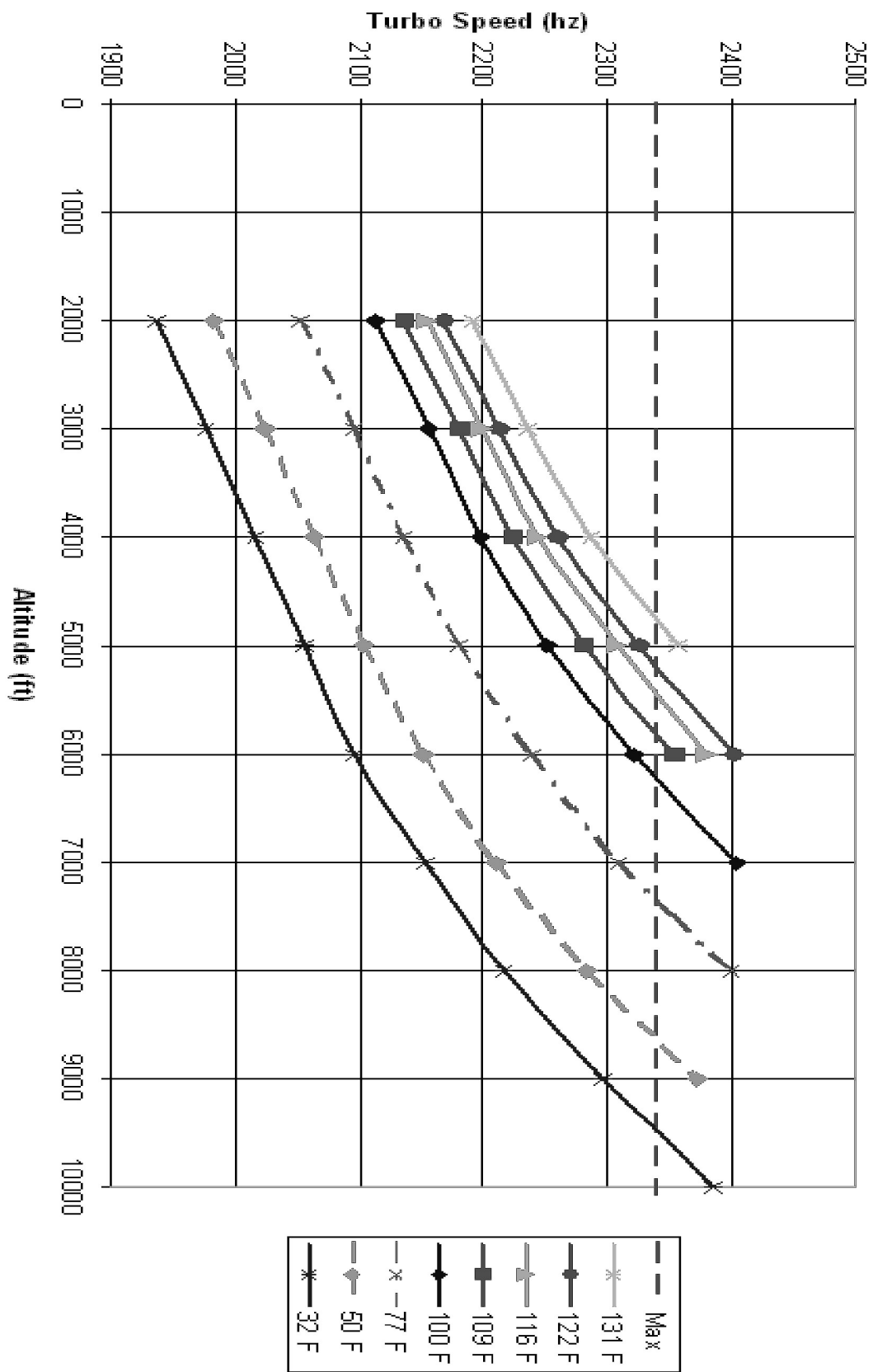


Illustration 27

g01946070

G3516B ULB 1g NOx NTE: Turbo Frequency 1400rpm 100% Load



g01946074

Illustration 28

G3516B ULB 1g NOx NTE: Turbo Frequency **1400rpm 90% Load**

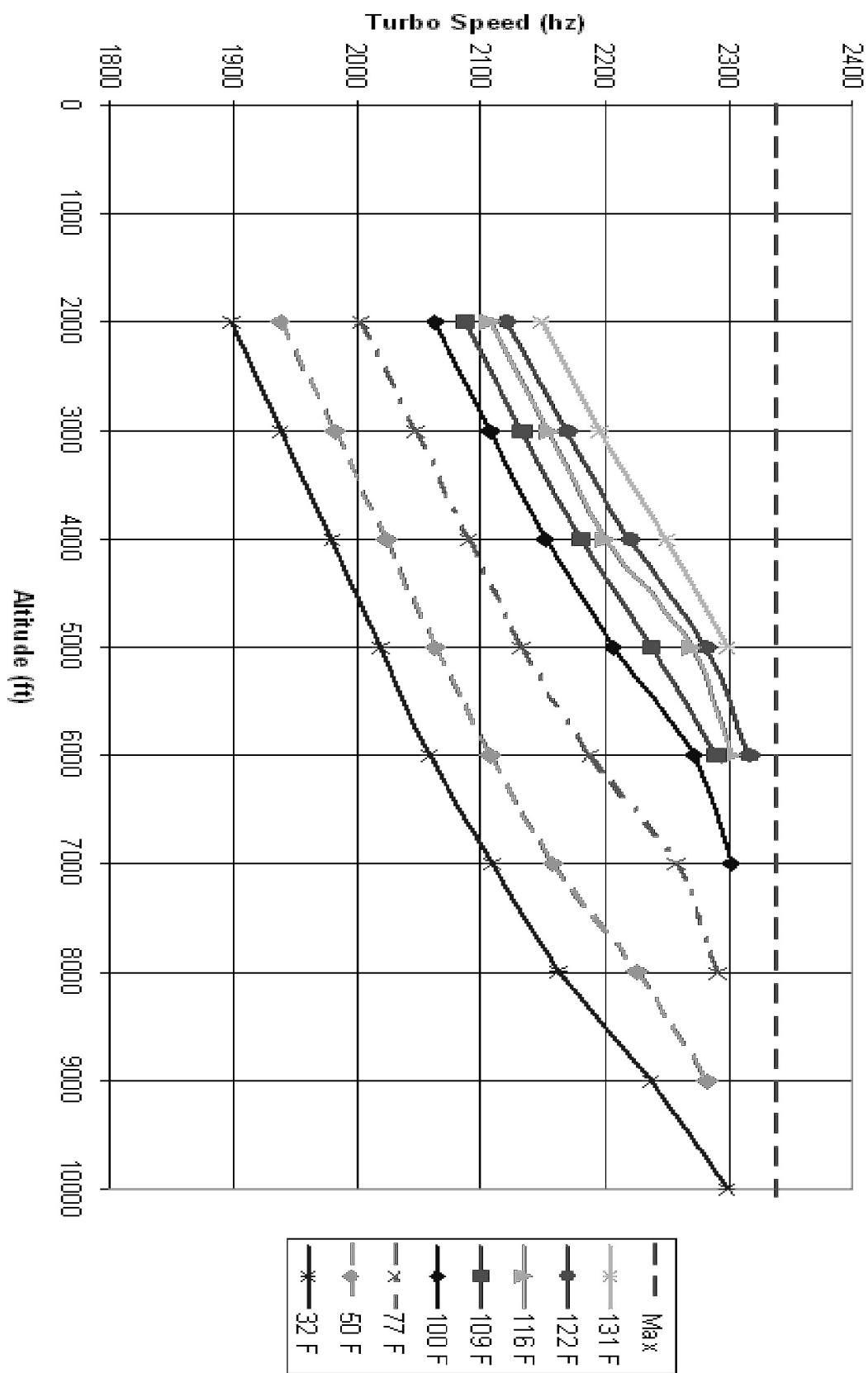
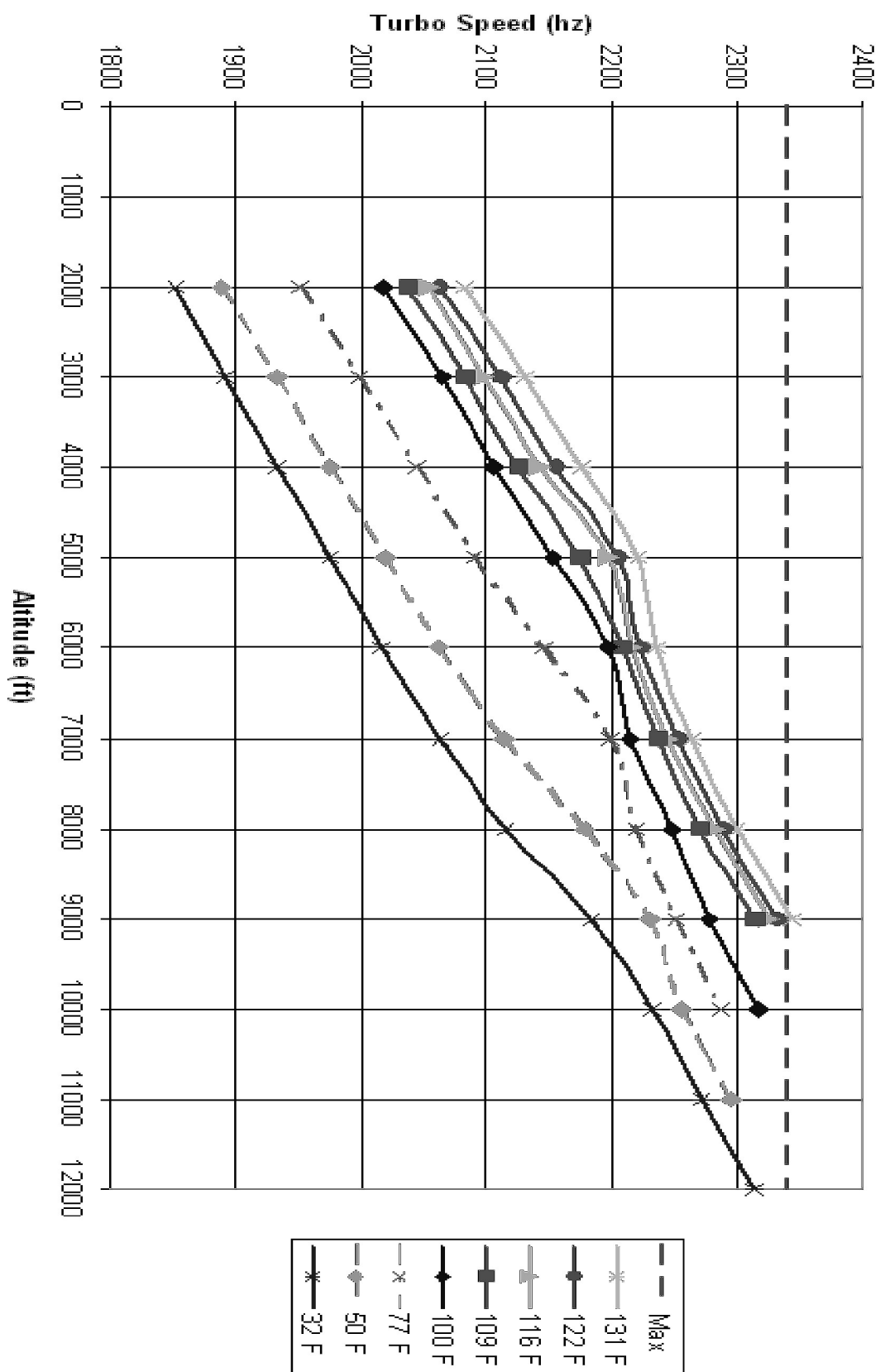


Illustration 29

g01946076

G3516B ULB 1g NOx NTE: Turbo Frequency **1400rpm 80% Load**



g01946093

Illustration 30

G3516B ULB 1g NOX NTE: Turbo Frequency 1200rpm 100% Load

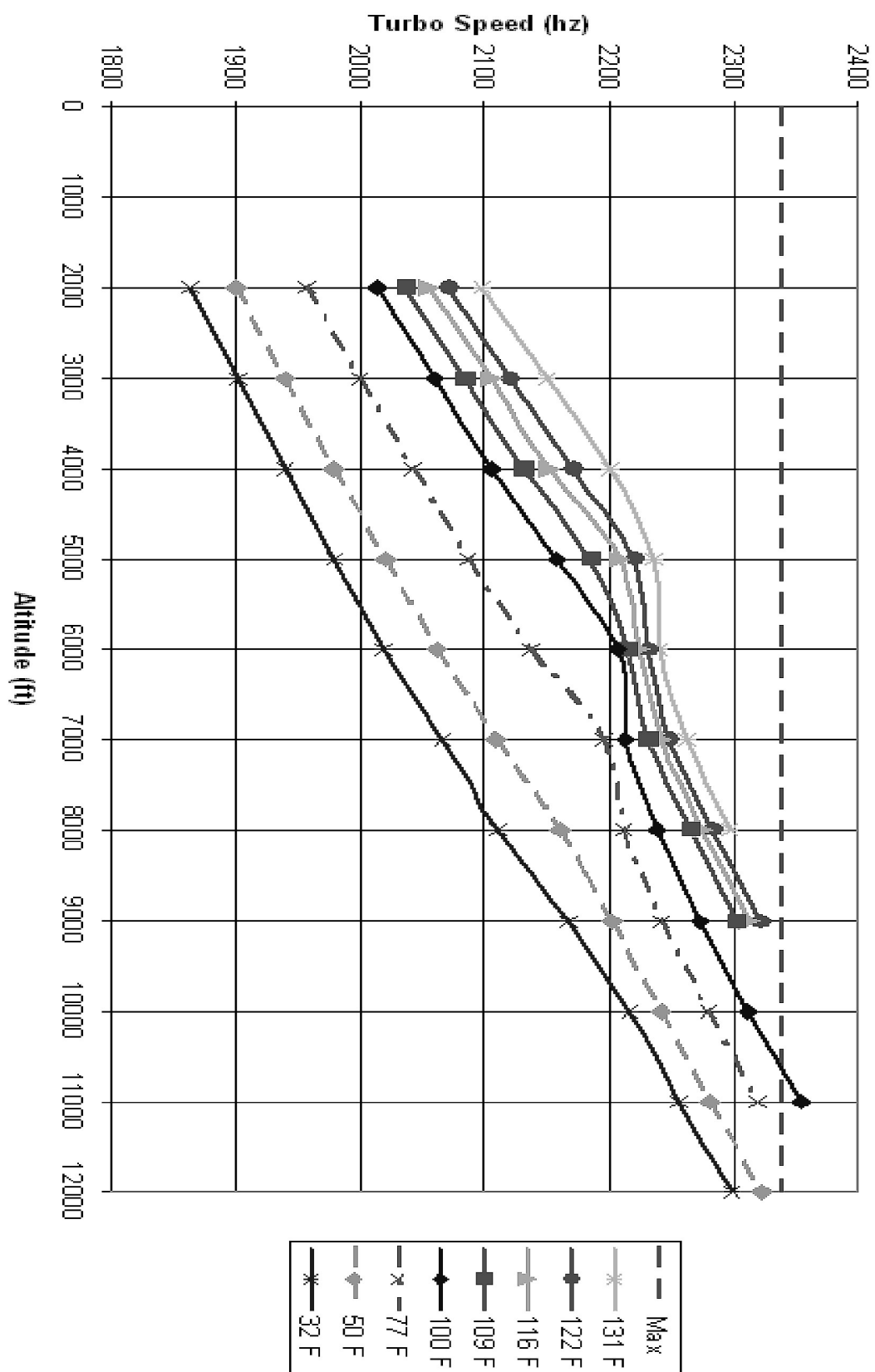


Illustration 31

g01946114

9. Check the Fuel Correction Factor (FCF).

- The FCF needs to be at 100 percent $\pm$ 5 percent above 50 percent load. If the FCF is not correct, adjust the fuel quality value in Cat ET until an FCF of 100 percent is attained.

Recheck the turbocharger speed, if the speed is not acceptable return to step 8.

10. Check emissions.

By using ET, monitor the NO_x PPM. The NO_x PPM screen will display the value shown on the analyzer ($\pm$ 10 PPM) for a five minute period. If not, return to step 7.

11. Remove the turbocharger speed sensor.

- a. Stop the engine and Allow To Cool! Then access the sensor and the wiring harness.
- b. Remove the wiring harness by unlocking the bayonet type lock ring and remove the harness away from the engine.
- c. Clean the area around the speed sensor and the speed sensor connector.
- d. Remove the speed sensor by using a deep well socket in order to prevent damage.
- e. Inspect the threaded plug and the O-ring. Replace the o-ring if necessary with Parker 0036-6087. Verify that the plug is free of debris.
- f. Install the threaded O-ring plug and torque plug to 10 N·m (7 lb ft) to 15 N·m (11 lb ft).

12. Start the engine and set the engine to the desired speed and load.

Adjusting the Governor

The response of the throttle actuator can be adjusted with Cat ET. Use Cat ET to change these parameters:

- “Governor Gain Factor”
- “Governor Stability Factor”
- “Governor Compensation Factor”

Gain – Gain determines the speed of the controls response in adjusting for the difference between the desired condition and the actual condition. Increasing the gain provides a faster response to the difference between the desired condition and the actual condition.

Stability – Stability controls the speed for elimination of the error in the difference between the desired condition and the actual condition. The stability dampens the response to the error. Increasing the stability provides less damping.

Compensation – Compensation is used to adjust the time delay between the control signal and the movement of the actuator. If the compensation is too low, the engine speed will slowly hunt. If the compensation is too high, the engine speed will rapidly fluctuate.

Note: The default value for these parameters is “0”. The default values should be sufficient for initial start-up. However, the values may not provide optimum performance.

These adjustments are provided in order to obtain optimum responses to changes in the engines load and in the engines speed. The adjustments also provide stability during steady state operation.

If you have a problem with instability, always investigate other causes before you adjust the governor. For example, diagnostic codes and unstable gas pressure can cause instability.

When you adjust the governor, make sure that the “Grid Status” parameter is “Off”.

To change the “Governor Gain Factor” or the “Governor Stability Factor”, use the “Real Time Graphing” feature on the “Information” drop-down menu of Cat ET. The graph provides the best method for observing the effects of your adjustments.

After you make adjustments, always test the stability by interrupting the engine speed and/or load. Operate the engine through the entire range of speeds and of loads in order to ensure stability.

Note: Adjustment of the “Governor Gain Factor” directly affects the speed of the throttle actuator when there is a difference between the actual engine speed and the desired engine speed. An excessive increase of “Governor Gain Factor” may amplify instability.

To set the “Governor Gain Factor”, increase the value until the actuator becomes unstable. Slowly reduce the value in order to stabilize the actuator. Observe that the engine operates properly with little overshoot or undershoot.

Adjustment of “Governor Stability Factor” dampens the actuators response to changes in load and in speed. Increasing the value provides less damping. Decreasing the value provides more damping. To reduce the overshoot, decrease the value. To reduce the undershoot, increase the value.

Note: An increase of the “Governor Stability Factor” requires a decrease of the “Governor Gain Factor” in order to maintain engine stability.

Illustration 32 shows some typical curves for transient responses.

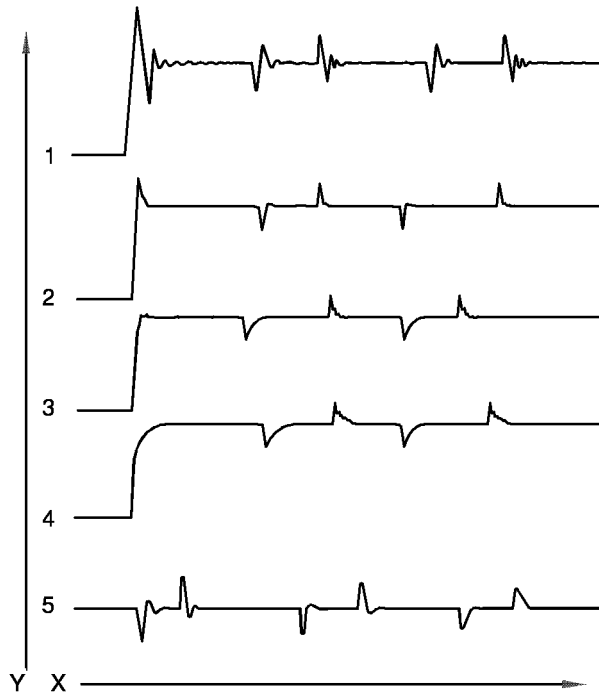


Illustration 32 g01017530

Typical curves for transient responses

(Y) Engine speed
(X) Time

- (1) The “Governor Gain Factor” is too high and the “Governor Stability Factor” is too low. There is a large overshoot on start-up and there are secondary overshoots on transient loads.
- (2) The “Governor Gain Factor” is slightly high and the “Governor Stability Factor” is slightly low. There is a slight overshoot on start-up but the response to transient loads is optimum.
- (3) The “Governor Gain Factor” is slightly low and the “Governor Stability Factor” is slightly high. There is optimum performance on start-up but slow response for transient loads.
- (4) The “Governor Gain Factor” is too low and the “Governor Stability Factor” is too high. The response for transient loads is too slow.
- (5) The response to transient loads is adjusted for optimum performance.

The default value of the “Governor Compensation Factor” is acceptable for most applications. Do not adjust unless the “Governor Compensation Factor” engines response to changes in load is unacceptable.

Decrease until a “Governor Compensation Factor” slow, periodic instability is observed. Then, slightly increase the value. Repeat the adjustments of the “Governor Gain Factor” and of the “Governor Stability Factor”. Continue to increase the “Governor Compensation Factor” and readjust the “Governor Gain Factor” and the “Governor Stability Factor” until stability is achieved and the engines response to changes in load and in speed is optimized.

Illustration 33 is a graphic representation of adjusting the “Governor Compensation Factor”.

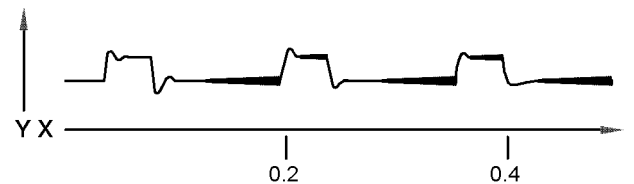


Illustration 33 g01017541

The increased width of the line for the actuator voltage indicates that the throttle actuator is more active as the value of the “Governor Compensation Factor” is increased.

(Y) Actuator voltage
(X) Time in seconds

Unburned Gas – Purge

The following events cause unburned gas to remain in the air inlet and in the exhaust manifold:

- Emergency stop
- Engine overspeed
- The GSOV is commanded to close and the GSOV does not close.
- Unsuccessful successive attempts to start the engine

Unburned gas may remain in the air inlet and exhaust system after several unsuccessful attempts to start the engine. The unburned gas may increase to a concentration that may ignite during a successive attempt to start the engine.

Perform the following procedure in order to purge the unburned gas:

Note: This procedure will not work if the engine control does not control the GSOV.

1. Connect Cat ET to the engine.
2. Verify that the value of the “Engine Purge Cycle” parameter is equal to ten seconds less than the value of the “Crank Cycle” parameter.

3. Set the engine control to the START mode. The engine will crank for the “Engine Purge Cycle” time. Then, the gas shutoff valve will be energized and the ignition will be enabled. The engine will start.
4. Continue with your previous procedure.

