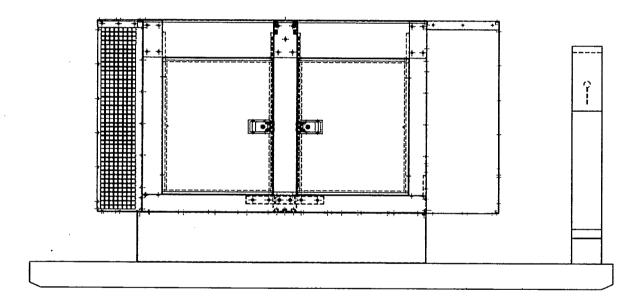
IPSWICH WATER

(C/O: J & P RICHARDSON)

STANDBY DIESEL GENERATOR

Model: C150D5 - STK1 - CPY Serial Number: E080S800561



OPERATION & MAINTENANCE MANUALS

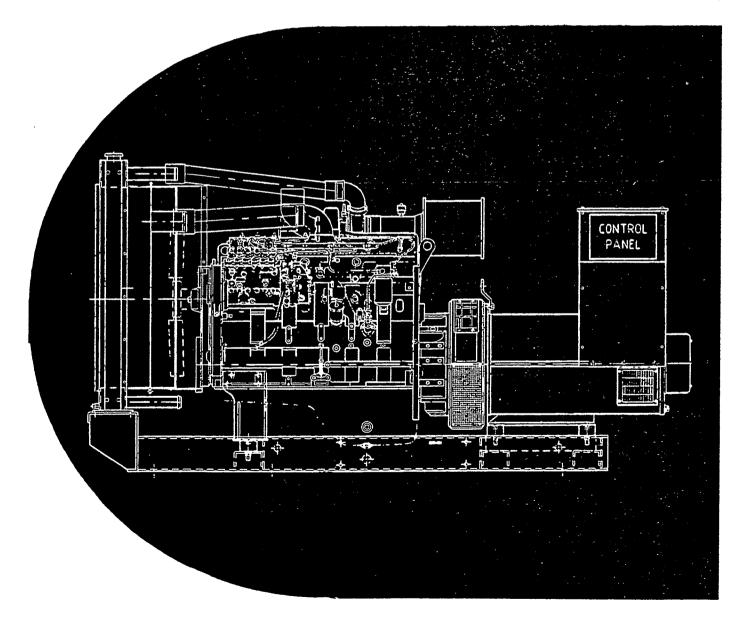


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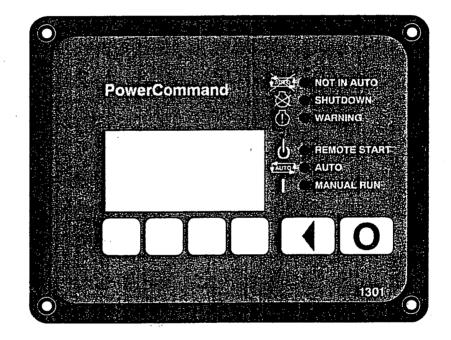
Genset Control System Power Command® 1301



Printed in Singapore J0960-0023 AUG-06

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PowerCommand[®] Control 1301



12-2004

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1. PCC 1301 Control Operation

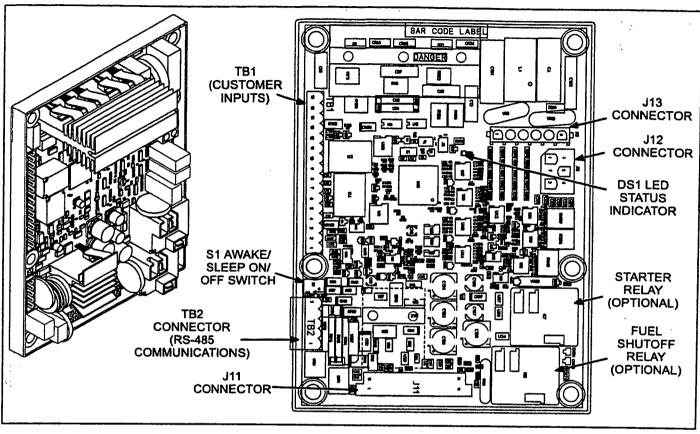


FIGURE 1-1, PCC 1301 CONTROL BOARD

The following describes the function and operation of the PowerCommand® 1301 Control (PCC). The PCC 1301 meets NFPA 110 requirements and is designed for connection to a 12 or 24 VDC control system.

PCC 1301 FEATURES

The PCC 1301 includes:

- Single-phase or three-phase (delta or wye) voltage and current sensing
- 50 or 60 Hertz frequency
- RS-485 communications connector (TB2)
- Start/stop functionality through either a control panel or an Manual Run/Off/Auto switch located in the harness (TB1-11 to TB1-10).
- Control board status LED (DS1)

 Awake/Sleep On/Off switch (S1) – The wake up in auto functionality is enabled when the switch is set to "Awake" (On).

A PCC 1301 installation may also include the following options.

- If a control panel is mounted on the genset (local display), as many as seven additional control panels can be mounted up to 4000 feet from the genset (remote displays). A setup menu in the optional display panel is required to designate a display as Local or Remote.
- Optional starter relay (K7) and fuel shutoff relay (K8)
- Status indicator lamp
- Remote emergency stop (TB1-16 to TB1-15)

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 Customer fault inputs 1 (TB1-14 to TB1-13) and 2 (TB1-12 to TB1-13) – Grounding one of these inputs activates the corresponding warning or shutdown sequence. External sensing equipment must be connected to the designated digital input.

The nature of the fault is an optional customer selection. Example inputs: Low Fuel Day Tank, Water in Fuel, Ground Fault, etc.

Two Customer Input Text message submenus are supplied to enter the event type and description (see page 2-18).

 Annunciator fault inputs 1, 2, and 3 – These outputs can be used when an annunciator is installed as part of an RS-485 PCCNet interface connected to TB1-2 and TB1-3. Grounding one of these inputs activates the corresponding warning or shutdown sequence.

Three Customer Annunciator Text message submenus are supplied to enter the event type and description (see page 2-22).

Local Status Output

A status indicator lamp can be used to flash genset status and shutdown fault codes. The Manual Run/ Off/Auto switch may include a status indicator lamp.

The following describes how to interpret the status indicator light.

- Constant On = The genset is running.
- Constant Fast Flashing = The genset is starting.
- Intermittent Flashing = A genset shutdown fault condition exists. All of the shutdown faults described in Table 1-2 can be announced with a status indicator lamp.
 - One blink, followed by a two-second pause, indicates a shutdown due to high engine coolant temperature.
 - Two blinks, followed by a two-second pause, indicates a shutdown due to loss of engine oil pressure.

 For two-digit shutdown fault codes, the first digit in the code is flashed, followed by a half-second pause, and then the second digit is flashed, followed by a two-second pause.

NOTE: Only the last shutdown fault is flashed.

When a fault is corrected, the Manual Run/Off/Auto switch must be placed in the Off position to reset the control.

OPERATING MODES

The PCC 1301 works with a Manual Run/Off/Auto switch, used to control genset operating modes. This capability is located either in the harness (switch) or is integrated into the optional control panel.

Off Mode

When in Off mode, the control does not allow the genset to start. If the genset is already running and the control is set to Off, it initiates a normal shutdown sequence.

Manual Run Mode

When in Manual Run mode, the genset starts and continues to run until the control is put into the Off mode. While in Manual Run mode, any remote start signal is ignored.

Auto Mode

When in Auto mode, the control allows the genset to be started with a remote start signal only.

When in Auto mode, the genset can start at any time. When a remote start signal is received, the genset starts after a time delay start (if programmed) is completed.

If the genset is running in Auto mode and the Off button is pressed, the control immediately stops the genset and the control transitions to the Off mode.

When all remote start signals are removed, the control performs a normal shutdown sequence which may include a time delay stop.

Emergency Stop Mode

When the optional emergency stop button is used, it immediately shuts down the generator set, bypassing any time delay stop. The red Shutdown LED lights and code 61 - Emergency Stop is either displayed (installations with a control panel) or flashed (installations with a status indicator lamp).

To reset the control, open (disable) the emergency stop button and either press the ① (Off) button (installations that include a control panel) or move the control switch to the OFF position (installations with a Manual Run/Off/Auto switch).

Sleep Mode

The PCC 1301 control enters a low power (sleep) mode of operation where the current draw is not greater than 60 milliamps (DC) at normal battery voltage levels. The control can be set to enter sleep mode after five minutes in the Off or Auto mode if there is no optional display panel.

The control will not enter the sleep mode if there are any active, unacknowledged faults, if the control is in the Manual Run mode, or if there are any active serial communications.

If the S1 switch on the control board is set to the "OFF" (sleep) position (away from the outside edge of the board), the control can only enter sleep mode if it is in Off mode. The control can be awakened by selecting Manual Run mode, selecting Auto mode, or by connecting the InPower engineering tool.

If the S1 switch on the control board is set to the "ON" (awake) position (near the outer edge of the board), the control can only enter sleep mode if it is in Auto mode. The control can be awakened by sending a Remote Start command to the control or by connecting the InPower engineering tool.

Installations with a Control Panel

Sleep mode is automatically enabled on the control panel. When sleep mode is enabled, the display panel turns itself off after five minutes of keypad inactivity. It awakes from sleep mode if any button is pressed.

Sleep mode can be disabled by connecting B+ to pin 4 (power on) of J1 or J2. This can be accomplished by installing a jumper between J1-3 and J1-4 (or between J2-3 and J2-4) on the back of the control panel (see Figure 1-2).

NOTE: J1 and J2 are identical. Either one can be used for the harness connection between the control board and the control panel.

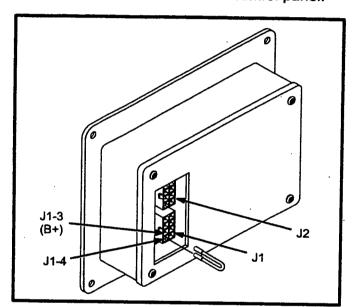


FIGURE 1-2. JUMPER INSTALLATION TO DISABLE SLEEP MODE

Installations with a Manual Run/Off/Auto Switch

For installations that utilize an Manual Run/Off/Auto switch located in the harness, the control awakes from sleep mode if Manual Run or Auto mode is selected.

Battle Short Mode

The purpose of Battle Short is to satisfy local code requirements, where necessary.

Battle Short mode prevents the genset from being shutdown by all but a select few critical shutdown faults. All shutdown faults, including those overridden by Battle Short, must be acted upon immediately to ensure the safety and well being of the operator and the genset.

AWARNING Use of the Battle Short mode feature can cause a fire or electrical hazard, resulting in severe personal injury or death and/or property and equipment damage. Operation of the genset must be supervised during Battle Short operation.

This feature should only be used during supervised, temporary operation of the genset. The faults that are overridden when in Battle Short mode are faults that can affect genset performance or cause permanent engine, alternator, or connected equipment damage. Operation may void the generator set warranty if damage occurs that relates to the fault condition(s).

Only trained and experienced service personnel should enable this feature. When shipped from the factory, this feature is disabled.

Installations with a Control Panel

Battle Short can be enabled or disabled (set to Active or Inactive) using the control panel.

The PC service tool is required to enable the Battle Short mode feature. Contact an authorized service center for assistance.

Before Battle Short can be used on installations with the display panel, the Battle Short Switch Input in the Display Setup submenu must be set to "Operator Panel" (see page 2-11). In addition, Battle Short mode must be enabled (set to Active) in the Battle Short submenu (see page 2-11).

When Battle Short mode is enabled, the Warning status indicator lights, and code 218 - Battle Short Active is displayed.

When Battle Short mode is enabled and an overridden shutdown fault occurs, the shutdown lamp remains lit even though the genset continues to run. Fault code 220 - Fail to Shut Down is displayed. If the , , or button is pressed to acknowledge the fault, the fault message is cleared from the display but remains in the Fault History file with an as-

terisk sign (* indicates an active fault) as long as Battle Short mode is enabled.

Battle Short is suspended and a shutdown occurs immediately if:

- Any of the following shutdown faults occurs.
 - Overspeed Fault code 31
 - Emergency Stop Fault code 61
 - Speed Signal Lost (Loss of Speed Sense) - Fault code 45
 - Excitation Fault (Loss of Voltage Sense) - Fault code 27
- Battle Short mode is disabled after an overridden shutdown fault occurred while in Battle
 Short mode. To disable Battle Short mode,
 navigate to the Battle Short submenu (see
 page 2-11) and select "Inactive." Fault code
 77 Shutdown After Battle Short is then
 displayed.

Installations with a Manual Run/Off/Auto Switch

Battle Short can be turned on or off with a customer installed external switch connected to one of the two customer configured inputs.

The PC service tool is required to enable the Battle Short mode feature and to enable the external Battle Short switch using one of the two available customer inputs. Contact an authorized service center for assistance.

When Battle Short mode is enabled and an overridden shutdown fault occurs, the genset continues to run and the status indicator lamp flashes the shutdown fault code. See "Local Status Output" on page 1-2 for information on interpreting the status indicator light.

Battle Short is suspended and a shutdown occurs immediately if:

- Any of the following shutdown faults occurs.
 - Overspeed Fault code 31
 - Emergency Stop Fault code 61
 - Speed Signal Lost (Loss of Speed Sense) - Fault code 45
 - Excitation Fault (Loss of Voltage Sense) - Fault code 27
- The external Battle Short switch is moved to the OFF position after an active but overridden shutdown fault occurred while in Battle Short mode. The status indicator lamp then flashes fault code 77 – Shutdown After Battle Short.

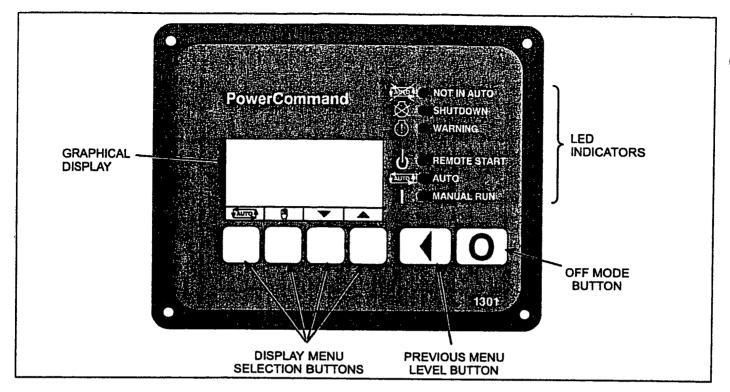


FIGURE 1-3. PCC 1301 OPTIONAL CONTROL PANEL

CONTROL PANEL

Figure 1-3 shows the front of the optional control panel. It includes six LED indicators, the graphical display, and six buttons used to navigate through the menus and adjust parameters.

Graphical Display

This graphical display is used to view menus of the menu-driven operating system. The bottom of the graphical display indicates the functions that are available by pressing the four selection buttons. Refer to the menu trees later in this section.

System messages (communication, event, status, and fault) are also shown on the graphical display. For more information, see page 1-8.

Display Text / Symbolic Versions

Using the Display Setup Service submenu (see page 2-12), the graphical display can be set up to show either text or symbolic versions of fault messages, some Operator menus, and the Mode Change menu. A description of commonly used symbols used are included in Table 1-1. Combinations of symbols are used to display some fault conditions. Additional specialized symbols are also used for some faults (see Table 1-2).

TABLE 1-1. SYMBOLS

SYMBOL	DESCRIPTION		
<u>(I)</u>	Generator Warning Fault		
\bigcirc	Generator Shutdown Fault		
≈	Coolant Temperature		
97	Oil Pressure		
\sim	Voltage Alternating Current (VAC)		
V	Voltage Direct Current (VDC)		
Ã	AC Current		
Hz	Frequency		
- +	Battery		
(>	Out of Range		
↑	High or Pre-High		
+	Low or Pre-Low		
	Annunciator		

Display Menu Selection Buttons

Four momentary soft-key buttons are used to step through the various menus and to adjust parameters. These selection buttons are "active" when a word or symbol in the graphical display is shown above the button. Some submenus do not include any active buttons.

The function of the four selection buttons varies with each menu.

- When the wire symbol is displayed, the selection button can be used to switch to Auto mode.
- When the ® symbol is displayed, the selection button can be used to switch to Manual Run mode.
- When the up and down triangles (▲ and ▼)
 are displayed, the selection buttons are used
 to navigate between a series of submenus.

NOTE: When a fault is displayed, it can be cleared from the front panel by pressing the ▲ or ➤ button.

When a
 symbol is displayed, the selection button can be used to abort the Auto or Manual Run mode and return to the Operator

- menu that was displayed before the Auto or Manual Run mode was selected.
- When ADJUST is displayed, the selection button is used to display an adjustable menu.
 When the ADJUST button is pressed, the first adjustable parameter or value in the submenu is highlighted.
- When the ---> symbol is displayed, the selection button is used to navigate to an editable field within a menu.
- When the + and symbols are displayed, the selection buttons are used to increase or decrease a parameter or value shown on the screen.

When changing values, pressing the button below the + symbol increase the value and pressing the button below the - symbol decreases the value.

- When SAVE is displayed, the selection button is used to save changes made in a submenu. If the Previous Menu button is pressed before pressing SAVE, the changes are not saved.
- Some menus include a list of numbered subjects. These menus include numbers in parenthesis (for example, (1)) displayed above the selection buttons. The selection buttons are then used to display submenus of the subjects included in the list.
- When a black box selection button has no function.

Previous Main Menu Button

Press the button to view the previous main menu.

NOTE: In the Adjust menus, settings are not saved when the button is pressed.

The 1 button is also used to acknowledge warning and shutdown messages after the fault has been corrected. Pressing this button clears the fault from the front panel display.

NOTE: Pressing the → or ▼ button also clears the fault from the front panel display.

Off Button

Press the ① button to switch to the Off mode. The Off mode disables the control Auto or Manual Run modes. Pressing the ② button resets the control.

If the O button is pressed during genset operation (manual or remote start), the engine immediately shuts down. If possible, this hot shutdown should be avoided to help prolong the reliability of the genset.

If a shutdown fault occurs and the fault condition is corrected, pressing the ① button clears the fault from the display and resets the control.

If an emergency stop button is included in your installation, the ① button is also used to reset the control after the emergency stop button is used and then disabled.

Not In Auto Indicator

This red lamp is lit when the control is not in the Auto mode.

Shutdown Indicator

This red lamp is lit when the control detects a Shutdown condition. The generator set cannot be started when this lamp is on. After the condition is corrected, the lamp can be reset by pressing the O (off) button. When Battle Short mode is enabled and an overridden shutdown fault occurs, the Shutdown lamp is lit even though the genset continues to run.

Warning Indicator

This yellow lamp is lit whenever the control detects a warning condition. This lamp is automatically shut off when the warning condition no longer exists.

Remote Start Indicator

This green lamp indicates the control is receiving a remote run signal.

Auto Indicator

This green lamp indicates the control is in Auto mode. Auto mode can be selected by pressing the selection button from any of the Operator menus (see page 1-18).

Manual Run Indicator

This green lamp indicates the control is in the Manual Run mode. Manual Run mode can be selected by pressing the 9 selection button from any of the Operator menus (see page 1-18).

CONTROL PANEL SYSTEM MESSAGES

A system pop-up message is displayed when the event it is displaying becomes active. These pop-up messages remain displayed until pre-empted by another pop-up message or until the \checkmark or the display buttons is pressed. Once the \checkmark or the button is pressed, the previous screen is redisplayed.

Communication Messages

System messages are displayed for initial power-up or when there is a subsequent loss of communications. Auto and Manual Run modes can also be selected when communication messages are displayed (for more information, see page 1-18).

Upon initial power-up, the message "Establishing communication with control" is displayed (see Figure 1-4). This menu also displays the screen's software number and version.

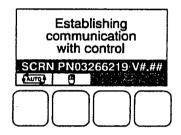


FIGURE 1-4. ESTABLISHING COMMUNICATIONS MESSAGE

When the display detects that it is no longer communicating with the control, the Shutdown, Warning, and Remote Start LEDs are turned off.

If communications are lost, the message "Re-establishing communication with control" is displayed until communications have been re-established (see Figure 1-5). The LEDs then return to the state determined by the control.

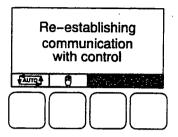


FIGURE 1-5. RE-ESTABLISHING COMMUNICATIONS MESSAGE

If either communication message remains displayed (cannot view other menus), this is an indication that communications between the control panel and the control logic is lost. Contact an authorized service center for service.

Event Messages

When pre-set events (start or stop) are activated, Event messages are displayed showing the time remaining until the event occurs (see Figure 1-6).

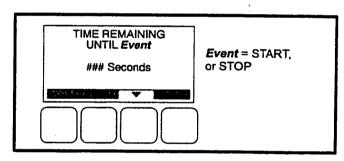


FIGURE 1-6. EVENT MESSAGE

Status Messages

Status messages for some events are displayed with a code number but are not announced with a lamp indicator. Text status messages include the event code, a short description, and the time the event occurred. Symbolic status messages include the event code and symbols to indicate the type of event that occurred. Status messages that are displayed with a code number are listed below. Additional information on these events is included in Table 1-2.

STATUS EVENT	CODE
Ready to Load	150
Not In Auto	153
Common Alarm	155
Common Warning	156
Common Shutdown	157
Cust Input 1	158
Cust Input 2	159
Annunciator Fault 1	160
Annunciator Fault 2	161
Annunciator Fault 3	162

Fault Messages

A Fault message is an indicator of a Warning or Shutdown condition that is also announced with a lamp indicator. Text fault messages include the fault code number, a short description, and when the fault occurred (see Figure 1-7). Symbolic fault messages include the fault code number and symbols, indicating the type of fault (see Figure 1-8). With the symbolic versions of fault messages, the ① and ② symbols flash.

Five of the most recent faults are placed in a fault history file that can be viewed using the Fault History Menus (see page 1-24).

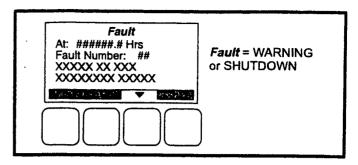


FIGURE 1-7. FAULT MESSAGE - TEXT VERSION

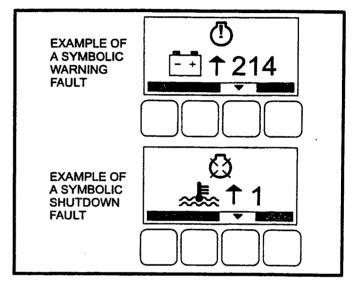


FIGURE 1-8. FAULT MESSAGES - SYMBOLIC VERSION

Fault Acknowledgement

Faults are re-announced if they are detected again after being acknowledged.

FAULT/STATUS CODES

Table 1-2 provides a list of fault and status codes, types, displayed messages/symbols, descriptions, and fault categories.

Category A Fault Codes: Pertain to engine or alternator shutdown faults that require immediate repair by trained and experienced service personnel (generator set non-operational). The control prevents the generator set from being restated if a shutdown fault is not corrected.

Category B Fault Codes: Consist of faults that can affect generator set performance or can cause en-

gine, alternator, or connected equipment damage. Operate the genset only when it is powering critical loads and cannot be shut down. Category B faults require repair by trained and experienced service personnel.

Category C Fault Codes: Consist of faults that are repairable by site personnel. Service will be required by trained and experienced service personnel if site personnel cannot resolve the problem.

Category D Fault Codes: Indicates non-critical operational status of generator set, external faults, or customer fault inputs. These faults require repair by trained and experienced service personnel.

TABLE 1-2. FAULT AND STATUS CODES

			DISPLAYED MESSAGE/SYMBOLS		
CTG	CODE	LAMP	TEXT VERSION	SYMBOLIC VERSION	DESCRIPTION
С	1 **	Shutdown	HIGH COOLANT TEMP	≈€ .↑1	Indicates that the engine coolant temperature is above normal and has reached the shutdown trip point.
Α	2 **	Shutdown	LOW OIL PRESSURE	₹ 12	Indicates the engine oil pressure has dropped below normal and has reached the shutdown trip point.
A	12 **	Shutdown	HIGH AC VOLTAGE	v ↑ 12	Indicates that the one or more measured AC output voltages has exceeded the threshold for longer than a specified time limit. The threshold and time limits are 130% of nominal for 0 seconds or 110% of nominal for 10 seconds.
Α	13 **	Shutdown	LOW AC VOLTAGE	ṽ ↓ 13	Indicates that the measured AC output voltage is below the threshold for longer than a specified time limit. The threshold and time limits are 85% of nominal for 10 seconds.
Α	14 **	Shutdown	OVER FREQUENCY	Hz† 14	Indicates that the alternator frequency is 6 hertz above the governor reference.
Α	15 **	Shutdown	UNDER FREQUENCY	Hz ↓ 15	Indicates that the alternator frequency is 6 hertz under the governor reference.
Α	27	Shutdown	EXCITATION FAULT	፟ 27	Indicates that a loss of voltage or frequency sensing from the generator has occurred.
А	31 **	Shutdown	OVERSPEED	€ 2 ↑ 31	Indicates that the engine has exceeded normal operating speed. The default thresholds are 1725 RPM (50 Hz) or 2075 RPM (60 Hz).
Α	38	Shutdown	FIELD OVERLOAD	፟ 38	Indicates that the Field AVR Duty Cycle has been at the maximum continuously for 15 seconds.

- For more information on these events, refer to the Battle Short Mode description on page 1-4.
- ** Any values listed in the Description column for these faults are default values. If authorized, these values can be changed using the Genset Setup menus (see page 2-28).

TABLE 1-2. FAULT AND STATUS CODES (CONT.)

	DISPLAYED MESSAGE/SYMBOLS						
СТБ	CODE	LAMP	DISPLATED WES				
CIG		LAMP	TEXT VERSION	SYMBOLIC VERSION	DESCRIPTION		
A	45	Shutdown	SPEED SIGNAL LOST	፟ 45	Indicates that no magnetic pickup pulses were sensed for a Loss of Speed delay. If a magnetic pickup is not installed, then speed sensing is performed by monitoring AC line frequency.		
A	46 **	Shutdown	HIGH AC CURRENT	à ↑ 46	Indicates that alternator output current (one or more phases) has exceeded 150% of the rated output current continuously for more than 10 seconds.		
С	61	Shutdown	EMERGENCY STOP	① 61	Indicates an Emergency Stop has been activated.		
Α	71 **	Shutdown	SPEED HZ MATCH	N≠HZ 71	Indicates that measured engine speed and measured alternator AC output frequency do not agree.		
С	72	Shutdown	FAIL TO CRANK	! 72	The genset has failed to sense rotation for two start attempts. This indicates a possible fault with the control, speed sensing, or the starting system.		
С	73	Shutdown	FAIL TO START	¾ 73	The genset has failed to start after a set number of crank attempts. This indicates a possible fuel system problem (engine cranks but fails to start).		
В	74	Shutdown	FAIL TO STOP	Ø 74	The genset continues to run after receiving a shutdown command from the controller.		
D	75	Shutdown	Customer Input 1	፟ 75	The nature of the fault is an optional customer selection.		
D	76	Shutdown	Customer Input 2	፟ 76	The nature of the fault is an optional customer selection.		
В	77 *	Shutdown	SHUTDOWN AFTER BS	② 77	A shutdown fault occurred while the Battle Short mode was enabled.		
D	81	Shutdown	Annunciator Fault 1	□ 81	The nature of the annunciator fault is an optional customer selection.		
D	82	Shutdown	Annunciator Fault 2	□ ⋈ 82	The nature of the annunciator fault is an optional customer selection.		
D	83	Shutdown	Annunciator Fault 3	□≒ 83	The nature of the annunciator fault is an optional customer selection.		
D	150	None	READY TO LOAD	፟ 150	The genset is at rated voltage and frequency.		
D	153	None	NOT IN AUTO	153	Indicates that the PCC 1301 control is not in the Auto mode.		

^{*} For more information on these events, refer to the Battle Short Mode description on page 1-4.

^{**} Any values listed in the Description column for these faults are default values. If authorized, these values can be changed using the Genset Setup menus (see page 2-28).

TABLE 1-2. FAULT AND STATUS CODES (CONT.)

DI			DISPLAYED MESSAGE/SYMBOLS		
СТС	CODE	LAMP	TEXT VERSION	SYMBOLIC VERSION	DESCRIPTION
D	155	None	COMMON ALARM	① 155	The control has detected a Warning or Shutdown fault.
D	156	None	COMMON WARNING	① 156	The control has detected a Warning fault.
D	157	None	COMMON SHUTDOWN	፟ 🔯 157	The control has detected a Shutdown fault.
D	158	None	Customer Input 1	! 158	The nature of the fault is an optional customer selection.
D	159	None	Customer Input 2	<u>(¹)</u> 159	The nature of the fault is an optional customer selection.
D	160	None	Annunciator Fault 1	□ 160	The nature of the annunciator fault is an optional customer selection.
D	161	None	Annunciator Fault 2	□≒ 161	The nature of the annunciator fault is an optional customer selection.
D	162	None	Annunciator Fault 3	□≒ 162	The nature of the annunciator fault is an optional customer selection.
С	202 **	Warning	PRE-HIGH COOLANT TEMP	≈ ↑ 202	Indicates that the engine has begun to overheat and the engine coolant temperature has risen to an unacceptable level.
С	203 **	Warning	LOW COOLANT TEMP	≈ € ↓ 203	Indicates that the engine coolant temperature is below the adjusted setpoint. This may indicate that the coolant heater is not operating or is not circulating coolant.
D	204	Warning	Customer Input 1	① 204	The nature of the fault is an optional customer selection.
D	205	Warning	Customer Input 2	<u>(†)</u> 205	The nature of the fault is an optional customer selection.
В	212	Warning	COOLANT SENSOR OOR	≈ \$\dag{\psi} \psi 212	Indicates the coolant temperature sensor output is out of range (OOR), high or low.
С	213 **	Warning	LOW BATTERY	<u>-</u> + 213	Indicates battery voltage supply to the control is approaching a low level at which unpredictable operation can occur.
С	214 **	Warning	HIGH BATTERY	<u>-</u> ↑ 214	Indicates battery voltage supply to the control is approaching a high level at which damage to the control can occur.
С	215 **	Warning	PRE-LOW OIL PRESSURE	₹7. 1215	Indicates that the engine oil pressure is approaching an unacceptable level.

For more information on these events, refer to the Battle Short Mode description on page 1-4.

^{*} Any values listed in the Description column for these faults are default values. If authorized, these values can be changed using the Genset Setup menus (see page 2-28).

TABLE 1-2. FAULT AND STATUS CODES (CONT.)

1			DISPLAYED ME	SSAGE/SYMBOLS	
СТС	CODE	LAMP	TEXT VERSION	SYMBOLIC VERSION	DESCRIPTION
В	216**	Warning	HIGH AC CURRENT	à † 216	Indicates that the alternator output current (one or more phases) has exceeded 130% of nominal, or has exceeded 110% of nominal for 60 seconds.
В	217	Warning	OIL PRESS SENSOR OOR	空小小217	Indicates the oil pressure sensor output is out of range (OOR), high or low.
С	218 *	Warning	BATTLE SHORT ACTIVE	① 218	Indicates that the control is in Battle Short mode – used to bypass several fault shutdowns for genset operation during emergencies.
В	219 **	Warning	CHARGER FAILURE		Indicates the battery charging alternator has not reached a acceptable voltage range within the selected time period (default = 120 seconds).
				① 219	This warning is also displayed if your alternator is a type that does not support the control's charging alternator logic functionality. If this occurs, this warning can be disabled if the Charging Alt. Enable setting is set to "No." See the Genset Service submenus on page 2-8.
В	220 *	Warning	FAIL TO SHUTDOWN	<u>(†</u>) 220	Indicates that a shutdown fault is active, but is being bypassed by Battle Short.
С	221 **	Warning	WEAK BATTERY	<u>-</u> + 221	Indicates that the genset battery voltage is below battery thresholds during cranking.
D	222	Warning	Annunciator Fault 1	□≒ 222	The nature of the annunciator fault is an optional customer selection.
D	223	Warning	Annunciator Fault 2	□ ≥ 223	The nature of the annunciator fault is an optional customer selection.
D	224	Warning	Annunciator Fault 3	□≒ 224	The nature of the annunciator fault is an optional customer selection.
D	225	Warning	ANNUNCIATOR OUTPUT CON- FIGURATION ERROR	□≒ 225	Indicates a mismatch in the configuration of one of the annunciator relay outputs.
NOTE:	Shutdov	vn fault code	e can also be enneur	200d with a last 1	

^{*} For more information on these events, refer to the Battle Short Mode description on page 1-4.

Any values listed in the Description column for these faults are default values. If authorized, these values can be changed using the Genset Setup menus (see page 2-28).

ADJUSTING DEFAULT SETTINGS

The optional control panel can be set up to display with SAE or SI units of measurement.

For more information, see the Adjust Screen menu shown on page 1-26.

SAVING YOUR CHANGES

All adjustments made to menus are temporary until the **SAVE** button is pressed. If the **SAVE** button is pressed and the engine is running, the adjustments are not saved until after the engine speed is zero. If power is lost to the control before a SAVE is executed, all temporary adjustments are lost.

Adjustments to the following are stored in flash memory in the optional display panel.

- Contrast
- Brightness
- Units
- Local or remote display
- · Symbols or text displayed
- Access code required for mode change to Auto or Manual Run

All other adjustments are stored in the control board.

When the **SAVE** button is pressed, the previous menu is redisplayed.

OPERATOR MENUS

Figures 1-9 and 1-10 show block representations of the following Operator menus.

- Engine Status
- Alternator Status
- Line-to-Line Voltage
- Line-to-Neutral Voltage
- Alternator Amperage

To navigate between the Operator menus, press the buttons next to the ▲ and ▼ symbols in the graphical display.

The Operator menus can be used to select Auto or Manual Run modes (see page 1-18).

Engine Status Menu

This menu displays the engine starting battery voltage, engine coolant temperature, engine oil pressure, and hours of engine operation.

Alternator Status Menu

This menu displays genset load (in kVA), frequency, and engine speed (RPM).

Alternator Line-to-Line Voltage Menu

This menu displays L1-L2, L2-L3, and L3-L1 line-to-line voltages for three phase applications only.

Alternator Line-to-Neutral Voltage Menu

This menu displays line-to-neutral voltages for L1, L2, and L3 for three phase wye configurations only. In delta configurations, this menu is not shown.

Alternator Single Phase Voltage Menu

This menu displays L1-N, L2-N, and L1-L2 voltages for single phase applications only.

Alternator Amperage Menu

For applications that include current transformers, this menu displays L1, L2, and L3 current sense amperage.

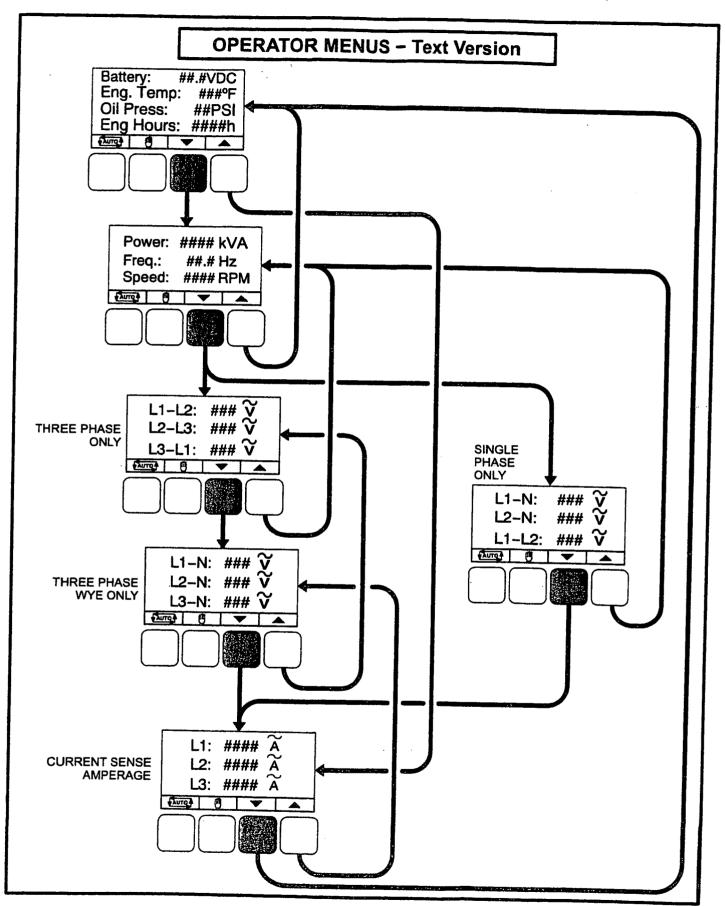


FIGURE 1-9. OPERATOR MENUS (TEXT VERSION)

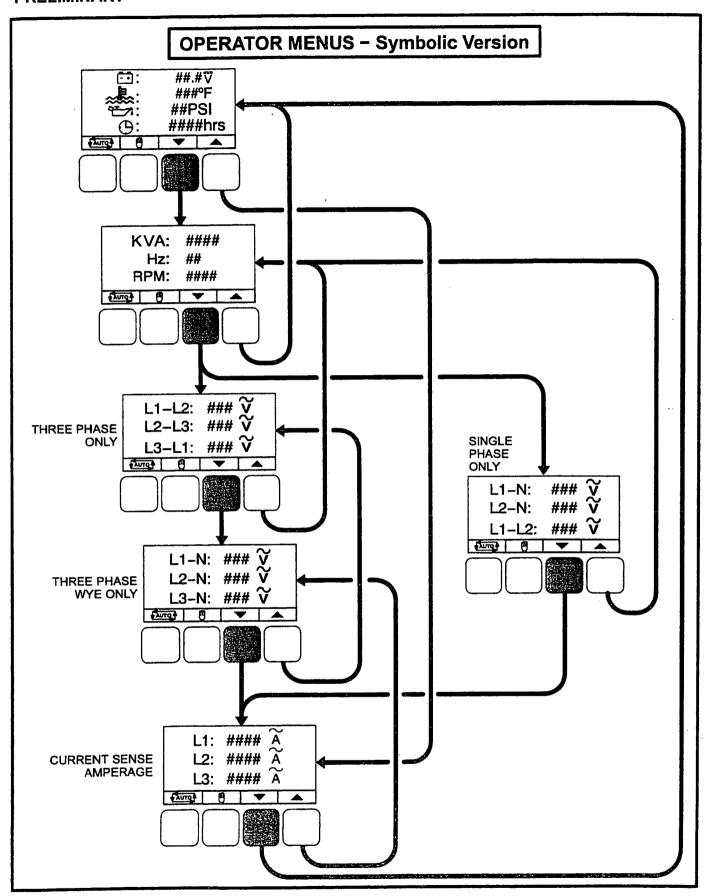


FIGURE 1-10. OPERATOR MENUS (SYMBOLIC VERSION)

1-16

SELECTING AUTO AND MANUAL RUN MODES

Auto and Manual Run modes can be selected:

- · From any of the Operator menus
- When the message "Establishing communication with control" is displayed
- When the message "Re-establishing communication with control" is displayed

Switching to Auto or Manual Run mode can be restricted to authorized personnel. If a control panel is set up with the mode change access code feature enabled, an access code must first be entered before the mode can be changed.

Entering the Mode Change Access Code

If the mode change feature access code is enabled, an access code must be entered to switch to Auto or Manual Run modes. The text and symbolic versions of the Mode Change menu are shown in Figure 1-11. To enter the mode change access code,

- With the first character highlighted, press the button below to the + or - symbols until the value reads "1."
- 2. Press the arrow selection button → to move to the next numeric character.
- 3. Press the button below the + or symbols until the value reads "2."

- Press the arrow selection button → to move to the next numeric character.
- 5. Press the button below the + or symbols until the value reads "1."
- 6. After you have completed entering the password, press the arrow selection button →.

NOTE: If an incorrect password is entered, the Operator menu that was displayed before Auto or Manual Run mode was selected is redisplayed.

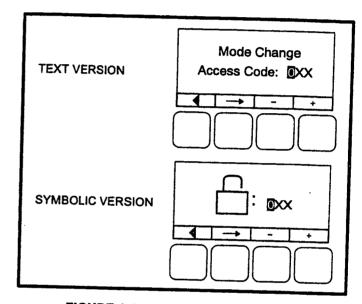


FIGURE 1-11. MODE CHANGE MENU

Selecting Auto Mode

To switch to Auto mode (see Figure 1-12),

- 1. Press the button on any of the Operator menus or the "Establishing/Re-establishing communication with control" menus.
- If the mode change access code feature is enabled, the Mode Change Access Code menu is displayed. Enter the mode change access code as described above.
- 3. A menu with alternating arrows is displayed above a second form symbol. Press the second form button. The Operator menu that was displayed before Auto mode was selected is redisplayed.

To disable Auto mode, press the **O** button.

NOTE: Manual Run mode can also be selected while in Auto mode.

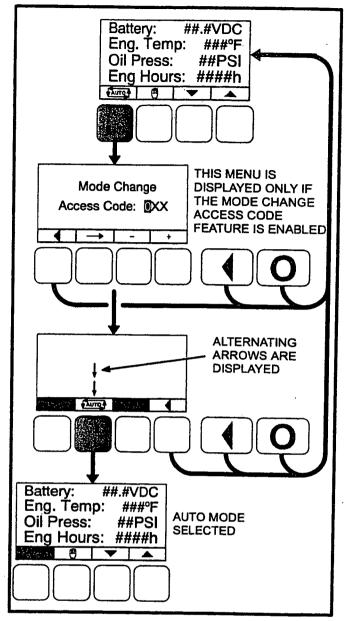


FIGURE 1-12. SELECTING AUTO MODE

Selecting Manual Run Mode

To switch to Manual Run mode (see Figure 1-13),

To switch to Manual Run mode,

- Press the button on any of the Operator menus or the "Establishing/Re-establishing communication with control" menus.
- If the mode change access code feature is enabled, the Mode Change Access Code menu is displayed. Enter the mode change access code as described on the previous page.
- 3. A menu with alternating arrows is displayed above a second of symbol. Press the second of button. The Operator menu that was displayed before Manual Run mode was selected is redisplayed.

To disable Manual Run mode, press the O button.

NOTE: Auto mode can also be selected while in Manual Run mode. Switching to Auto mode may result in the generator set shutting down.

Aborting the Transition to Auto or Manual Run Mode

If the Mode Change Access Code menu or the menu showing alternating arrows above the word or buttons is displayed, the transition to Auto or Manual Run mode is aborted when:

- Either the ◀, ◀, or O button is pressed.
- A selection button is not pressed within ten seconds.

If the transition to Auto or Manual Run mode is aborted, the Operator menu that was displayed be-

fore Auto or Manual Run mode was selected is redisplayed

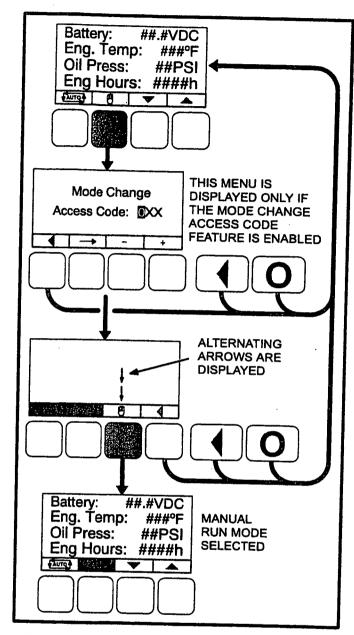


FIGURE 1-13. SELECTING MANUAL RUN MODE

SERVICE MENUS

Figure 1-14 shows a block representation of the menus available from the Service Menus.

The first Service Menu can be viewed from any of the Operator menus by simultaneously pressing the and selection buttons for two seconds. The first Service Menu provides access to the following menus:

- Setup Menus Used by Service personnel.
 Adjusting the Setup menus is restricted by a
 password and is described in the Control
 Service section. To view the Setup menus
 only, press the VIEW button on the Setup
 password menu.
- History / About see page 1-22
- Screen Adjust see page 1-26

To return to the Operator menu that was displayed prior to viewing the Service Menu, press the button.

The second Service Menu can be viewed by pressing the ▼ selection button on the first Service Menu. The second Service Menu provides access to the following menus:

- Fault History see page 1-24
- Status see below
- Lamp Test The six LEDs on the control panel should light as long as the button (6) is pressed.

The third Service Menu can be viewed by pressing the selection button on the second Service Menu. The third Service Menu provides access to the Network Status menus.

Network Status Menus

The Network Status menus are displayed when the (7) button is pressed on the third Service Menu. Two menu are used to display the quantity of the following devices that are connected to the network.

- Auto Mains Failure (AMF) modules
- Universal Annunciators
- · Bar graphs
- Battery chargers
- Controls
- I/O modules
- Operator panels (any type)

Status Menu

The Status menu is displayed when the (5) button is pressed on the second Service Menu. The Status menu shows the following:

- Voltage regulator (drive) level, in percentage of duty cycle
- Governor regulator (drive) level, in percentage of duty cycle. This value is only displayed if the governor is enabled.

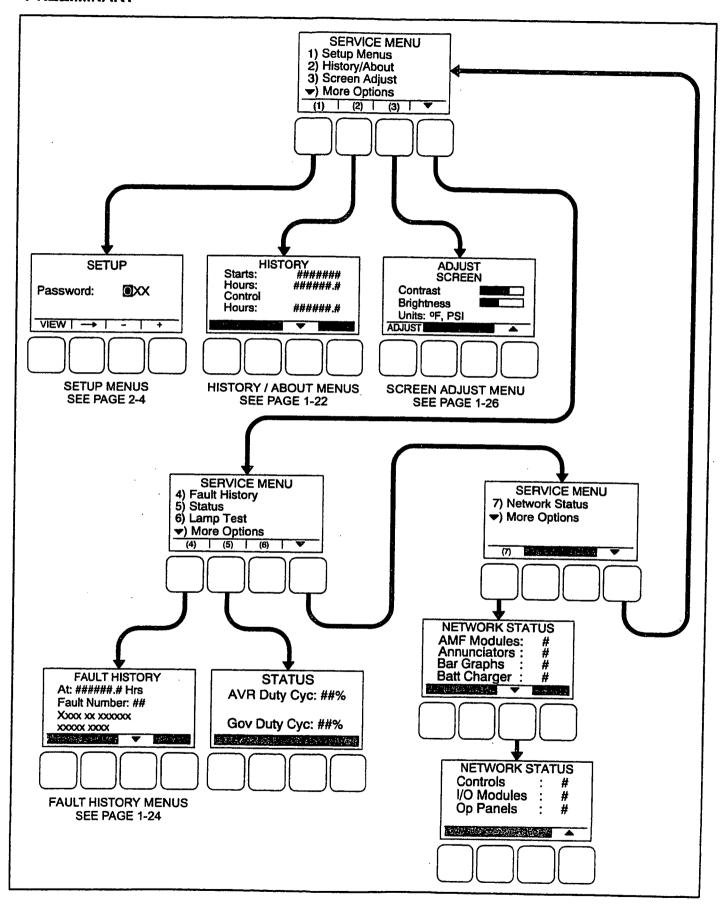


FIGURE 1-14. SERVICE MENUS

1-21

HISTORY / ABOUT MENUS

Figure 1-15 shows a block representation of the History / About menu. The first History / About submenu is displayed when the (2) button is pressed on the Service Menu.

History Submenu

This submenu displays the number of engine starts, hours of operation for the engine, and hours of operation for the control.

About Genset Submenus

Two submenus display the generator set model number, control number, and genset application frequency rating.

About Control Submenu

This submenu displays the control's part number, serial number (up to 11 characters), software part number (up to 9 characters), and software version.

About Display Submenu

This submenu displays the optional control panel software part number, software version, screen part number, and screen version of the display.

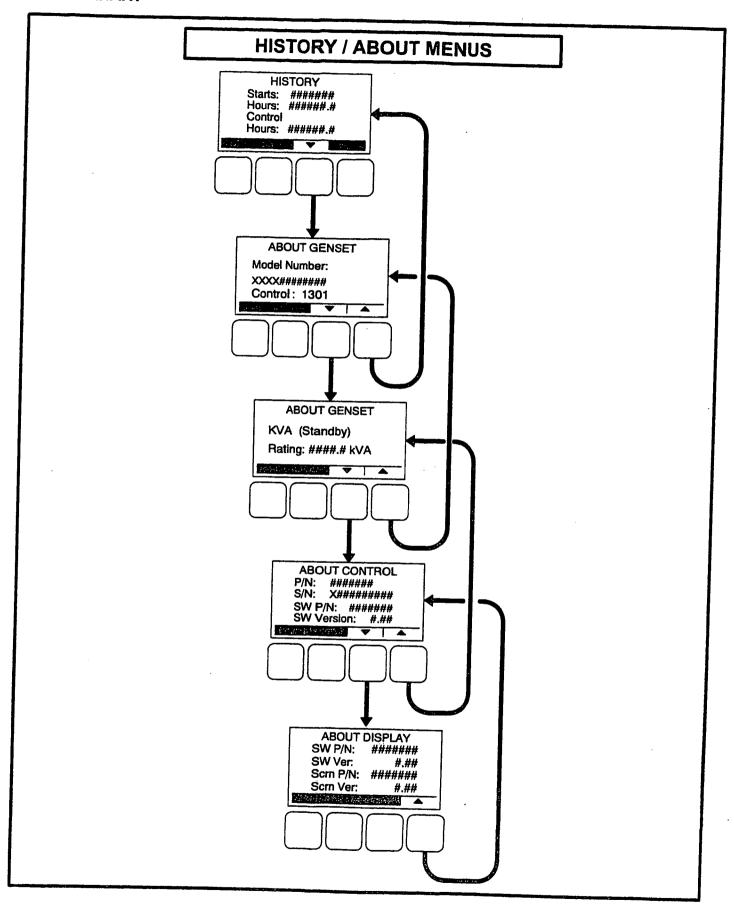


FIGURE 1-15. HISTORY / ABOUT MENUS

1-23

FAULT HISTORY MENU

Figure 1-17 shows a block representation of the Fault History menu. The first Fault submenu is displayed when the (4) button is pressed on the first Service Menu. If there are any active fault submenus, an "Active Fault" heading is displayed for the most recent active fault. All other fault submenus display a "Fault History" heading. Five of the most recent faults can be viewed. An example of how a fault code is displayed is shown in Figure 1-16.

Press the buttons next to the riangle and riangle symbols in the graphical display to navigate between menus.

Press the button to return to the Service Menu.

Information on faults is included in Table 1-2 on page 1-10.

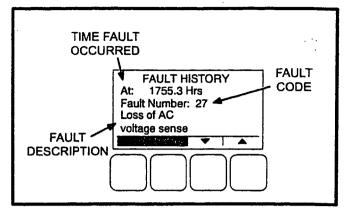


FIGURE 1-16. FAULT HISTORY MENU EXAMPLE

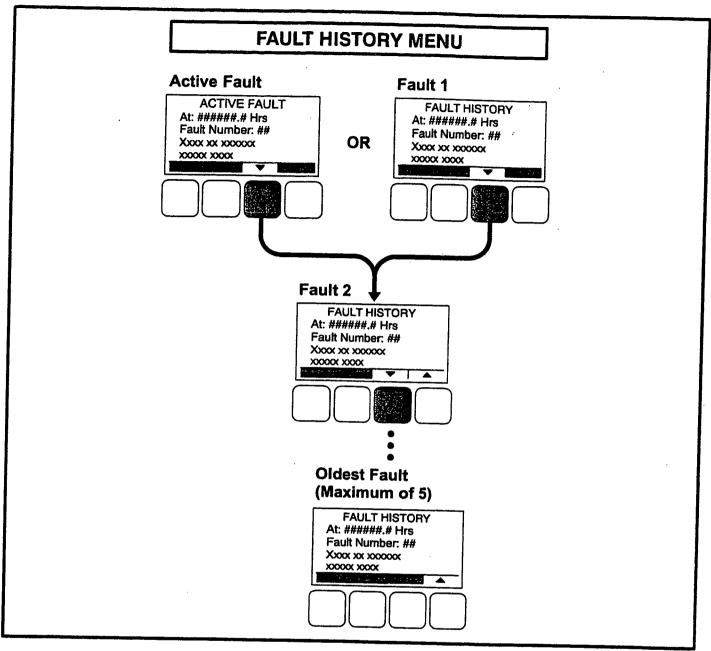


FIGURE 1-17. FAULT HISTORY MENU

SCREEN ADJUST MENU

Figure 1-18 shows a block representation of the Screen Adjust menu. The Screen Adjust submenu is displayed when the (3) button is pressed in the first Service Menu.

Adjusting Values/Parameters

- 1. Press the **ADJUST** selection button to select the first parameter or value to be changed.
- 2. Press the + or selection buttons to adjust values or select parameters.
- Press the arrow selection button → to navigate to the next or previous adjustable value or parameter.
- After adjusting values/selecting parameters, press the SAVE button to save your settings.

- NOTE: If the Previous Menu button is pressed before pressing the SAVE button, the changes are not saved.
- 5. Press the button to return to the Service Menu.

Screen Adjust Menu

This menu allows for adjusting the screen's contrast and brightness and for selecting the units of measurement (SAE or SI) to be displayed.

- Contrast and Brightness: Press the + or selection buttons to adjust the screen's contrast and brightness. Changing the brightness setting also affects the brightness of the LEDs on the control panel.
- Units: Press the + or selection buttons to select SAE (°F, PSI) or SI (C, kPa) units of measurement to be displayed.

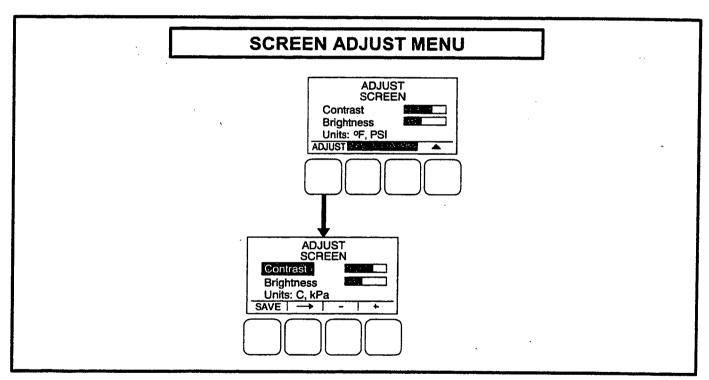


FIGURE 1-18. SCREEN ADJUST MENU

2. PCC 1301 Control Service

SERVICE MENUS

Figure 2-1 shows a block representation of the menus available from the Service Menu.

- Setup Menus See page 2-3
- · History / About
- Screen Adjust

Changes can be made to Adjust submenus without entering a password. However, a password is required to change any of the Setup submenus.

To return to the Operator menu that was displayed prior to viewing the Service Menu, press the 4 button.

The second Service Menu can be viewed by pressing the ▼ selection button on the first Service Menu. The second Service Menu provides access to the following menus:

- Fault History
- Status
- Lamp Test The six LEDs on the control panel should light as long as the button (6) is pressed.

The third Service Menu can be viewed by pressing the selection button on the second Service Menu. The third Service Menu provides access to the Network Status menus. The Network Status menus are displayed when the (7) button is pressed on the third Service Menu. Two menu are used to display the quantity of the following devices that are connected to the network.

- Auto Mains Failure (AMF) modules
- Universal Annunciators
- Bar graphs
- Battery chargers
- Controls (PCC 1301)
- I/O modules
- Operator panels (any type)

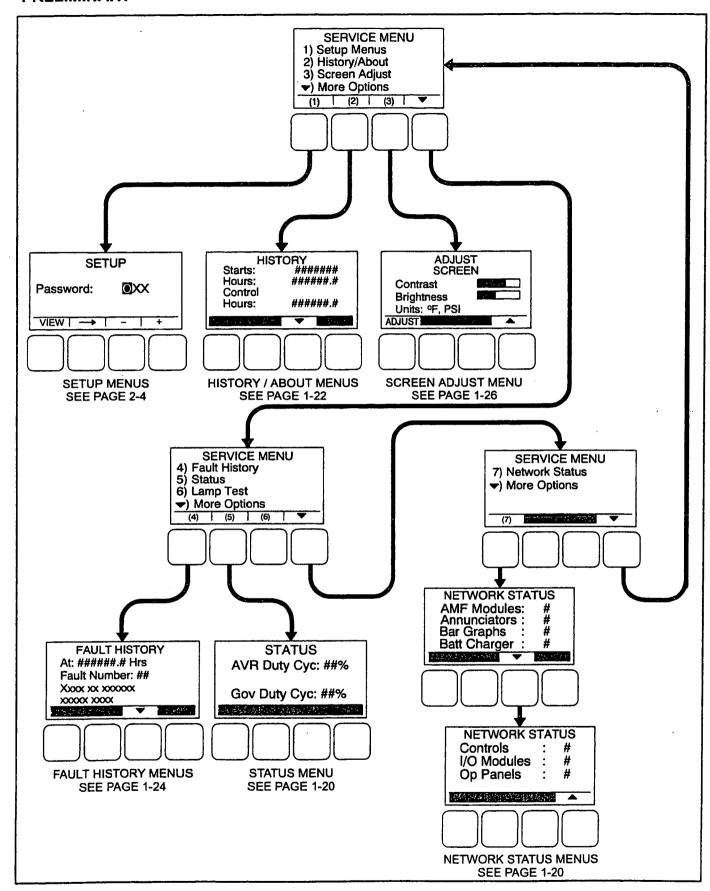


FIGURE 2-1. SERVICE MENUS

SETUP MENUS

The Setup Menus (see Figure 2-2) provide access to genset menus with settings that can be viewed and, if a password is entered, adjusted.

The first Setup menu is displayed when the (1) button is pressed on the Service Menu. From the Setup Password menu, a second Setup menu is displayed that provides access to the following two categories of genset menus.

- Genset Service menus
- Genset Setup menus Go to page 2-26

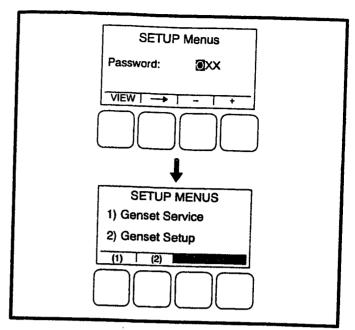


FIGURE 2-2. SETUP MENUS

GENSET SERVICE MENUS

This section covers Genset Service menus only. For information on Genset Setup menus, go to page 2-26.

If a password is entered, the settings in the Genset Service menus can be adjusted. However, if a password is not entered, these menus can still be viewed.

Viewing Only

Figure 2-3 is a block representation of the four Genset Service menus that are available when a password is not entered (or an incorrect password is entered) in the Setup Password menu.

- Genset
- Customer I/O
- Meter Calibration
- Annunciator

The Genset Service menus can be viewed by selecting the VIEW button on the Setup Password menu and then selecting (1) on the second Setup menu. When the VIEW button is selected without entering the correct password, the ADJUST button is not displayed on any of the Genset Service menus; therefore, no adjustments can be made.

Menu Navigation

- Press the buttons above the
 and
 symbols in the digital display to navigate between submenus.
- 2. To return to the genset Setup Menus menu from any of the submenus, press the button:
- 3. To return to the Service Menu from the genset Setup Menus menu, press the button.

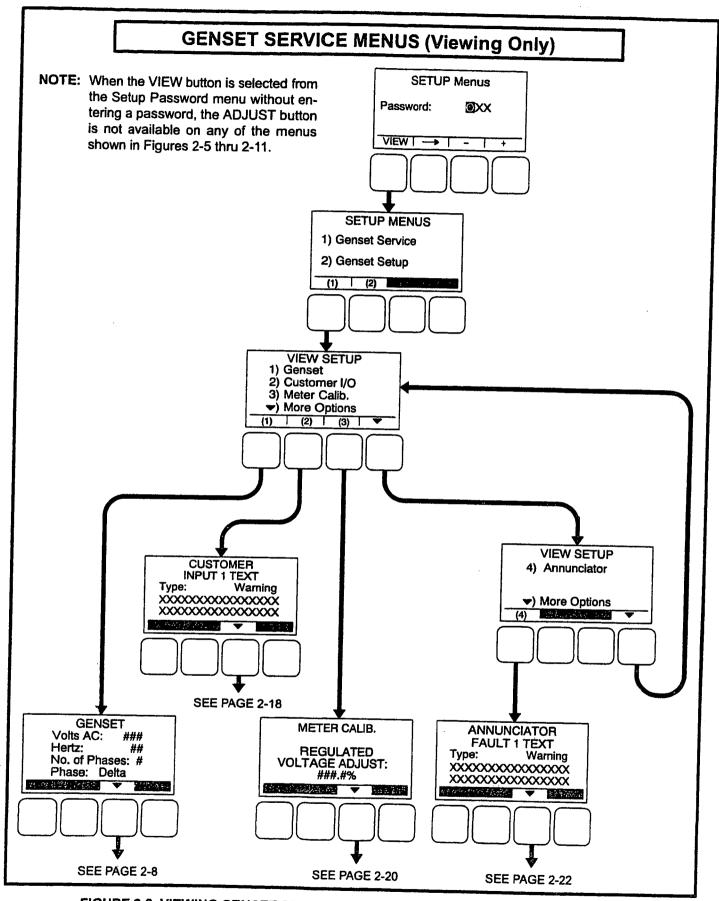


FIGURE 2-3. VIEWING GENSET SERVICE MENUS WITHOUT ENTERING A PASSWORD

Viewing and Adjusting

Figure 2-4 is a block representation of the four Genset Service menus that are available from the Setup Menus menu after the correct password has been entered. The **ADJUST** button is available on these submenus; therefore, adjusting the settings is allowed.

- Genset
- Customer I/O
- Meter Calibration
- Annunciator

Setup Password Submenu

Adjusting the Genset Service menus is restricted to service personnel and a password must be entered to modify these menus.

When the Password menu is displayed, the first numeric character (0) is highlighted (see Figure 2-4).

NOTE: When selected (highlighted), each character initially turns to "0" and the remaining characters turn to "X".

NOTE: Make sure that each numeric character is correct before you move to the next character. If a wrong character is entered, you will not be able to go back and correct it. If the wrong password is entered, you will be able to view the Genset Service menus but you won't be able to change them.

To enter the password:

- 1. With the first character highlighted, press the button below to the + or symbols until the value reads "5."
- 2. Press the arrow selection button to move to the next numeric character.
- 3. Press the button below the + or symbols until the value reads "7."

- 4. Press the arrow selection button → to move to the next numeric character.
- 5. Press the button below the + or symbols until the value reads "4."
- 6. After you have completed entering the password, press the arrow selection button →.

 The first main Setup menu is displayed.

After the correct password is entered, it will be remembered until five minutes of button inactivity has elapsed. If five minutes of button inactivity has elapsed, you will have to re-enter the password to access and change Setup menus.

Adjusting Values/Parameters

Once the correct password has been entered and Genset Service (1) is selected on the Setup Menus menu, the first Genset Service submenu is displayed.

- Press the buttons above the

 and
 symbols in the digital display to navigate between submenus.
- 2. Press the **ADJUST** selection button to select the first parameter or value to be changed.
- 3. Press the + or selection buttons to adjust values or select parameters.
- Press the arrow selection button → to navigate to the next or previous adjustable value or parameter.
- 5. After adjusting values/selecting parameters, press the **SAVE** button to save your settings.
 - NOTE: If the button is pressed before pressing the SAVE button, the changes are not saved.
- 6. Press the button to return to the Service Menu.

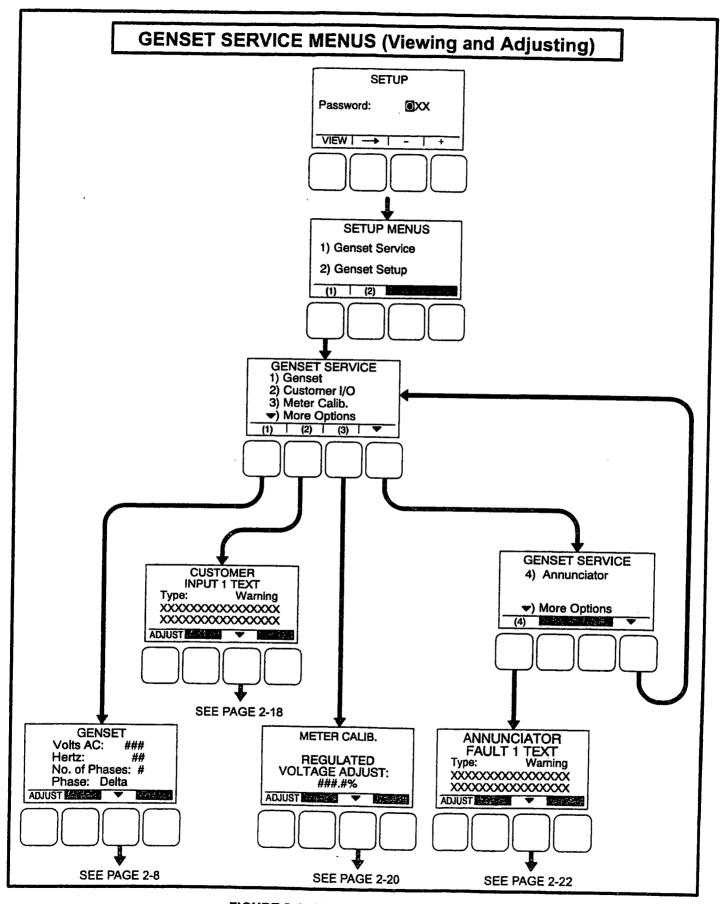


FIGURE 2-4. GENSET SERVICE MENUS

Genset Service Submenus

The Genset Service submenus consist of nine basic submenus.

- Genset, Part 1
- Genset, Part 2
- Start/Stop Time Delays
- Cycle Drank
- Battle Short
- Automatic Voltage Regulator Setup*
- Electronic Governor*
- Genset Model and Serial Number
- Display Setup
- * If enabled, the Automatic Voltage Regulator has two additional submenus and the Electronic Governor has five additional submenus.

Genset Submenu, Part 1

The first genset submenu displays the preset AC Voltage, genset frequency, number of phases, and phase type.

- Volts AC: Displays the AC voltage (190, 200, 208, 220, 230, 240, 380, 400, 416, 440, 460, or 480 VAC, default = 208).
- Hertz: Displays the genset frequency (50 or 60 Hz, default = 60 Hz). The control selects limits, gains, and frequency values based upon this selection.
- No. of Phases: Displays the number of phases (1 or 3, default = 3).
- Phase: Displays the phase type (Delta or Wye default = Wye).

Genset Submenu, Part 2

The second genset submenu allows for enabling or disabling glow plugs and charging alternators.

- Glow Plug: Allows control of Glow Plugs for a particular genset (Yes or No, default = No)
- Charging Alt. Enable: While the default setting is "Yes," this menu provides a means to disable the control's charging alternator logic if it is not supported by your alternator. If your alternator does not support this functionality, the Charger Failure warning (fault code 219) will constantly be displayed. When disabled, the start disconnect signal is based only on the average engine speed or frequency and the warning is disabled.

Start/Stop Delay Submenu

The time delay after receiving a valid start signal, until the genset starts, can be adjusted. The time delay that the genset is allowed to ruin at rated speed after receiving a stop signal, until the genset stops, can also be adjusted. These time delays do not apply to manual start/runs.

- Start: The genset start time delay can be adjusted from 0 to 300 seconds (default = 0 seconds).
- Stop: The genset stop time delay can be adjusted from 0 to 600 seconds (default = 0 seconds).

Cycle Crank Submenu

The Cycle Crank submenu allows for configuring the generator for all starting modes (manual and remote), as follows:

- Crank: The cranking period can be set from 3 to 30 seconds (default = 15 seconds). This time limit is used to determine a Fail to Start status.
- Rest: The minimum amount of time between crank attempts can be set from 0 to 60 seconds (default = 30 seconds).
- Attempts: The maximum number of times the starter can be engaged when attempting to start the engine with cycle cranking can be set from 1 to 7 attempts (default = 3).

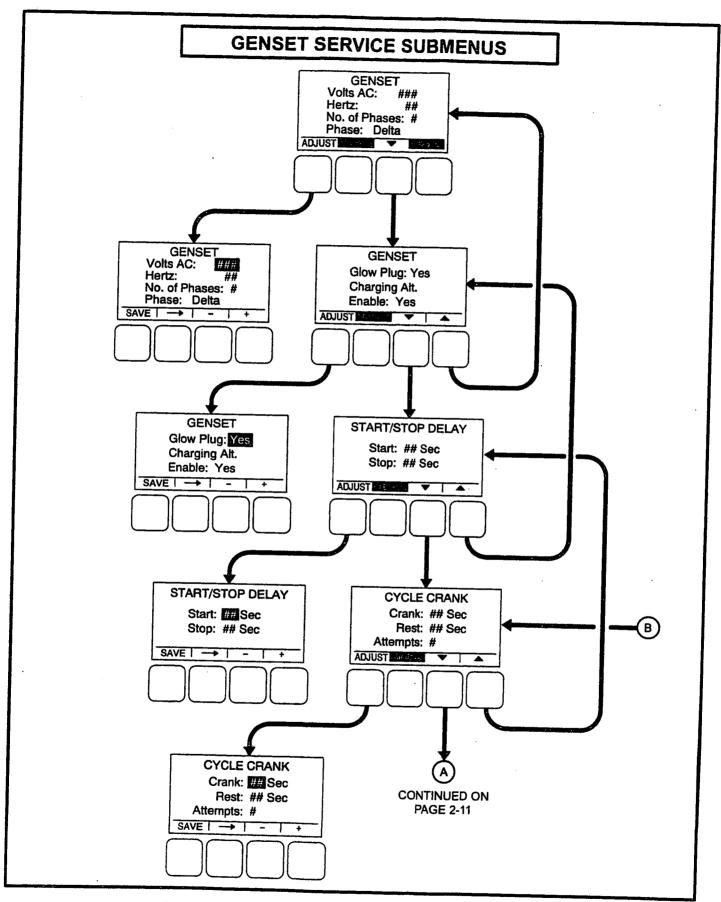


FIGURE 2-5. GENSET SERVICE SUBMENUS (SHEET 1 OF 3)

Rattle Short Submenu

Before the Battle Short feature can be used, it must be enabled with the Battle Short submenu. If desired, the Battle Short submenu also allows for selecting one of three available activation sources.

- Battle Short: The Battle Short feature can be enabled or disabled (set to Active or Inactive), (default = Inactive).
- Switch Input: The Switch Input can be set for Customer Input 1, Customer Input 2, Operator Panel, or None (default = None).

AVR Setup Submenu

The AVR Setup submenu is used to enable or disable the automatic voltage regulator (default = Yes). If enabled, two additional submenus are displayed that can be used to adjust the AVR settings (see page 2-15).

Electronic Governor Submenu

The engine Electronic Governor Enable submenu is used to enable or disable the electronic governor on gensets with electronic governors and magnetic pickup sensors (default = Yes). If enabled (set to "Yes"), four additional submenus are displayed that can be used to adjust governor settings (see page 2-17).

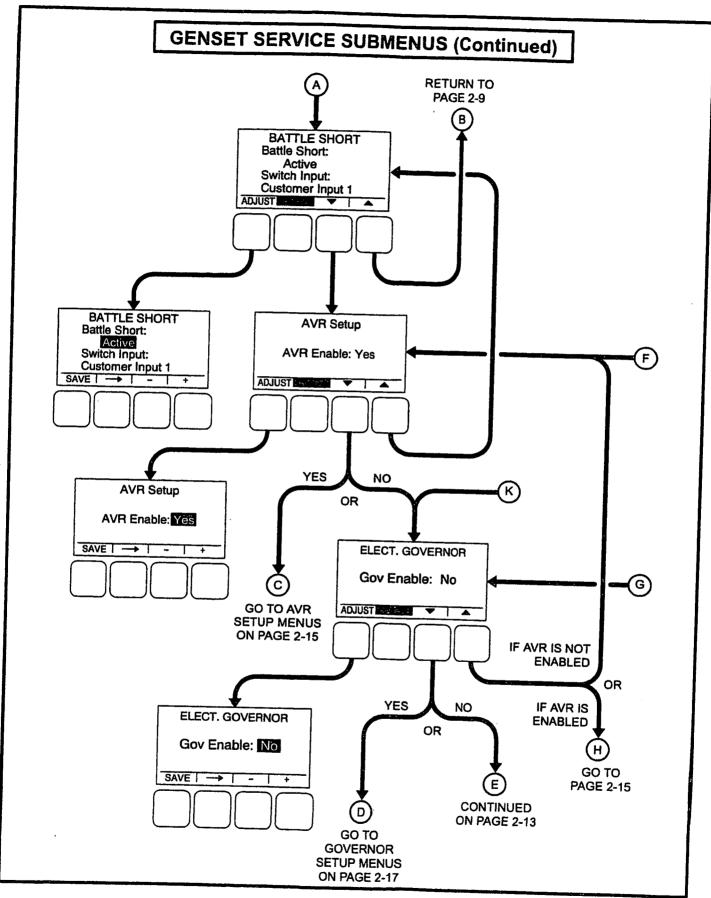


FIGURE 2-5. GENSET SERVICE SUBMENUS (SHEET 2 OF 3)

Genset Number Submenu

The Genset Number submenu is used to enter the genset's model and serial numbers. Each allow up to 16 characters to be entered.

Display Setup Submenu

The Display Setup submenu is used to set the display for Local (Auto/Off/Manual Run switch functions on the operator panel are turned on) or Re-

mote (Auto/Off/Manual Run switch functions on the operator panel are turned off).

- Connection: A display can be set up to be Local or Remote (default = Local).
- Access Code: A display can be set up to require or not require entering the mode change access code (default = No).
- Symbols: A display can be set up to display international symbols on the Operator menus (default = Yes).

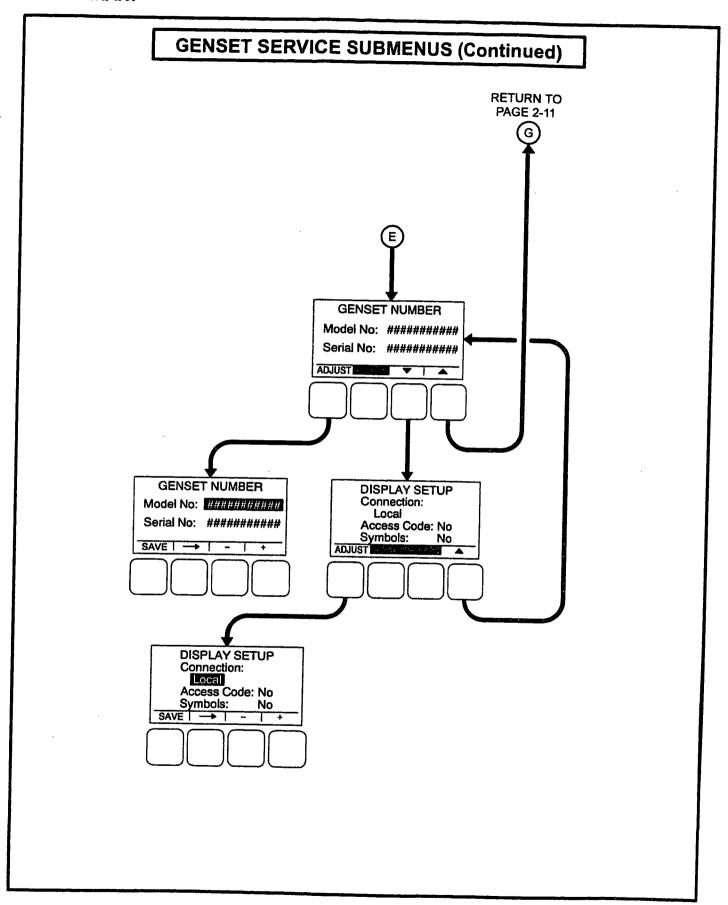


FIGURE 2-5. GENSET SERVICE SUBMENUS (SHEET 3 OF 3)

Automatic Voltage Regulator Submenus

Two Automatic Voltage Regulator (AVR) submenus (see Figure 2-7) can be used to adjust Volts/Hz Rolloff and Regulator Gains settings.

Volts/Hz Rolloff Submenu

The Volts/Hz Rolloff function helps optimize the genset's response to added load. If the engine speed drops below nominal frequency, the control automatically drops the voltage until the engine speed starts to recover.

This submenu allows for adjusting the knee frequency and voltage setpoint slope parameters. The knee frequency is the value below nominal frequency at which the rolloff function begins. For example, if the knee frequency is set to 5 Hz on a 60 Hz genset, this function begins when the frequency drops below 55 Hz.

Slope refers to how fast the voltage is rolled off below the knee frequency. The voltage is rolled off the slope percent setting for every 1 Hz below the knee. For example, on a 60 Hz genset, if the slope is set to 5% and the knee frequency is set to 5 Hz, then if the frequency drops to 54 Hz, the voltage set point is reduced 5%. If the frequency drops to 53 Hz, the voltage set point is reduced 10%, etc.

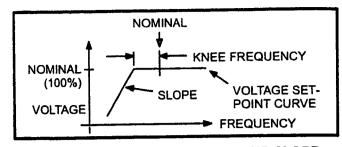


FIGURE 2-6. KNEE FREQUENCY AND SLOPE

- V/Hz Knee: The Knee Frequency can be adjusted from 0.0 to 10.0 Hertz in 0.1 Hz increments (default = 1.0 Hz). When generator set speed decreases by more than the value of the knee frequency, the generator set voltage decreases by the %/Hz value.
- V/Hz Rolloff. The Rolloff setting can be adjusted from 0.0 to 5.0 percent of rated voltage, in 0.1% increments (default = 2.0%).

Regulator Gains Submenu

The Regulator submenu allows for setting Gain, Integral Gain, and Damping values.

- Gain: The Gain adjustment for K1, K2, and K3 can be set from 5 to 1000% (default = 100%). This allows for a scale factor of 0.05 to 10.0.
- Int: The Integral Gain adjustment can be set from 5 to 1000% (default = 100%).
- D: The Damping value can be set from 95 to 105% (default = 100%).

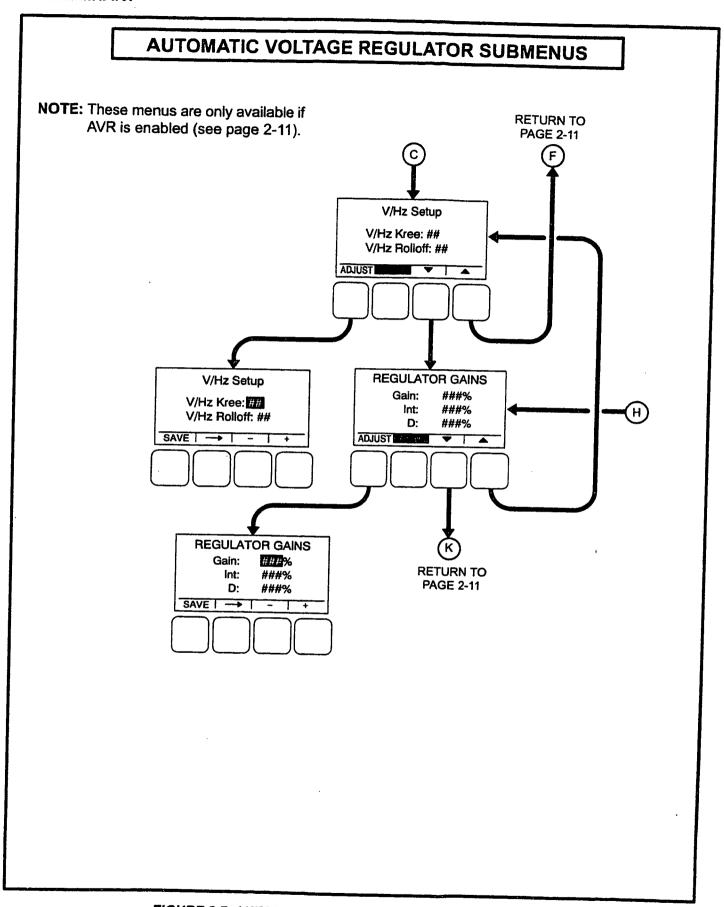


FIGURE 2-7. AUTOMATIC VOLTAGE REGULATOR SUBMENUS

2-15

Electronic Governor Submenus

Four Electronic Governor submenus (see Figure 2-8) can be used to adjust governor settings.

Governor Crank Fuel Submenu

The Governor Crank Fuel Submenu allows for setting the Initial Crank Fuel Duty Cycle, the Initial Crank Fueling Period, the Crank Fuel Ramp Rate, and the Maximum Crank Fuel Duty Cycle.

- Initial DC: The Initial Crank Fuel Duty Cycle is the initial value assigned to the Governor Duty Cycle parameter when cranking begins. This value can be set from 0 to 50 percent (default = 25%)
- Initial Time: The Initial Crank Fueling Period is the amount of time for which the value of Initial Crank Fuel Duty Cycle is assigned to the governor duty cycle after cranking begins. This value can be set from 0 to 10 seconds (default = 2 seconds).
- Ramp Rate: The Crank Fuel Ramp Rate is the rate at which the value of the Governor Duty Cycle is ramped up by during the Crank State, after expiration of the Initial Crank Fueling Period. This value can be set from 5 to 100 (default = 25).
- Max DC: The Maximum Crank Fuel Duty
 Cycle is the maximum level to which the Governor Duty Cycle should be limited to during
 a crank state. This value can be set from 50
 to 100% (default = 100%).

Electronic Governor Regulator Submenu

The Electronic Governor Regulator submenu allows for setting Gain, Integral Gain, and Damping values.

 Gain: The Gain adjustment for K1, K2, and K3 can be set from 5 to 1000% (default =

- 100%). This allows for a scale factor of 0.05 to 10.0.
- Int: The Integral Gain adjustment can be set from 5 to 1000% (default = 100%).
- D: The governor Damping value can be set from 95 to 105% (default = 100%).

Electronic Governor Submenu

The Electronic Governor submenu allows for setting Crank Exit Fuel DC, Dither Factor, and Damping values. This menu is displayed only if the governor has been enabled with the Engine Electronic Governor Enable submenu.

- Crank Exit Fuel DC: The Crank Exit Fuel
 Duty Cycle is the value at which the governor
 duty cycle is held after disengaging the starter until the governor is enabled. This value
 can be set from 0 to 100% (default = 25%).
- Dither Factor: The Dither Factor is the dither percent added to the current duty cycle. The Dither Factor can be set from 0 to 30% (default = 15%). The dither function is disabled when the dither factor is set to 0%.
- Ramp Time: This feature is used to set the minimum governor speed reference ramp rate. The governor Ramp Time can be set from 0.00 to 30.0 seconds, in 0.01 second increments (default = 0.25 seconds).

Electronic Governor Enable Speed Submenu

These submenus allow for setting the minimum and maximum governor duty cycle.

- Min. Gov DC: The Minimum Governor Duty Cycle can be set from 0 to 100% (default = 5%).
- Max. Gov DC: The Maximum Governor Duty Cycle (with dithered value) can be set from 0 to 100% (default = 95%).

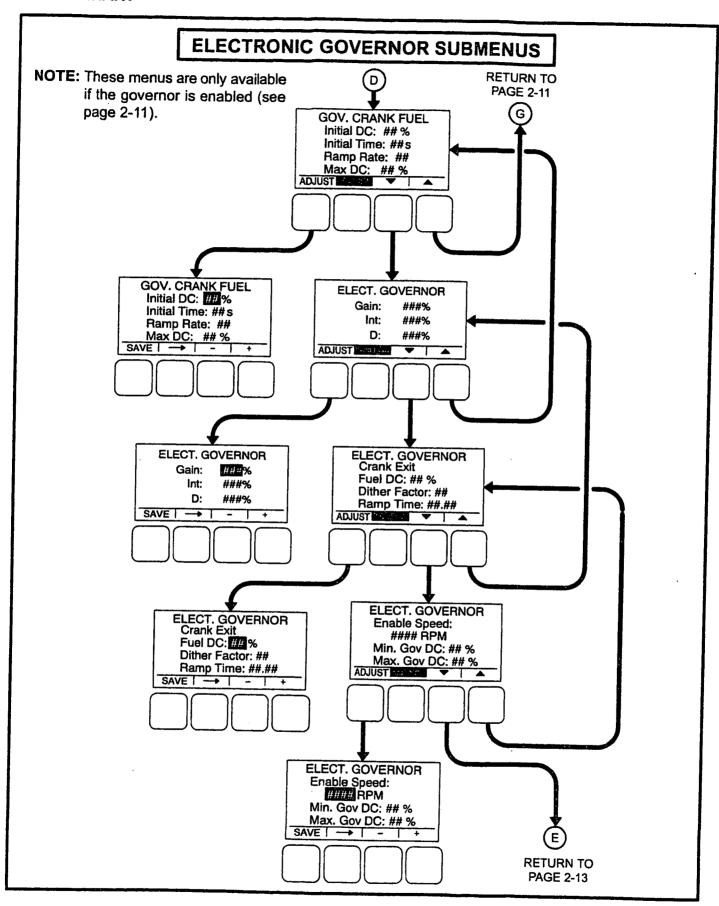


FIGURE 2-8. ELECTRONIC GOVERNOR SUBMENUS

Customer I/O Submenus

Four Customer I/O submenus (see Figure 2-9) can be used to define customer input messages and output maps.

Customer Inputs

The Customer Input Text message submenus are used to enter an event type and description for two events.

Type: Enter the event type (Warning, Shutdown or Event, default = Warning).

• Enter a brief description of the event (up to 32 characters).

Customer Outputs

Two Customer Outputs are configurable to display common warning alarms. The two Customer Output Map submenus allow for entering a fault number and fault name to be displayed for the two configurable customer outputs.

- Number: Enter a code number (0-255, default = 0) for the event.
- A brief description of the event is automatically displayed.

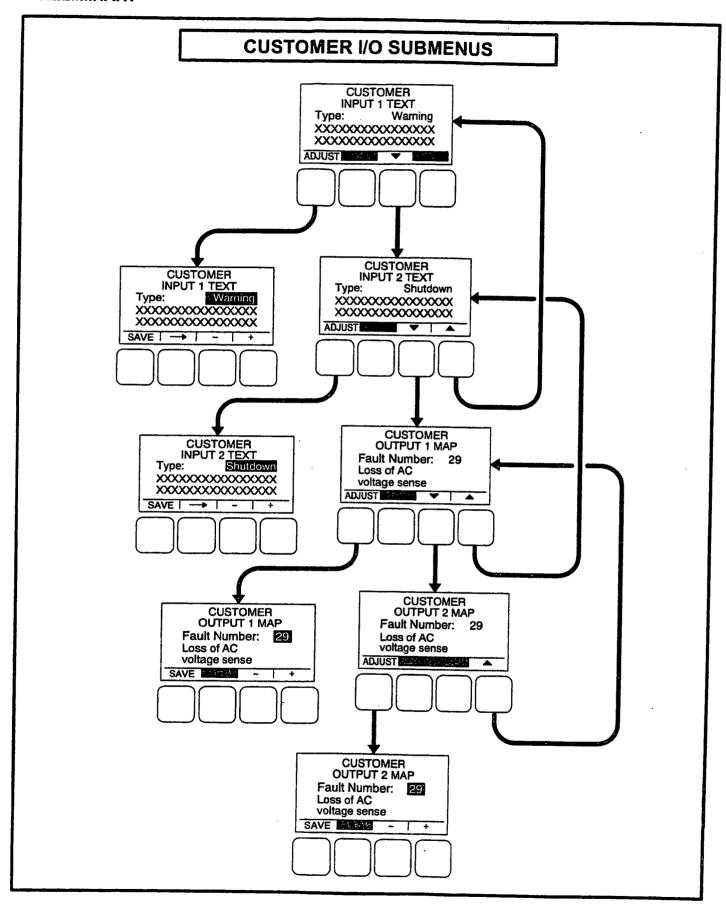


FIGURE 2-9. CUSTOMER I/O SUPMENUS

2-19

Metering Submenus

Three Metering submenus (see Figure 2-10) can be used to adjust regulated voltage, frequency, line-to-neutral voltage, and line current settings.

Meter Calib Submenu

The Meter Calib submenu allows for adjusting the actual output voltage of the genset. The percentage can be set from 90 to 110% (default = 100%). The alternator voltage is also shown on this submenu.

Freq. Adjust Submenu

The Frequency Adjust submenu allows for adjusting the genset frequency. The frequency can be adjust from -6.0 to +6.0 Hz (default = 0.0 Hz). The actual frequency is also shown on this submenu.

Metering Voltage Adjust Submenu

The Metering Voltage Adjust submenu allows for adjusting metered line voltage.

Metering Current Adjust Submenu

The Metering Current Adjust submenu allows for adjusting metered amps.

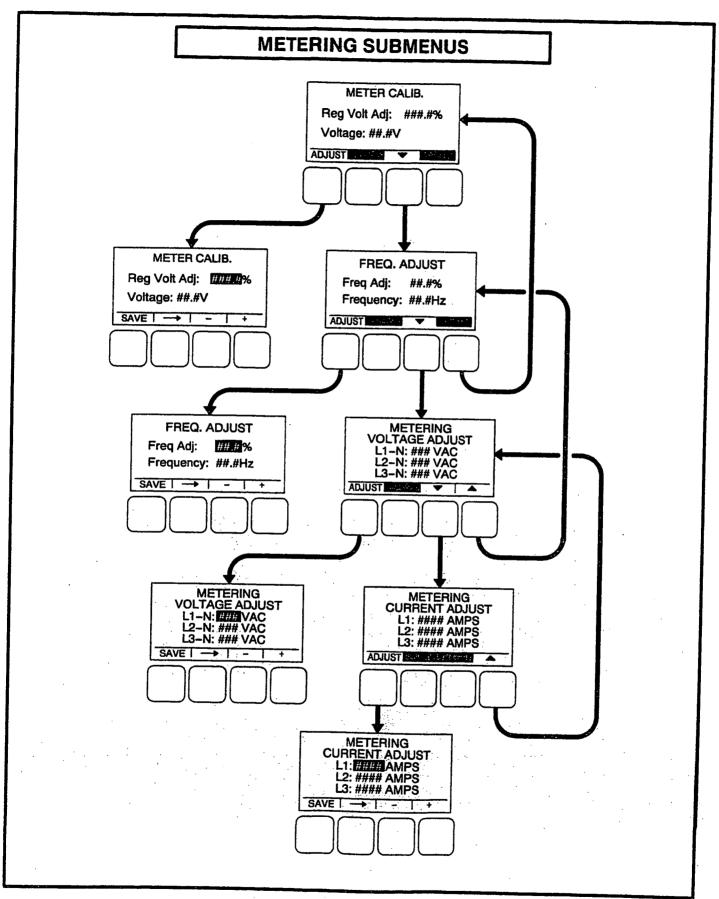


FIGURE 2-10. METERING SUBMENUS

2-21

Annunciator Submenus

Seven Annunciator submenus (see Figure 2-11) can be used to define three Annunciator Fault Text messages and four Annunciator Output Maps.

Annunciator Inputs

The Annunciator Fault Text message submenus are used to enter an event type and description for three events.

- Type: Enter the event type (Warning, Shutdown or Event, default = Warning).
- Enter a brief description of the event (up to 32 characters).

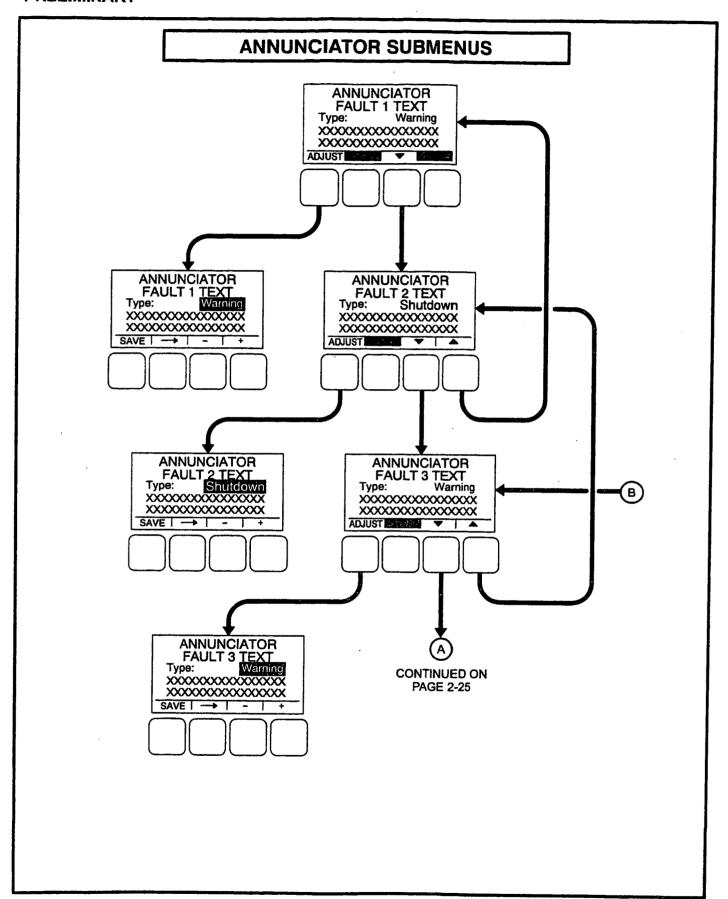


FIGURE 2-11. ANNUNCIATOR SUBMENUS (SHEET 1 OF 2)

Annunciator Outputs

Four Annunciator Outputs are configurable to display common warning alarms. The four Annunciator Output Map submenus allow for entering a fault number and fault name to be displayed for the configurable annunciator outputs.

- Number: Enter a code number (0-255, default = 0) for the event.
- A brief description of the event is automatically displayed.

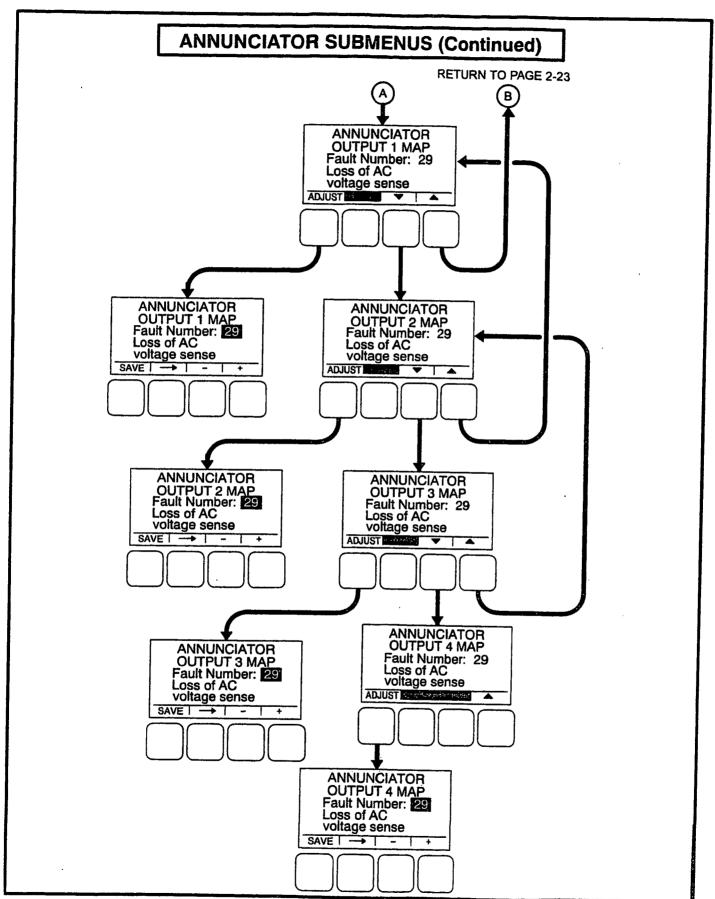


FIGURE 2-11. ANNUNCIATOR SUBMENUS (SHEET 2 OF 2)

GENSET SETUP SUBMENUS

The first Setup menu is displayed when the (1) button is pressed on the Service Menu. From the Setup Password menu, a Setup Menus menu is displayed that provides access to the following two categories of genset menus.

- Genset Service menus Go to page 2-3
- · Genset Setup menus

This section covers Genset Setup menus only. A password does not need to be entered on the Setup Password menu in order to view or adjust the Genset Setup submenus.

When the (2) button is selected to access Genset Setup menus, a second password menu (Genset Setup Password) is displayed (see Figure 2-12). If a password is entered on the Genset Setup Password, the settings in the Genset Setup menus can be adjusted. However, if a password is not entered, these menus can still be viewed.

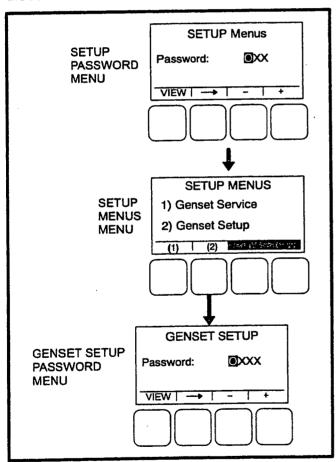


FIGURE 2-12. SETUP PASSWORD MENUS

Viewing Only

Figure 2-13 is a block representation of the four Genset Setup menus that are available when a password is not entered (or an incorrect password is entered) in the Genset Setup Password menu.

- Genset
- Voltage Protection
- Current Protection
- Engine Protection

The Genset Setup submenus can be viewed by selecting the **VIEW** button on the Genset Setup Password menu. When the VIEW button is selected without entering the correct password, the **ADJUST** button is not displayed on any of the Genset Setup menus; therefore, no adjustments can be made.

Menu Navigation

- 1. Press the buttons above the ▲ and ▼ symbols in the digital display to navigate between submenus.
- 2. To return to the genset Setup Menus menu from any of the submenus, press the 1 button.
- 3. To return to the Service Menu from the genset Setup Menus menu, press the button.

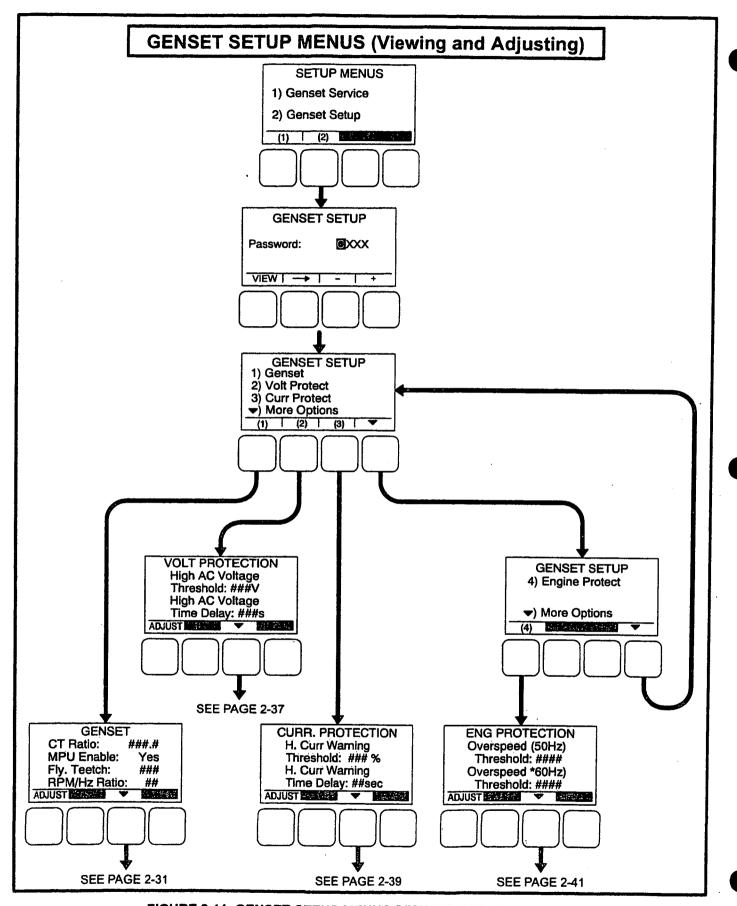


FIGURE 2-14. GENSET SETUP MENUS (VIEWING AND ADJUSTING)

Genset Submenu

The Genset Setup submenu is used to set the CT Ratio, enable the Magnetic Pickup Unit (MPU), set the number of teeth pulses per revolution on the Flywheel, and set the Speed/Frequency Ratio.

- CT Ratio: The CT Ratio value must be set to match the CT Ratio of the current transformers on the genset (default = 150.5).
- MPU Enable: Displays whether or not the Magnetic Pickup Unit is installed (Yes or No, default = No).
- Fly. Teeth: The total number of teeth pulses per revolution on the flywheel (used for electronic governed systems) can be set from 0 to 256 (default = 110).
- RPM/Hz Ratio: Allows for setting the Speed/ Frequency Ratio to 20, 30, or 60 RPM/Hz (default = 30).

Application Rating Select Submenu

The genset application rating can be set to either Standby or Prime (default = Standby).

Standby kVA Rating Submenu

The kVA Rating submenu displays the kVA rating of single-phase or three-phase, 50 or 60 hertz standby genset systems. These value are used by the control to determine what is 100% load. The values must match the kVA rating of the genset application and cannot be more than 2000 kVA.

- 3Ph/50Hz: The three phase, 50 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).
- 3Ph/60Hz: The three phase, 60 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).
- 1Ph/50Hz: The single phase, 50 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).
- 1Ph/60Hz: The single phase, 60 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).

Prime kVA Rating Submenu

The kVA Rating submenu displays the kVA rating of single-phase or three-phase, 50 or 60 hertz prime genset systems. These value are used by the control to determine what is 100% load. The values must match the kVA rating of the genset application and cannot be more than 2000 kVA.

- 3Ph/50Hz: The three phase, 50 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).
- 3Ph/60Hz: The three phase, 60 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).
- 1Ph/50Hz: The single phase, 50 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).
- 1Ph/60Hz: The single phase, 60 Hertz rating can be set from 0 to 2000 kVA (default = 25 kVA).

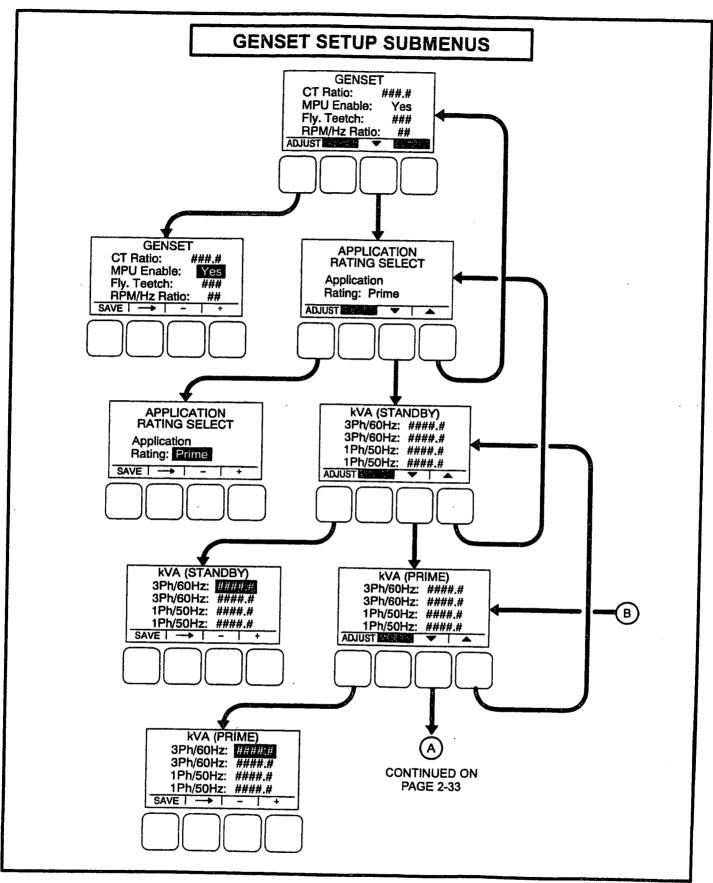


FIGURE 2-15. GENSET SETUP SUBMENUS (SHEET 1 OF 3)

Battery Select Submenu

The Battery Select submenu is used to set the nominal battery voltage.

 Nominal Battery Voltage: Allows for setting the nominal battery voltage (12 or 24V, default = 12V).

Battery Thresholds Submenus

The Battery Thresholds submenu is used to set the low and high voltage values to determine when the battery voltage is out of the set range during normal operation. This submenu is also used to determine when the battery voltage is below weak battery thresholds during cranking. The Battery Thresholds submenu that is displayed is dependent upon the

battery voltage entered in the Battery Select submenu.

- Low Batt: The low battery voltage threshold can be set from 11.0 to 13.0 VDC for 12 volt batteries (default = 12.0 VDC) and from 22.0 to 27.0 VDC for 24 volt batteries (default = 24.0 VDC), in 0.1 VDC increments.
- High Batt: The high battery voltage threshold can be set from 14.0 to 17.0 VDC for 12 volt batteries (default = 16.0 VDC) and from 28.0 to 34.0 VDC for 24 volt batteries (default = 32.0 VDC), in 0.1 VDC increments.
- Weak Batt: The weak battery voltage threshold can be set from 6.0 to 10.0 VDC for 12 volt batteries (default = 8.0 VDC) and from 12.0 to 16.0 VDC for 24 volt batteries (default = 14.4 VDC), in 0.1 VDC increments.

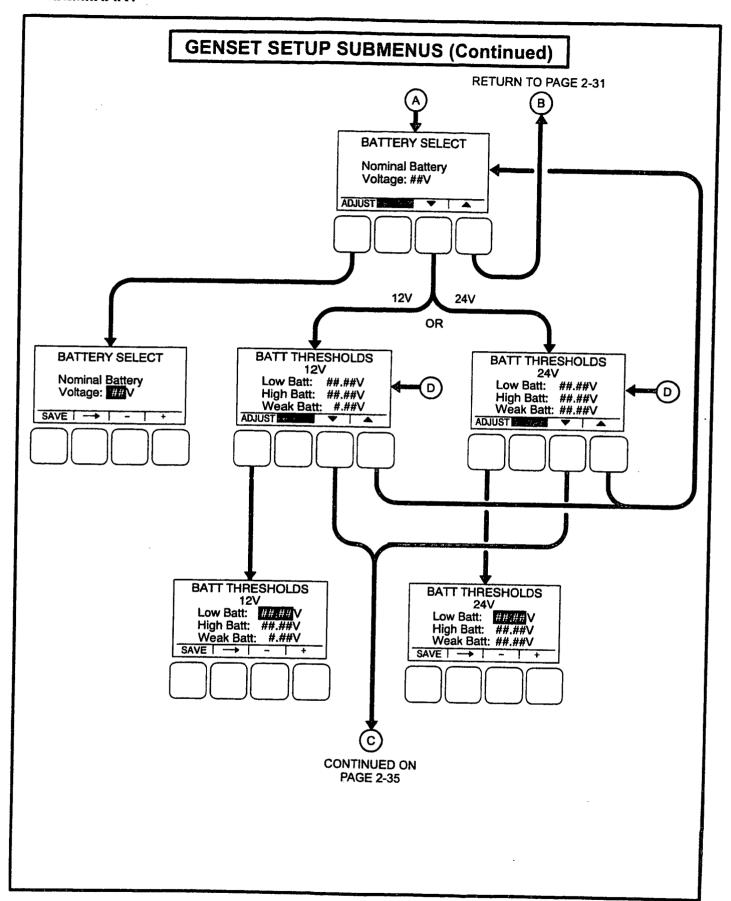


FIGURE 2-15. GENSET SETUP SUBMENUS (SHEET 2 OF 3)

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Battery Delay Setup Submenu

This submenu is used to determine when, after determining that the battery condition is out of the preset operating range, a warning message is announced.

- L. Batt TD: A time delay from 2 to 60 seconds (default = 60 seconds) can be set before the Low Battery warning message (fault code 213) is announced.
- H. Batt TD: A time delay from 2 to 60 seconds (default = 60 seconds) can be set before the High Battery warning message (fault code 214) is announced.
- Wk Batt TD: A time delay from 1 to 5 seconds (default = 2 seconds) can be set before the Weak Battery warning message (fault code 221) is announced.

Oil Pressure Setup Submenus

A submenu is available to set the sensor type. If the sensor type is Switch, then another menu is available to set the sensor polarity. If the sensor type is Sender, then another menu is available to set the sender type.

- Sensor Type: The sensor type can be set for either Switch or Sender (default = Switch).
- Sensor Polarity: This submenu is displayed only if the sensor type is set to Switch. Sensor polarity can be set to either Active Low or Active High (default = Active Low).
- Sender Type: This submenu is displayed only
 if the sensor type is set to Sender. The sender type can be set to either 2 Wire or 3 Wire
 (default = 2 Wire).

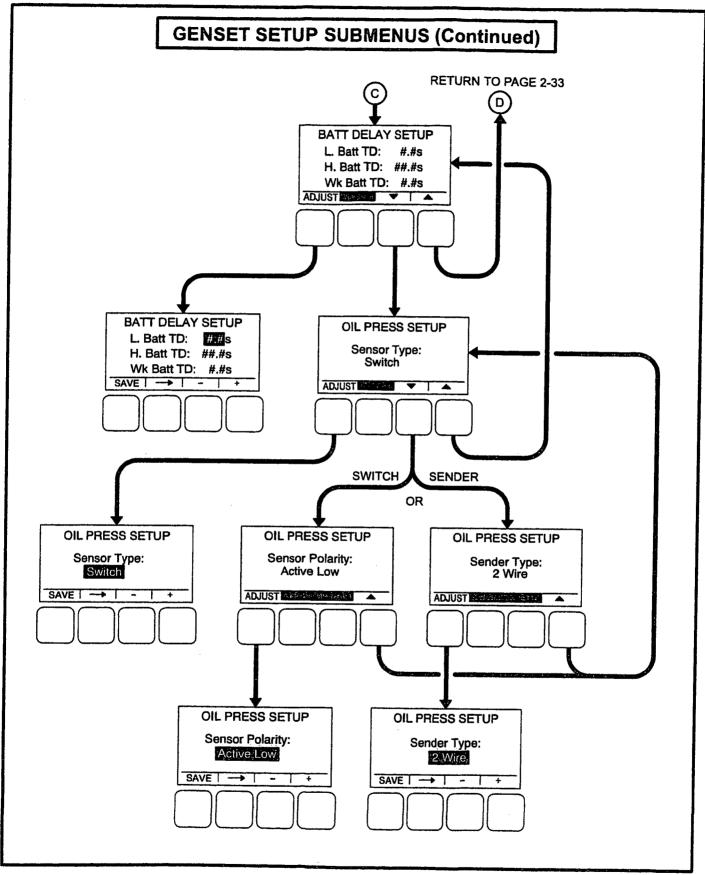


FIGURE 2-15. GENSET SETUP SUBMENUS (SHEET 3 OF 3)

Voltage Protection Submenus

Figure 2-16 is a block representation of the four Voltage Protection submenus that are available.

High AC Voltage Submenu

This submenu is used to determine when a high AC voltage fault condition exists and for how long the fault condition should be present before the engine is shut down.

- High AC Voltage Threshold: This threshold is used to set the percentage of desired voltage necessary to activate a High AC Voltage fault condition. This value can be set from 105 to 125% (default = 110%).
- High AC Voltage Time Delay: A time delay of 1 to 10 seconds (default = 10 seconds) must expire before the engine shuts down because of a high AC voltage fault condition. If the fault condition is active for the duration of this time delay, the engine shuts down and the High AC Voltage shutdown message (fault code 12) is announced.

Low AC Voltage Submenu

This submenu is used to determine when a low AC voltage fault condition exists and for how long the fault condition should be present before the engine is shut down.

- Low AC Voltage Threshold: This threshold is used to set the percentage of desired voltage necessary to activate a Low AC Voltage fault condition. This value can be set from 50 to 95% (default = 85%).
- Low AC Voltage Time Delay: A time delay of 2 to 20 seconds (default = 10 seconds) must expire before the engine shuts down because of a low AC voltage fault condition. If the fault condition is active for the duration of this time delay, the engine shuts down and the Low AC Voltage shutdown message (fault code 13) is announced.

Overfrequency Submenu

This submenu is used to determine when an overfrequency fault condition exists and for how long the fault condition should be present before the engine is shut down.

- Overfrequency Threshold: This threshold is used to set the amount of Hertz that the alternator line frequency can be over to activate an Overfrequency fault condition. This value can be set from 2 to 10 Hz (default = 6 Hz).
- Overfrequency Delay: A time delay of 100 to 2000 half cycles (default = 1100 half cycles) must expire before the engine shuts down because of an overfrequency fault condition. If the fault condition is active for the duration of this time delay, the engine shuts down and the Overfrequency shutdown message (fault code 14) is announced.

Underfrequency Submenu

This submenu is used to determine when an underfrequency fault condition exists and for how long the fault condition should be present before the engine is shut down.

- Underfrequency Threshold: This threshold is used to set the Hertz number that the alternator line frequency can be under to activate an Underfrequency fault condition. This value can be set from 2 to 10 Hz (default = 6 Hz).
- Underfrequency Time Delay: A time delay of 500 and 2000 half cycles (default = 1100 half cycles) must expire before the engine shuts down because of an underfrequency fault condition. If the fault condition is active for the duration of this time delay, the engine shuts down and the Underfrequency shutdown message (fault code 15) is announced.

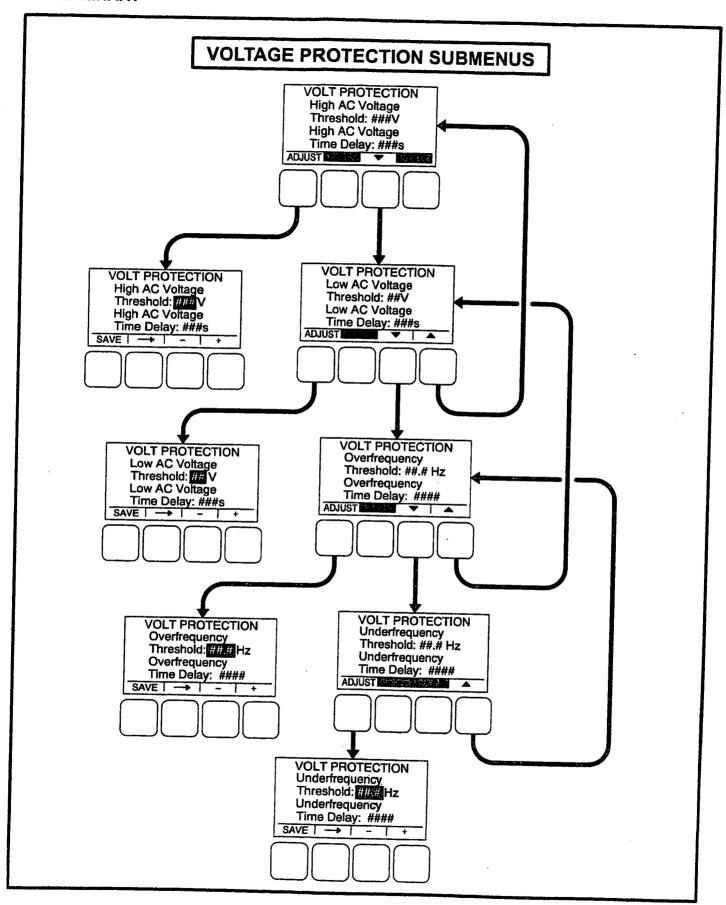


FIGURE 2-16. VOLTAGE PROTECTION SUBMENUS

Current Protection Submenus

Figure 2-17 is a block representation of the two Current Protection submenus.

High AC Current Warning Submenu

This submenu is used to determine when a high AC current warning fault condition exists and for how long the fault condition should be present before the High AC Current warning message is announced.

- H. Curr Warning Threshold: This threshold is used to set the percentage of rated AC current at which the High AC Current warning fault condition becomes active. This value can be set from 110 to 130% (default = 110%).
- H. Curr Warning Time Delay: A time delay of 10 to 60 seconds (default = 60 seconds) must expire before a warning message is announced. If the fault condition is active for the duration of this time delay, the High AC Cur-

rent warning message (fault code 216) is announced.

High AC Current Shutdown Submenu

This submenu is used to determine when a high AC current shutdown fault condition exists and for how long the fault condition should be present before the engine is shut down.

- H. Curr Shutdown Threshold: This threshold is used to set the percentage of rated AC current at which the High AC Current shutdown fault condition becomes active. This value can be set from 130 to 190% (default = 150%).
- H. Curr Shutdown Time Delay: A time delay
 of 2 to 60 seconds (default = 10 seconds)
 must expire before the engine shuts down
 because of a high AC current fault condition.
 If the fault condition is active for the duration
 of this time delay, the engine shuts down and
 the High AC Current shutdown message
 (fault code 46) is announced.

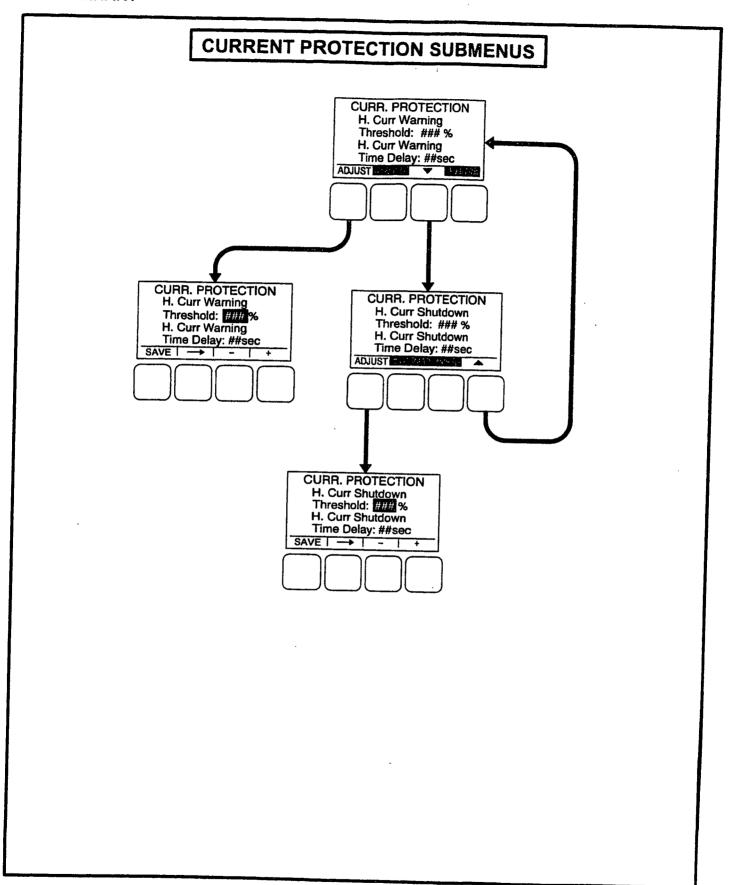


FIGURE 2-17. CURRENT PROTECTION SUBMENUS

Engine Protection Submenus

The Engine Protection submenus (see Figure 2-18) are used to set thresholds to determine when engine fault conditions exist and time delays to determine how long a fault condition is present before the fault message is announced and, if necessary, shut down the engine.

Engine Protection Overspeed Submenu

This submenu is used to set the value necessary to shut down the genset and activate an Overspeed shutdown message (fault code 31) on 50 and 60 Hz gensets, indicating that the engine has exceeded normal operating speed.

- Overspeed (50Hz) Threshold: This threshold is used to set the overspeed value necessary to activate an Overspeed shutdown fault condition on 50 Hz gensets. This value can be set from 0 to 8192 RPM, in 25 RPM increments (default = 1725 RPM).
- Overspeed (60Hz) Threshold: This threshold is used to set the overspeed value necessary to activate an Overspeed shutdown fault condition on 60 Hz gensets. This value can be set from 0 to 24,096 RPM, in 25 RPM increments (default = 2075 RPM).

Engine Protection Speed/Frequency Submenu

This submenu is used to determine when a speed/ frequency conflict shutdown fault condition exists and for how long the fault condition should be present before the engine is shut down.

- Speed/Freq Fault Threshold: This threshold is used to set the value necessary to activate the speed/frequency conflict shutdown fault condition. This value can be set from 0.1 to 20.0 Hz (default = 2.0 Hz).
- Speed/Freq Fault Time Delay: A time delay of 0.2 to 10.0 seconds (default = 1 second) must expire before the warning message is announced because of a speed/frequency conflict shutdown fault condition. If the fault condition is active for the duration of this time delay, the genset is shut down and the Speed Hz Match shutdown message (fault code 71) is announced.

Low Oil Pressure Warning Submenu

This submenu is used to determine when a low oil pressure warning fault condition exists and for how long the fault condition must be present before the warning message is announced.

- LOP Warning Threshold: This threshold is used to set the oil pressure value necessary to activate a Pre-Low Oil Pressure warning fault condition. This value can be set from 0 to 100 psi (default = 35 psi).
- LOP Warning Time Delay: A time delay of 2 to 15 seconds (default = 8 seconds) must expire before the warning message is announced because of a low oil pressure warning fault condition. If the fault condition is active for the duration of this time delay, the Pre-Low Oil Pressure warning message (fault code 215) is announced.

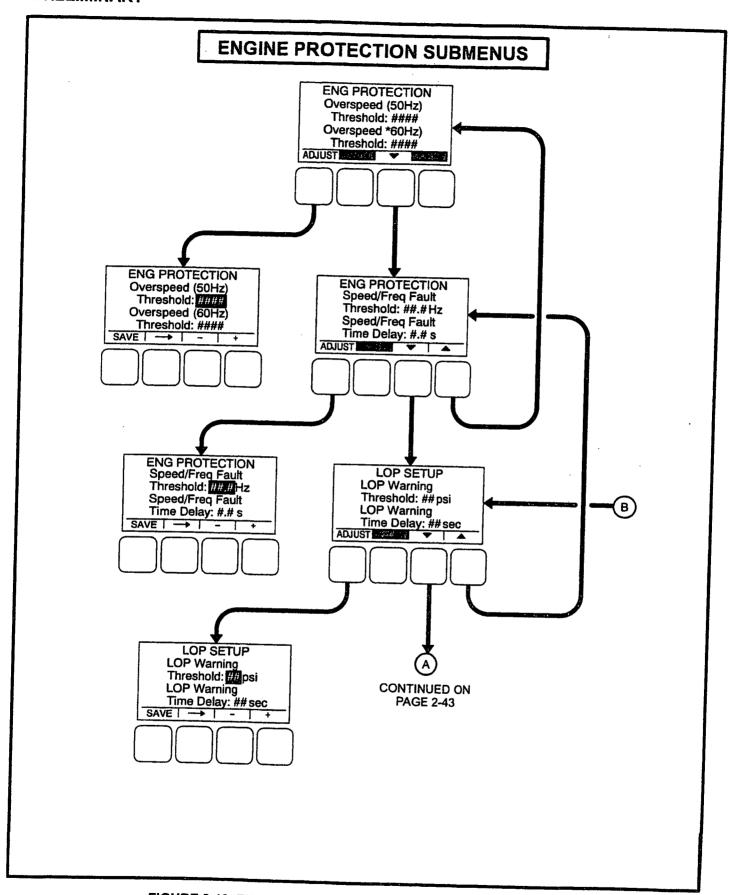


FIGURE 2-18. ENGINE PROTECTION SUBMENUS (SHEET 1 OF 3)

Low Oil Pressure Shutdown Submenu

This submenu is used to determine when a low oil pressure shutdown fault condition exists and for how long the fault condition should be present before the engine is shut down.

- LOP Shutdown Threshold: This threshold is used to set the oil pressure value necessary to activate a Low Oil Pressure Shutdown fault condition. This value can be set from 0 to 100 psi (default = 30 psi).
- LOP Shutdown Time Delay: A time delay of 2 to 15 seconds (default = 8 seconds) must expire before the engine shuts down because of a low oil pressure fault condition. If the fault condition is active for the duration of this time delay, the engine shuts down and the Low Oil Pressure shutdown message (fault code 2) is announced.

High Coolant Temperature Warning Submenu

This submenu is used to determine when a high coolant temperature warning fault condition exists and for how long the fault condition should be present before the warning message is announced.

 HCT Warning Threshold: This threshold is used to set the temperature value necessary to activate a High Coolant Temperature Warning fault condition. This value can be set

- from 180 to 220 degrees F (default = 215 degrees F).
- HCT Warning Time Delay: A time delay of 2 to 10 seconds (default = 2 seconds) must expire before the warning message is announced. If the fault condition is active for the duration of this time delay, the High Coolant Temperature warning message (fault code 202) is announced.

High Coolant Temperature Shutdown Submenu

This submenu is used to determine when a high coolant temperature shutdown fault condition exists and for how long the fault condition should be present before the engine is shut down.

- HCT Shutdown Threshold: This threshold is used to set the temperature value necessary to activate a High Coolant Temperature Shutdown fault condition. This value can be set from 200 to 230 degrees F (default = 223 degrees F).
- HCT Shutdown Time Delay: A time delay of 2 to 10 seconds (default = 2 seconds) must expire before the engine shuts down because of a high coolant temperature fault condition. If the fault condition is active for the duration of this time delay, the engine shuts down and the High Coolant Temperature shutdown message (fault code 1) is announced.

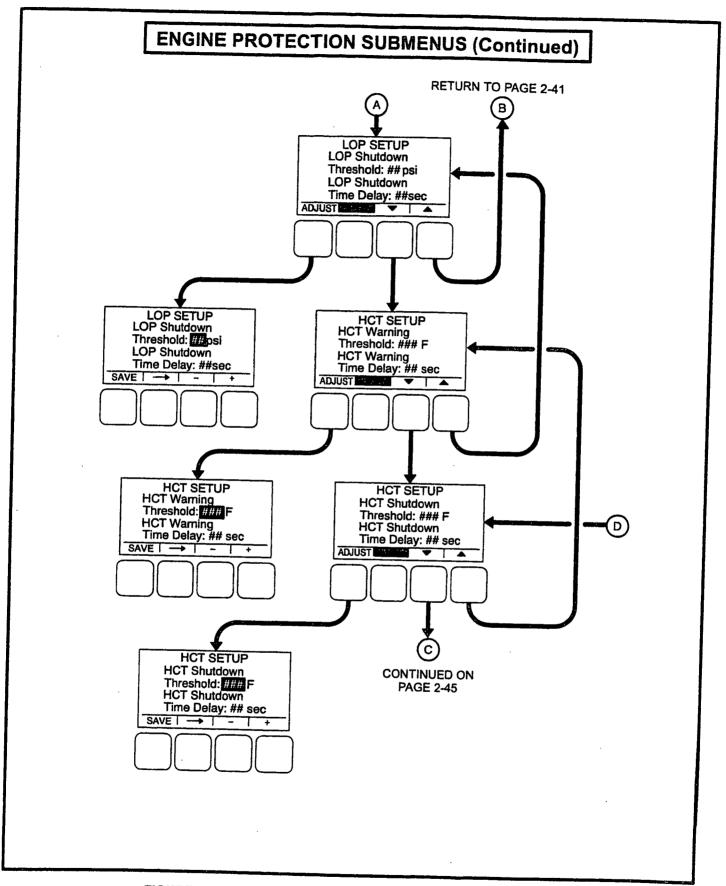


FIGURE 2-18. ENGINE PROTECTION SUBMENUS (SHEET 2 OF 3)

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Engine Protection Low Coolant Temperature and Battery Charger Submenus

The low coolant temperature submenu is used to determine when the genset's coolant temperature is too low and a Low Coolant Temperature warning message (fault code 203) is announced. This warning message is not announced unless the coolant temperature has been determined to be low for one minute.

 LCT Warning Threshold: This threshold is used to set the temperature value necessary to activate a Low Coolant Temperature Warning fault condition. This value can be set from 32 to 100 degrees F (default = 70 degrees F).

These charging submenus are used to determine when the alternator charger failure condition exists and when the warning message should be announced. The fault condition exists when either the low or high threshold is reached.

- Charger Failed H Threshold: This threshold is used to set the high charging alternator voltage value. This value can be set from 13.0 to 20.0 VDC (default = 18.0 VDC) for 12V units and from 25.0 to 40.0 VDC (default = 32.0 VDC) for 24V units.
- Charger Failed L Threshold: This threshold is used to set the low charging alternator voltage value. This value can be set from 2.0 to 13.0 VDC (default = 5.0 VDC) for 12V units and from 2.0 to 25.0 VDC (default = 10.0 VDC) for 24V units.
- Charger Failed Time Delay: A time delay of 2 to 300 seconds (default = 120 seconds) must expire before the warning message is announced. If the fault condition is active for the duration of this time delay, the Charger Failure warning message (fault code 219) is announced.

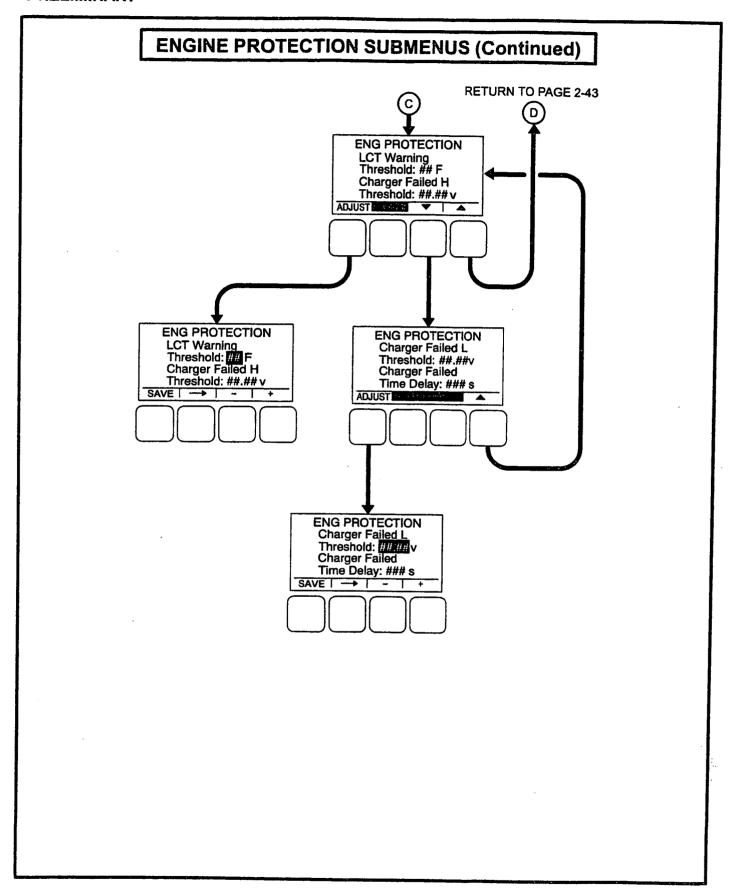
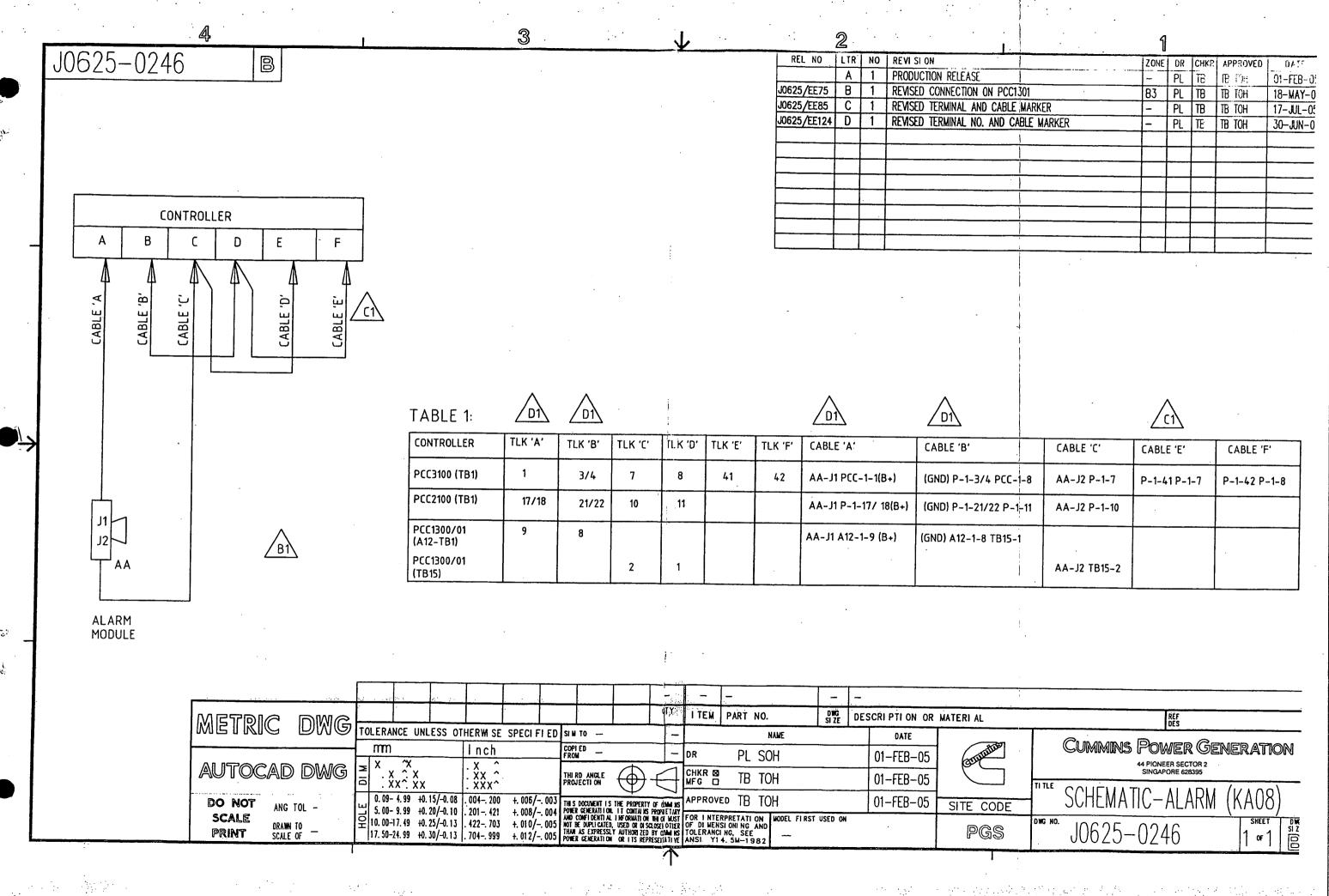
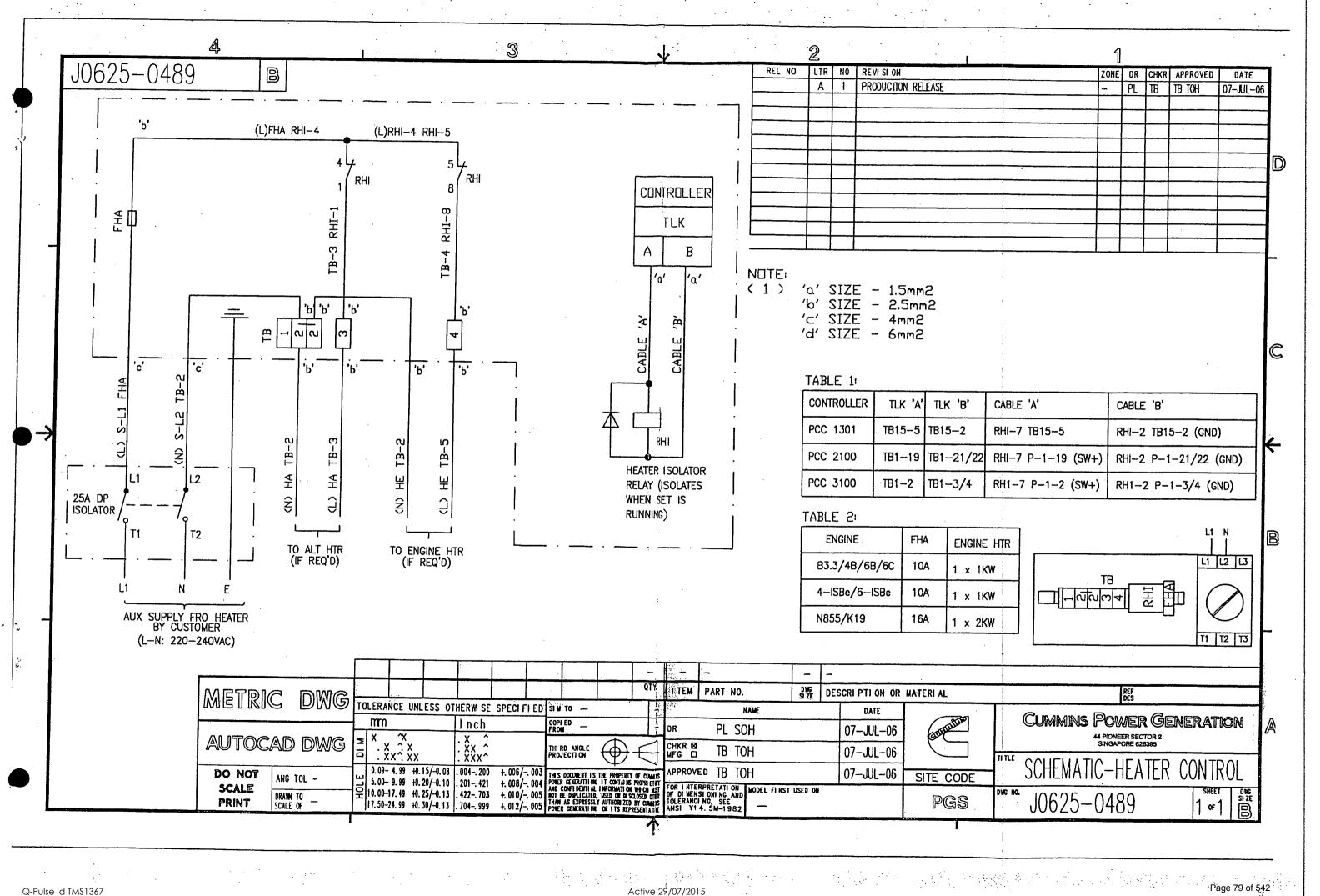


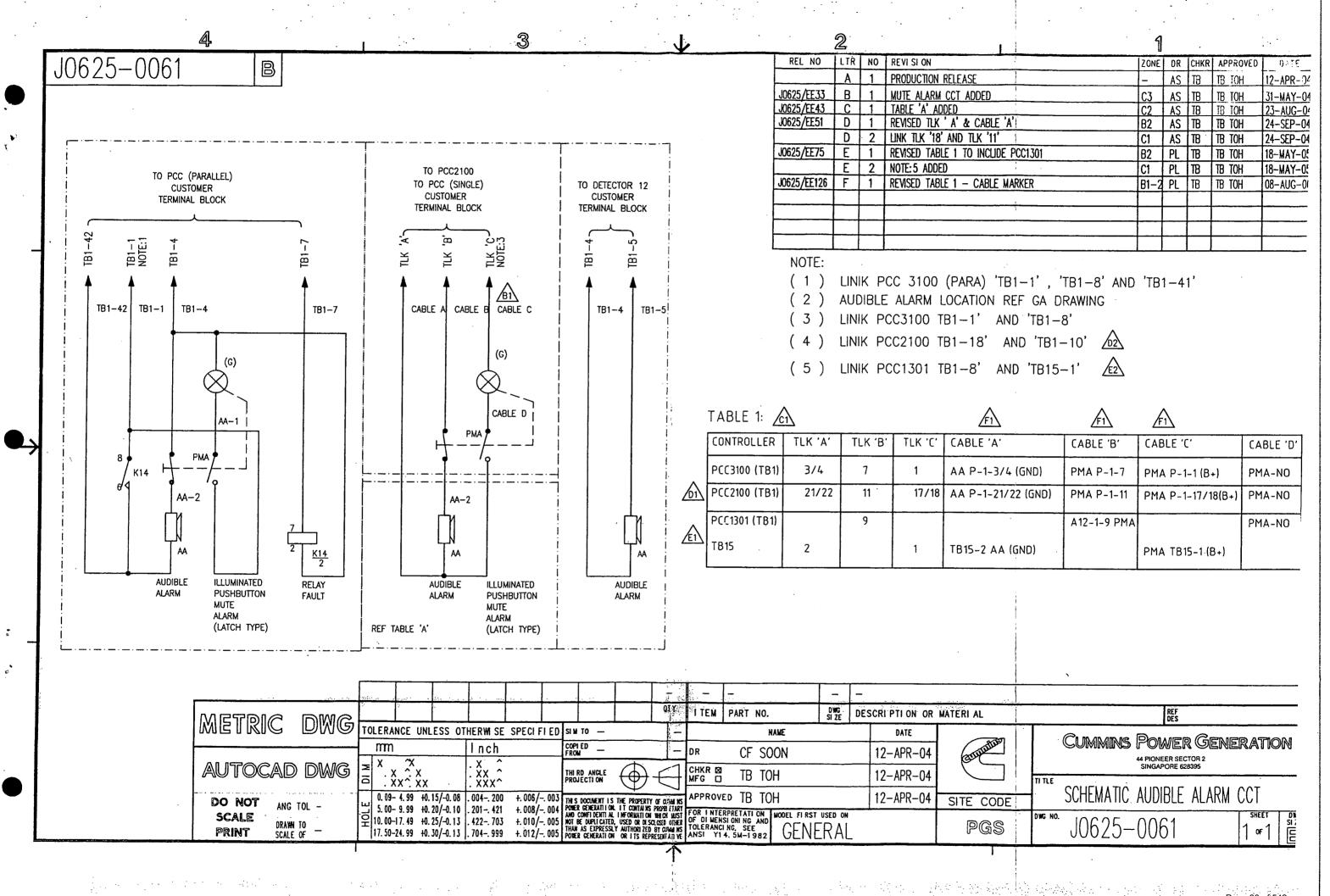
FIGURE 2-18. ENGINE PROTECTION SUBMENUS (SHEET 3 OF 3)

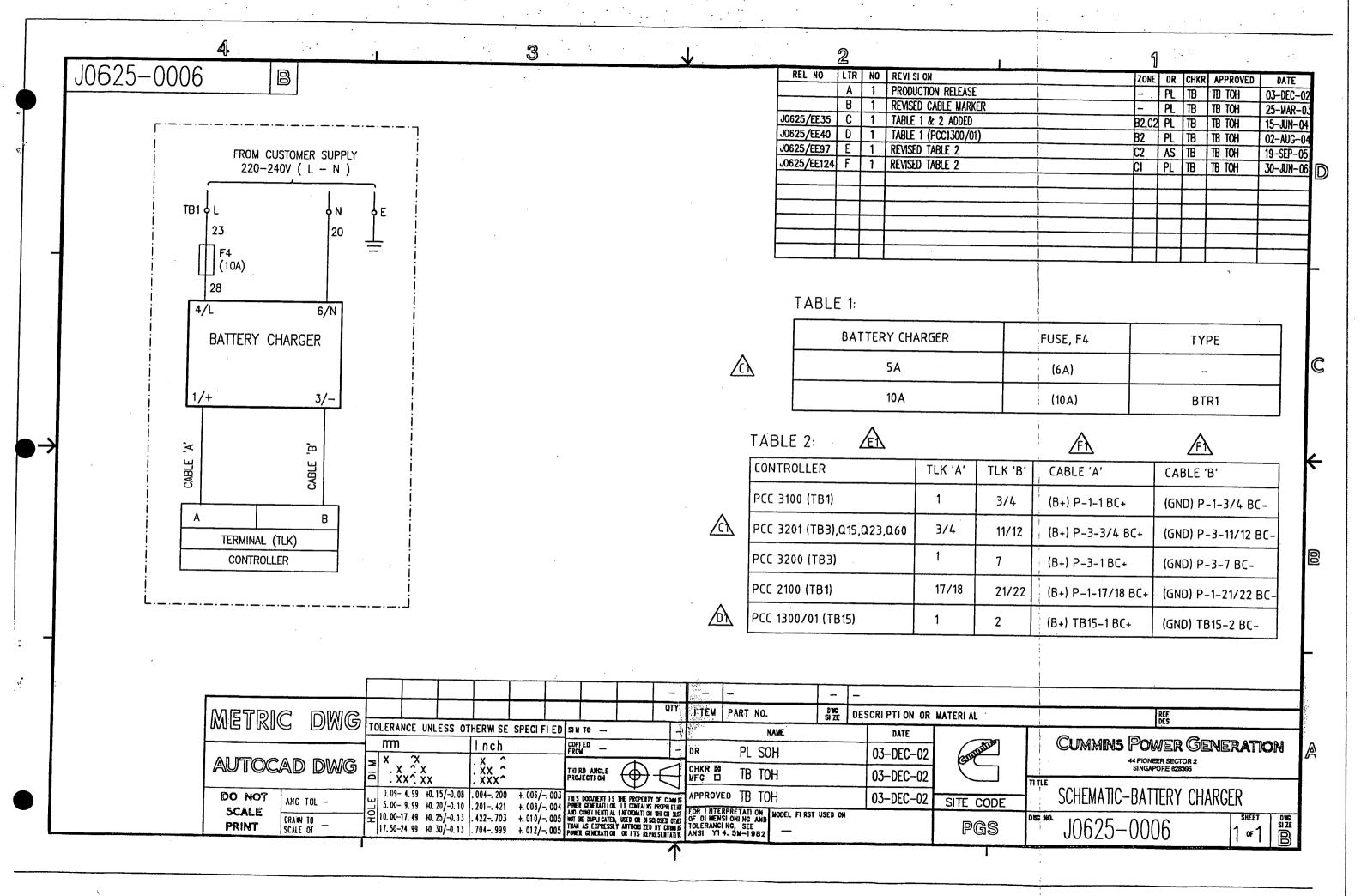
Power Command 1301		
Standard		
Drawing no.	Description	LTR
J0630-0051 (Sht 1,2)	WD-Control (PCC1301)	F
J0630-0052 (Sht 1)	Schematic-PMG/MX321, PCC1301	A
J0630-0056 (Sht 1)	WD-Genset (Reconnect)	Α
Optional		
Drawing no.	Description	LTR
J0625-0006	Schematic - Battery Charger	F
J0625-0061	Schematic - Audible Alarm CCT	F
J0625-0489	Schematic - Heater Control	Α
J0625-0246	Schematic - Alarm (KA08)	· D

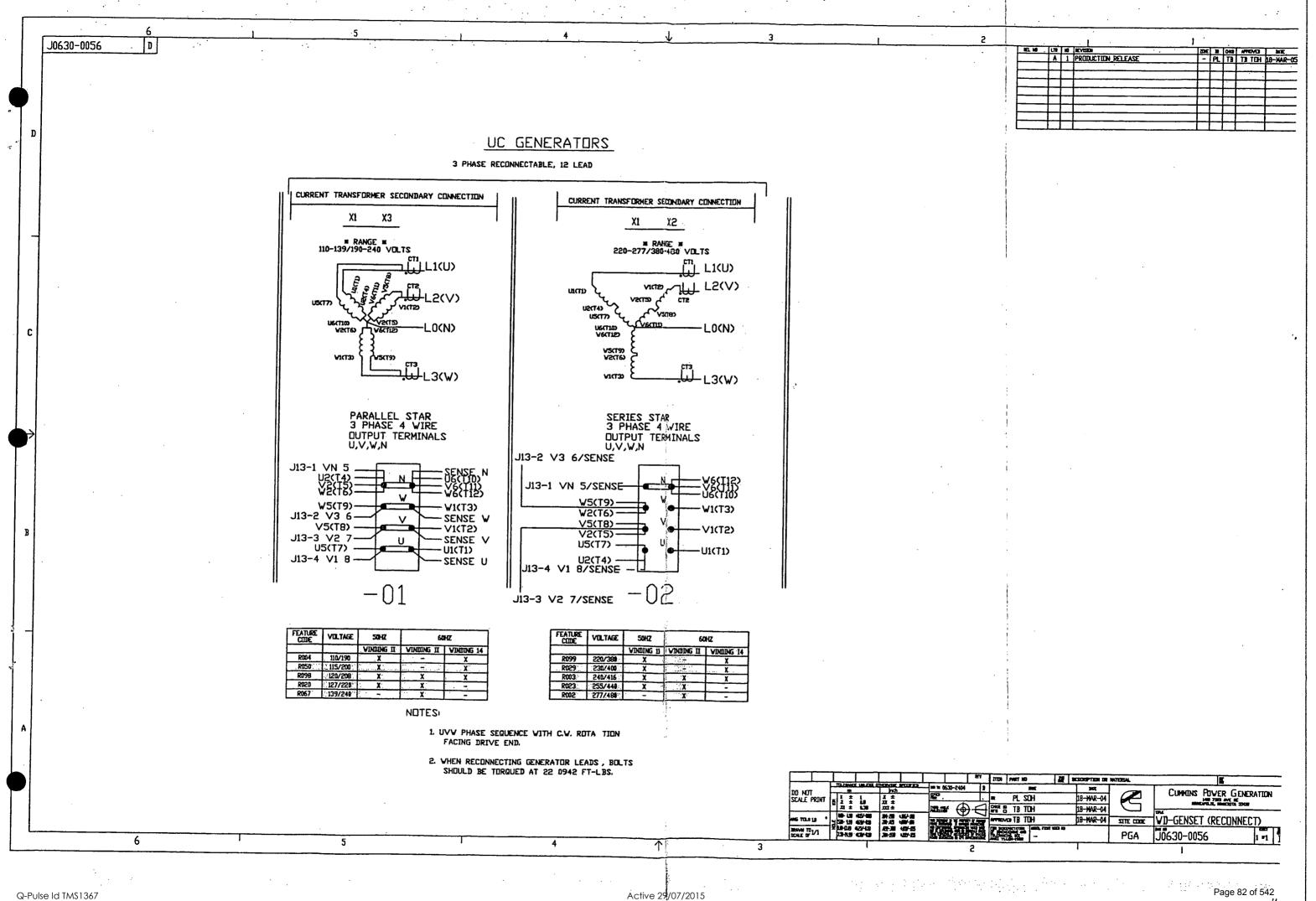
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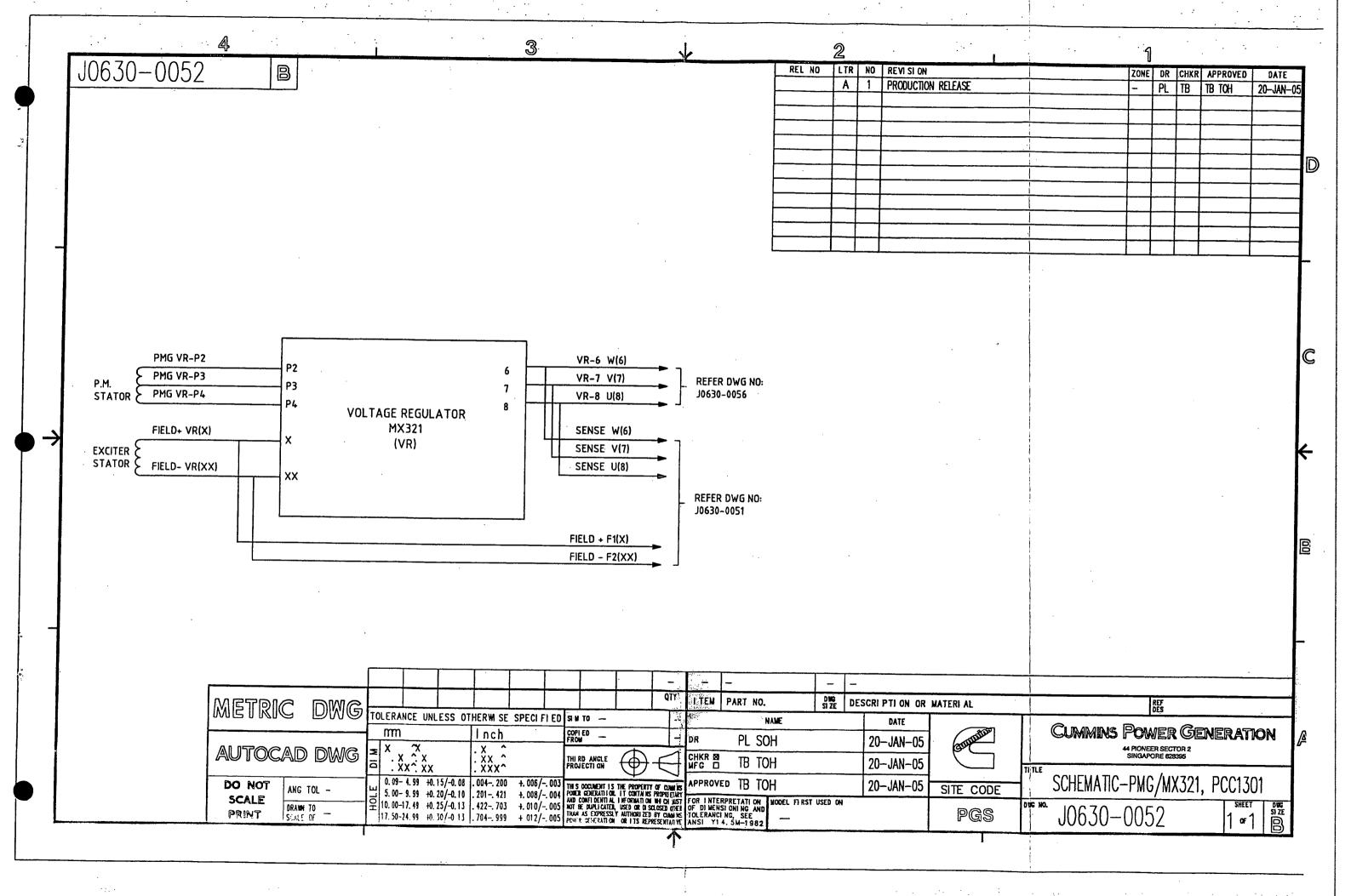


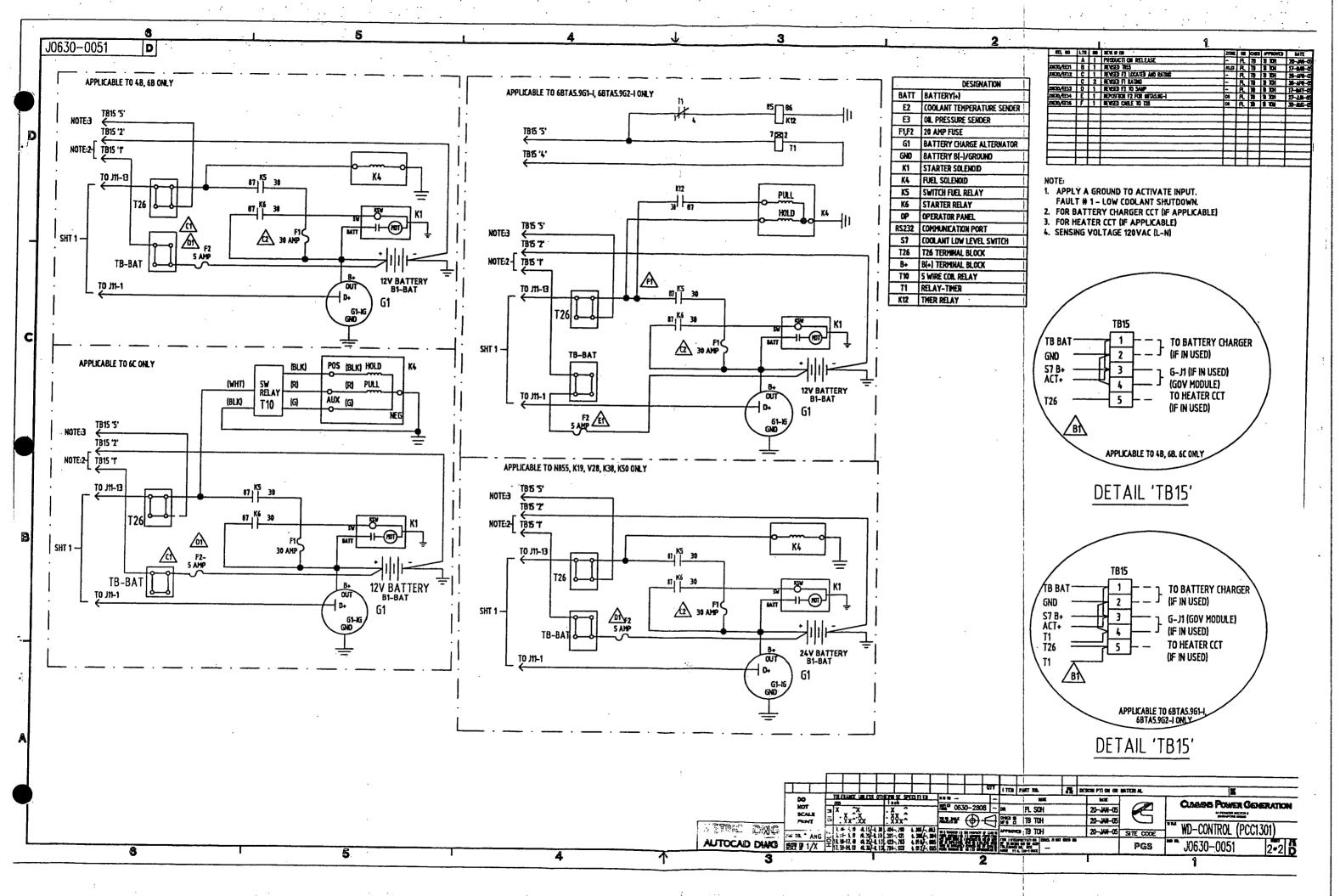


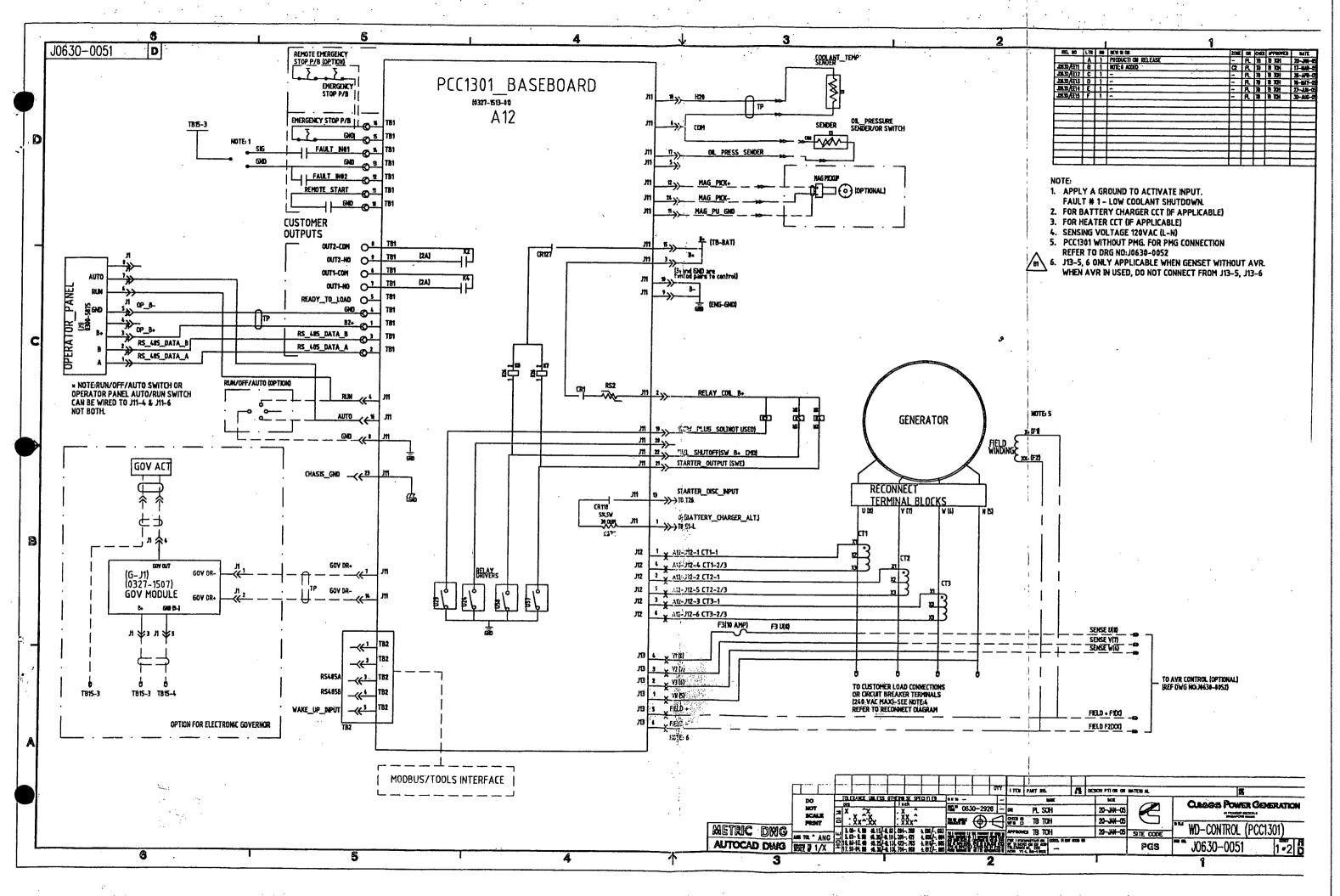












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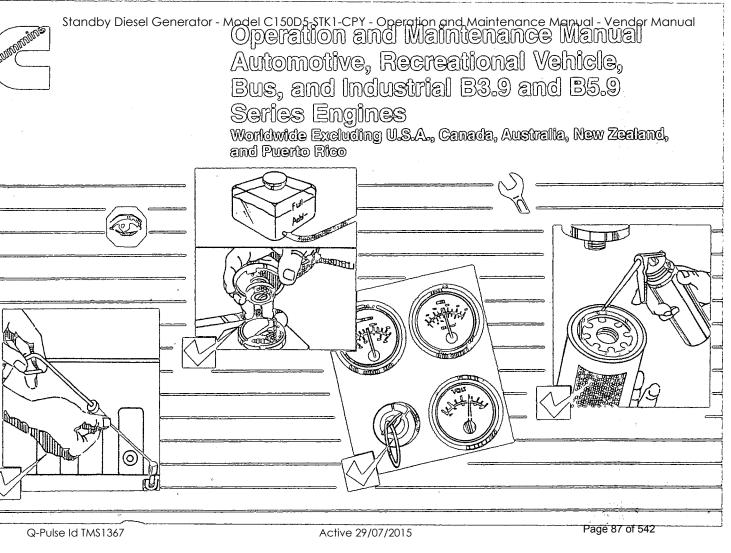
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Web Sites www.cumminspower.com

www.cummins.com

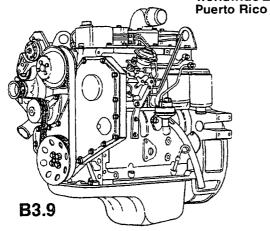


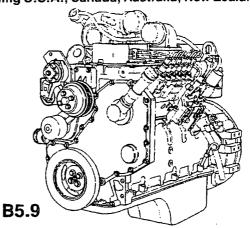




Operation and Maintenance Manual Automotive, Recreational Vehicle, Bus, and Industrial B3.9 and B5.9 Series Engines

Worldwide Excluding U.S.A., Canada, Australia, New Zealand, and





00900282

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Foreword

This manual contains information for the correct operation and maintenance of your Cummins engine. It also includes important safety information, engine and systems specifications, troubleshooting guidelines, and listings of Cummins Authorized Repair Locations and component manufacturers.

Read and follow all safety instructions. Refer to the WARNING in the General Safety Instructions in Section i - Introduction.

Keep this manual with the equipment. If the equipment is traded or sold, give the manual to the new owner.

The information, specifications, and recommended maintenance guidelines in this manual are based on information in effect at the time of printing. Cummins Engine Company, Inc. reserves the right to make changes at any time without obligation. If you find differences between your engine and the information in this manual, contact your local Cummins Authorized Repair Location or call 1-800-DIESELS (1-800-343-7357) toll free in the U.S. and Canada.

The latest technology and the highest quality components were used to produce this engine. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts. These parts can be identified by the following trademarks:



Note: Warranty information is located in Section W. Make sure you are familiar with the warranty or warranties applicable to your engine.

q-03 (om-frwd)

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Important Reference Numbers

Fill in the part name and number in the blank spaces provided below. This will give you a reference whenever service or maintenance is required.

Part Name	Part Number	Part Number
Engine Model		
Engine Serial Number (ESN)		
Control Parts List (CPL)		
Fuel Pump Part Number		
Electronic Control Module (ECM)		
Electronic Control Module Serial Numbers (ECM)		
Filter Part Numbers:		
Air Cleaner Element		
Lubricating Oil Filter		
o Fuel		
Fuel-Water Separator		
Coolant		
Remote Gas		

g-04 (refno)

Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Part Name	Part Number	Part Number
Governor Control Module (GCM) (if applicable)		
Belt Part Numbers:		· · · · · · · · · · · · · · · · · · ·
•		
0		
•		1
Clutch or Marine Gear (if applicable):		·
Model		
Serial Number		
Part Number		
Oil Type		
Sea Water Pump		
- Model		
 Part Number 		

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Section i - Introduction

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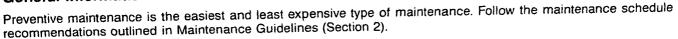
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B3.9 and B5.9 Series Engines Section i - Introduction

To the Owner and Operator Page i-1

To the Owner and Operator

General Information





Keep records of regularly scheduled maintenance.

Use the correct fuel, oil, and coolant in your engine as specified in Maintenance Specifications (Section V).

Cummins Engine Company, Inc. uses the latest technology and the highest quality components to produce its engines. Cummins recommends using **only** genuine Cummins parts and ReCon® exchange parts.

Personnel at Cummins Authorized Repair Locations have been trained to provide expert service and parts support. If you have a problem that can **not** be resolved by a Cummins Authorized Repair Location, follow the steps outlined in the Service Assistance (Section S).

Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

About the Manual Page i-2

B3.9 and B5.9 Series Engines Section i - Introduction

About the Manual

General Information

This manual contains information needed to operate and maintain your engine correctly as recommended by Cummins Engine Company, Inc. Additional service literature can be ordered from your local Cummins Distributor. For problems with literature orders, contact (800) DIESELS ((800) 343-7357) for U.S.A. and Canada.

This manual does **not** cover vehicle or equipment maintenance procedures. Consult the vehicle or original equipment manufacturer (OEM) for specific maintenance recommendations.

Both metric and U.S. customary values are listed in this manual. The metric value is listed first, followed by the U.S. customary in brackets.

Numerous illustrations and symbols are used to aid in understanding the meaning of the text. Refer to Symbols (Section i) for a complete listing of symbols and their definitions.

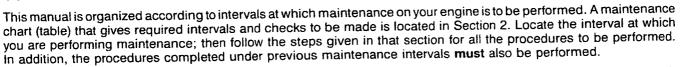
Each section is preceded by a Section Contents to aid in locating information quickly.

B3.9 and B5.9 Series Engines Section i - Introduction

How to Use the Manual Page i-3

How to Use the Manual

General Information





Keep a record of all the checks and inspections made. A record form for recording the date or hours at which maintenance checks were performed is located in Section 2.

Refer to Section TS for a guide to troubleshooting your engine. Follow the directions given in that section to locate and correct engine problems.

Refer to Section V for specifications recommended by Cummins Engine Company, Inc. for your engine. Specifications and torque values for each engine system are given in that section.

Symbols Page i-4

B3.9 and B5.9 Series Engines Section i - Introduction

Symbols

General Information

The following symbols have been used in this manual to help communicate the intent of the instructions. When one of the symbols appears, it conveys the meaning defined below:



WARNING - Serious personal injury or extensive property damage can result if the warning instructions are not followed.



CAUTION - Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are not followed.



Indicates a REMOVAL or DISASSEMBLY step.



Indicates an INSTALLATION or ASSEMBLY step.



INSPECTION is required.



CLEAN the part or assembly.



PERFORM a mechanical or time MEASUREMENT.



LUBRICATE the part or assembly.



Indicates that a WRENCH or TOOL SIZE will be given.



TIGHTEN to a specific torque.



PERFORM an electrical MEASUREMENT.



Refer to another location in this manual or another publication for additional information.



The component weighs 23 kg [50 lb] or more. To avoid personal injury, use a hoist or get assistance to lift the component.

g-02 (half-sym)

B3.9 and B5.9 Series Engines Section i - Introduction

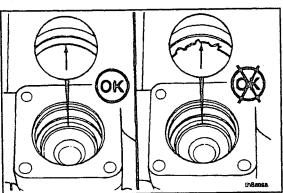
Illustrations

General Information

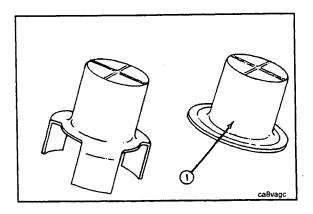
Some of the illustrations throughout this manual are generic and will **not** look exactly like the engine or parts used in your application. The illustrations can contain symbols to indicate an action required and an acceptable or **not** acceptable condition.

The illustrations are intended to show repair or replacement procedures. The procedure will be the same for all applications, although the illustration can differ.

Illustrations Page i-5







General Safety Instructions Page i-6

B3.9 and B5.9 Series Engines Section i - Introduction

General Safety Instructions Important Safety Notice



WARNING A



Improper practices or carelessness can cause burns, cuts, mutilation, asphyxiation or other bodily injury or death.

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that must be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

- Make sure the work area surrounding the product is dry, well lit, ventilated, free from clutter, loose tools, parts. ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- Always wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do not wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do Not Operate" tag in the operator's compartment or on the controls.
- · Use ONLY the proper engine barring techniques for manually rotating the engine. Do not attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage. or damage to the fan blade(s) causing premature fan failure.
- . If an engine has been operating and the coolant is hot, allow the engine to cool before you slowly loosen the filler cap and relieve the pressure from the cooling system.
- . Do not work on anything that is supported ONLY by lifting jacks or a hoist. Always use blocks or proper stands to support the product before performing any service work.
- · Relieve all pressure in the air, oil, fuel and the cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do not check for pressure leaks with your hand. High pressure oil or fuel can cause personal

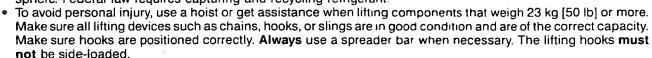
g-03 (safety)

B3.9 and B5.9 Series Engines Section i - Introduction

General Safety Instructions Page i-7

injury.

• To prevent suffocation and frostbite, wear protective clothing and ONLY disconnect fuel and liquid refrigerant (freon) lines in a well ventilated area. To protect the environment, liquid refrigerant systems **must** be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capturing and recycling refrigerant.



- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do not get the substance in your
 eyes. Avoid prolonged or repeated contact with skin. Do not swallow internally. In case of contact, immediately
 wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a
 minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and must be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.
- To avoid burns, be alert for hot parts on products that have just been turned off, and hot fluids in lines, tubes, and compartments.
- Always use tools that are in good condition. Make sure you understand how to use them before performing any service work. Use ONLY genuine Cummins or Cummins ReCon* replacement parts.
- Always use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lesser quality if replacements are necessary.
- Do not perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.
- Coolant is toxic. If not reused, dispose of in accordance with local environmental regulations.



Acronyms and Abbreviations Page i-8

B3.9 and B5.9 Series Engines Section i - Introduction

Acronyms and Abbreviations

Kilometers per Liter

General Information

AFC	Air Fuel Control	kPa	Kilopascal
API	American Petroleum Institute	LNG	Liquid Natural Gas
ASA	Air Signal Attenuator	LTA	Low Temperature Aftercooling
ASTM	American Society of Testing and Materials	MIP	Mixer Inlet Pressure
°C	Celsius	MPa	Megapascal
CARB	California Air Resources Board	mph	Miles Per Hour
C.I.D.	Cubic Inch Displacement	mpq	Miles Per Quart
CNG	Compressed Natural Gas	Nom	Newton-meter
CPL	Control Parts List	NG	Natural Gas
cSt	Centistokes	OEM	Original Equipment Manufacturer
ECM	Electronic Control Module	ppm	Parts Per Million
ECS	Emission Control System	psi	Pounds Per Square Inch
EPA	Environmental Protection Agency	PTO	Power Takeoff
EPS	Engine Position Sensor	rpm	Revolutions Per Minute
°F	Fahrenheit	SAE	Society of Automotive Engineers
GVW	Gross Vehicle Weight	SCA	Supplemental Coolant Additive
Hg	Mercury	STC	Step Timing Control
hp	Horsepower	vs	Variable Speed
H ₂ O	Water	VSS	Vehicle Speed Sensor
ICM	Ignition Control Module		

km/l

B3.9 and B5.9 Series Engines Section E - Engine Identification

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Section E - Engine Identification

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B3.9 and B5.9 Series Engines Section E - Engine Identification

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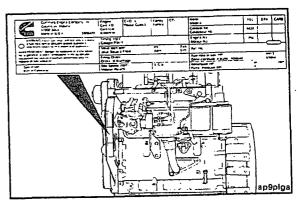
B3.9 and B5.9 Series Engines Section E - Engine Identification

Engine Identification

Engine Dataplate

The engine dataplate shows specific information about the engine. The engine serial number (ESN) and control parts list (CPL) provide information for ordering parts and for service needs. The engine dataplate **must not** be changed unless approved by Cummins Engine Company, Inc.

Engine Identification Page E-1



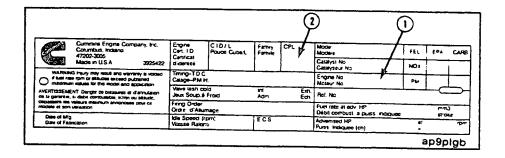


Engine Identification Page E-2

B3.9 and B5.9 Series Engines Section E - Engine Identification

Have the following engine data available when communicating with a Cummins Authorized Repair Facility. The information on the dataplate is **mandatory** when sourcing service parts.

- 1. Engine Serial Number (ESN)
- 2. Control Parts List (CPL).



B3.9 and B5.9 Series Engines Section E - Engine Identification

Cummins Engine Nomenclature

Automotive Applications

The model name for automotive engines provides the following engine data:

B5.9-C

B = Engine series

5.9 = Displacement

Industrial Applications

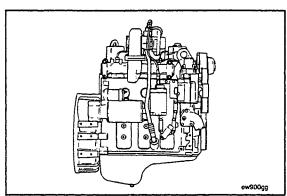
The model name for industrial engines provides the following engine data:

B3.9-C

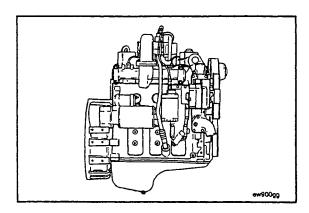
B = Engine series

3.9 = Displacement in liters.

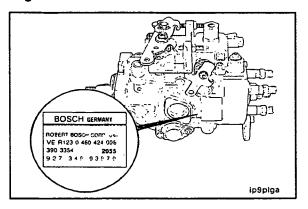
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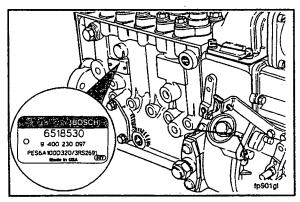






Engine Identification Page E-4





B3.9 and B5.9 Series Engines Section E - Engine Identification

Fuel Injection Pump Dataplate

Bosch®

The injection pump dataplate for the Bosch® VE pump is located on the side of the injection pump. The dataplate provides information for fuel pump calibration.

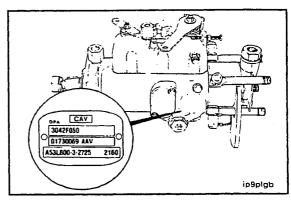
Bosch® In-line Dataplate

The injection pump dataplate for the Bosch® in-line pump is located on the side of the injection pump. The dataplate provides information for fuel pump calibration.

CAV

The injection pump dataplate for the Lucas DPA pump is located on the side of the injection pump. The dataplate provides information for fuel pump calibration.

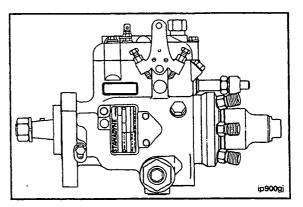
Engine Identification Page E-5



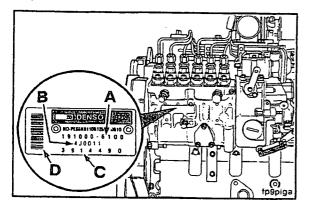


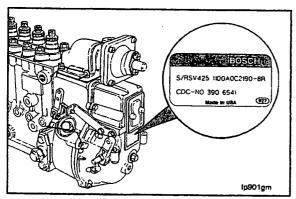
Stanadyne

The injection pump dataplate for the Stanadyne DB4 is located on the side of the injection pump. The dataplate provides information for the fuel pump calibration.



Engine Identification Page E-6





B3.9 and B5.9 Series Engines Section E - Engine Identification

Denso Dataplate

The Denso fuel injection pump dataplate contains the following information:

- (A) Fuel injection pump part number
- (B) Denso serial number
- (C) Cummins part number
- (D) Fuel injection pump bar code.

The Cummins part number for the fuel pump-governor combination is located on the governor dataplate.

Specifications Page E-7

Specifications

General Specifications

General 4B Engine Data (nonautomotive)

	4B3.9	4BT3.9	4BTA3.9
Bore	102 mm [4.02 in]	102 mm [4.02 in]	102 mm [4.02 in]
Stroke	120 mm [4.72 in]	120 mm [4.72 in]	120 mm [4.72 in]
Displacement	3.9 liters [238 in ³]	3.9 liters [238 in ³]	3.9 liters [238 in ³]
Engine Weight (dry) Less Flywheel and Electric Com-	308 kg [679 lb]	320 kg [705 lb]	329 kg [725 lb]
ponents Firing Order	1, 3, 4, 2	1, 3, 4, 2	1, 3, 4, 2
Valve Clearances: - Intake - Exhaust Compression Ratio	0.25 mm [0.010 in] 0.51 mm [0.020 in] 18.5:1	0.25 mm [0.010 in] 0.51 mm [0.020 in] 17.5:1	0.25 mm [0.010 in] 0.51 mm [0.020 in] 16.5:1
Rotation, Viewed from the Front of the Engine	Clockwise	Clockwise	Clockwise
Aspiration: - Naturally Aspirated	×		

Specifications Page E-8

B3.9 and B5.9 Series Engines Section E - Engine Identification

	4B3.9	4BT3.9	4BTA3.9
- Turbocharged		×	X
- Aftercooled			X

Specifications Page E-9

General 6B Engine Data (nonautomotive)

	6B5.9	6BT5.9	6BTA5.9
Bore	102 mm [4.02 in]	102 mm [4.02 in]	102 mm [4.02 in]
Stroke	120 mm [4.72 in]	120 mm [4.72 in]	120 mm [4.72 in]
Displacement	5.88 liters [359 in ³]	5.88 liters [359 in ³]	5.88 liters [359 in ³]
Engine Weight (dry) Less Flywheel and Electric Com-	388 kg [855 lb]	399 kg [880 lb]	411 kg [906 lb]
ponents Firing Order	1, 5, 3, 6, 2, 4	1, 5, 3, 6, 2, 4	1, 5, 3, 6, 2, 4
Valve Clearances: - Intake - Exhaust Compression Ratio	0.25 mm [0.010 in] 0.51 mm [0.020 in] 18.5:1	0.25 mm [0.010 in] 0.51 mm [0.020 in] 17.5:1	0.25 mm [0.010 in] 0.51 mm [0.020 in] 16.5:1
Rotation, Viewed from the Front of the Engine	Clockwise	Clockwise	Clockwise
Aspiration: - Naturally Aspirated - Turbocharged - Aftercooled	x	x	X X



Specifications Page E-10

B3.9 and B5.9 Series Engines Section E - Engine Identification

General Engine Data (automotive)

	B3.9	B5.9
Bore	102 mm [4.02 in]	102 mm [4.02 in]
Stroke	120 mm [4.72 in]	120 mm [4.72 in]
Displacement	3.9 liters [238 in ³]	5.9 liters [360 in ³]
Engine Weight (dry) Less Flywheel and Electric Components	308 to 329 kg [679 to 725 lb]	388 to 411 kg [855 to 906 lb]
Firing Order	1, 3, 4, 2	1, 5, 3, 6, 2, 4
Valve Clearances:		
-intake	0.25 mm [0.010 in]	0.25 mm [0.010 in]
-Exhaust	0.51 mm [0.020 in]	0.51 mm (0.020 in)
Compression Ratio	(rotary pump) 17.6:1	(in-line pump) 17.9:1
Rotation, Viewed from the Front of the Engine	Clockwise	Clockwise
Aspiration:		
- Turbocharged	X	×
- Charge-Air Cooled	X	x

Specifications Page E-11

Fuel System

4B Fuel System Data (nonautomotive)

	Distributor-Type Fuel Injection Pumps	4B3.9	4BT3.9	4BTA3.9
	Maximum Allowable Restriction to the Fuel Transfer Pump Must Not Exceed	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]
	Maximum Allowable Return Line Restriction	518 mm Hg [20.4 in Hg]	518 mm Hg [20 4 in Hg]	518 mm Hg [20.4 in Hg]
	Maximum Allowable Pressure Drop across Fuel Filter	35 kPa [5 psi]	35 kPa [5 psi]	35 kPa [5 psi]
	Maximum Inlet Pressure to the Injection Pump Must Not Exceed	70 kPa [10 psi]	70 kPa [10 psi]	70 kPa [10 psi]
	In-Line-Type Fuel Injection Pumps			
	Maximum Inlet Restriction to the Fuel Transfer Pump Must Not Exceed	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]
	Fuel Transfer Pump Minimum Output Pressure	172 kPa [25 psi] High Flow and 90 kPa [13 psi] Low Flow @ Rated rpm	172 kPa [25 psi] High Flow and 90 kPa [13 psi] Low Flow @ Rated rpm	172 kPa [25 psi] High Flow and 90 kPa [13 psi] Low Flow @ Rated rpm
	Fuel Filter Restriction (maximum pressure drop across filters)	35 kPa [5 psi]	35 kPa [5 psi]	35 kPa [5 psi]
	Fuel Pump Gallery Pressure	* 140 kPa [20 psi] @ Rated rpm	* 140 kPa [20 psi] @ Rated rpm	* 140 kPa [20 psi] @ Rated rpm
	Fuel Return Maximum Restriction	0. 0.	518 mm Hg [20.4 in Hg]	518 mm Hg [20.4 in Hg]
_	* The low-flow fuel transfer pump	will have 82.7 kPa [12 psi].		



Specifications Page E-12 B3.9 and B5.9 Series Engines Section E - Engine Identification

6B Fuel System Data (nonautomotive)

Distributor-Type Fuel Injection Pumps	6B5.9	6BT5.9	6BTA5.9
Maximum Allowable Restriction to the Fuel Transfer Pump Must Not Exceed	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]
Maximum Allowable Return Line Restriction	518 mm Hg [20.4 in Hg]	518 mm Hg [20.4 in Hg]	518 mm Hg [20.4 in Hg]
Maximum Allowable Pressure Drop across Fuel Filter	35 kPa [5 psi]	35 kPa [5 psi]	35 kPa [5 psi]
Maximum Inlet Pressure to the Injection Pump Must Not Exceed	70 kPa [10 psi]	70 kPa [10 psi]	70 kPa [10 psi]
In-Line-Type Fuel Injection Pumps			
Maximum Inlet Restriction to the Fuel Transfer Pump Must Not Exceed	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]
Fuel Transfer Pump Minimum Output Pressure	172 kPa [25 psi] High Flow and 90 kPa [13 psi] Low Flow @ Rated rpm	172 kPa [25 psi] High Flow and 90 kPa [13 psi] Low Flow @ Rated rpm	172 kPa [25 psi] High Flow and 90 kPa [13 psi] Low Flow @ Rated rpm
Fuel Filter Restriction (maximum pressure drop across filters)	35 kPa [5 psi]	35 kPa [5 psi]	35 kPa [5 psi]
Fuel Pump Gallery Pressure	 * 140 kPa [20 psi] @ Rated rpm 	* 140 kPa [20 psi] @ Rated rpm	* 140 kPa [20 psi] @ Rated rpm
Fuel Return Maximum Restriction * The low-flow fuel transfer pump	518 mm Hg [20.4 in Hg] will have 82.7 kPa [12 psi].	518 mm Hg [20.4 in Hg]	518 mm Hg [20.4 in Hg]

Specifications Page E-13

Fuel System Data (automotive)

Distributor-Type Fuel Injection Pumps	B3.9	B5.9
Maximum Inlet Restriction to the Fuel Transfer Pump Must Not Exceed	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]
Maximum Allowable Return Line Restriction	518 mm Hg [20.4 in Hg]	518 mm Hg [20.4 in Hg]
Maximum Allowable Pressure Drop across Fuel Filter	35 kPa [5 psi]	35 kPa [5 psi]
Maximum Inlet Pressure to the Injection Pump Must Not Exceed	70 kPa [10 psi]	70 kPa [10 psi]
In-Line-Type Fuel Injection Pumps	B3.9	B5.9
In-Line-Type Fuel Injection Pumps Maximum Inlet Restriction to the Fuel Transfer Pump Must Not Exceed	B3.9 100 mm Hg [4 in Hg]	B5.9 100 mm Hg [4 in Hg]
Maximum Inlet Restriction to the Fuel Transfer		
Maximum Inlet Restriction to the Fuel Transfer Pump Must Not Exceed	100 mm Hg [4 in Hg]	100 mm Hg [4 in Hg]



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B3.9 and B5.9 Series Engines Section E - Engine Identification

Lubricating Oil System

4B Lubrication System Data (nonautomotive)

	4B3.9	4BT3.9	4BTA3.9
Lubricating Oil Pressure at Idle - (minimum allowable)	69 kPa [10 psi]	69 kPa [10 psi]	69 kPa [10 psi]
Lubricating Oil Pressure at Rated - (minimum allowable)	207 kPa [30 psi]	207 kPa [30 psi]	207 kPa [30 psi]
Regulating Valve Opening Pressure	449 kPa [65 psi]	449 kPa [65 psi]	449 kPa [65 psi]
Lubricating Oil Capacity: Standard Pan Only	9.5 liters [10 qt]	9.5 liters [10 qt]	9.5 liters [10 qt]
Total System	10.9 liters [11.5 qt]	11 liters [11.6 qt]	11 liters [11.6 qt]
Low to High	0.9 liter [1 qt]	0.9 liter [1 qt]	0.9 liter [1 qt]

Specifications Page E-15

6B Lubrication System Data (nonautomotive)

	6B5.9	6BT5.9	6BTA5.9
Lubricating Oil Pressure at Idle - (minimum allowable)	69 kPa [10 psi]	69 kPa [10 psi]	69 kPa [10 psi]
Lubricating Oil Pressure at Rated - (minimum allowable)	207 kPa [30 psi]	207 kPa [30 psi]	207 kPa [30 psi]
Regulating Valve Opening Pressure	449 kPa [65 psi]	449 kPa [65 psi]	449 kPa [65 psi]
Lubricating Oil Capacity: Standard Pan Only	14.2 liters [15 qt]	14.2 liters [15 qt]	14.2 liters [15 qt]
Total System	16.3 liters [17.2 qt]	16.4 liters [17.3 qt]	16.4 liters [17.3 qt]
Low to High	1.9 liters [2 qt]	1.9 liters [2 qt]	1.9 liters [2 qt]

Specifications Page E-16 B3.9 and B5.9 Series Engines Section E - Engine Identification

Lubrication System Data (automotive)

	B3.9	B5.9
Lubricating Oil Pressure at Idle - (minimum allowable)	69 kPa [10 psi]	69 kPa [10 psi]
Lubricating Oil Pressure at Rated - (minimum allowable)	207 kPa [30 psi]	207 kPa [30 psi]
Regulating Valve Opening Pressure	449 kPa [65 psi]	449 kPa [65 psi]
Lubricating Oil Capacity: Standard Pan Only Total System - Liters [U.S. qt] Low to High	9.5 liters [10 qt] 11 liters [11.6 qt] 0.9 liter [1 qt]	14.2 liters [15 qt] 16.4 liters [17.3 qt] 1.9 liters [2 qt]

Specifications Page E-17

Cooling System

4B Cooling System Data (nonautomotive)

	4B3.9	4BT3.9	4BTA3.9
Coolant Capacity (engine only) Standard Modulating Thermo- stat Range	7 liters [7.4 qt] Start 83°C [181°F]; Fully Open 95°C [203°F]	7 liters [7.4 qt] Start 83°C [181°F]; Fully Open 95°C [203°F]	9.7 liters [10.2 qt] Start 83°C [181°F]; Fully Open 95°C [203°F]
Pressure Cap: 104°C [220°F] Systems 99°C [210°F] Systems	103 kPa [15 psi] 48 kPa [7 psi]	103 kPa [15 psi] 48 kPa [7 psi]	103 kPa [15 psi] 48 kPa [7 psi]
6B Cooling System Data (nona	utomotive)		
	6B5.9	6BT5.9	6BTA5.9
	40 C 13 [44 4 mt]	10 5 liters [11 1 at]	14.5 liters [15.3 gt]

	6B5.9	6BT5.9	6BTA5.9
Coolant Capacity (engine only) Standard Modulating Thermostat Range	10.5 liters [11.1 qt] Start 83°C [181°F]; Fully Open 95°C [203°F]	10.5 liters [11.1 qt] Start 83°C [181°F]; Fully Open 95°C [203°F]	14.5 liters [15.3 qt] Start 83°C [181°F]; Fully Open 95°C [203°F]
Pressure Cap: 104°C [220°F] Systems 99°C [210°F] Systems	103 kPa [15 psi] 48 kPa [7 psi]	103 kPa [15 psi] 48 kPa [7 psi]	103 kPa [15 psi] 48 kPa [7 psi]

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B3.9 and B5.9 Series Engines Section E - Engine Identification

Cooling System Data (automotive)

	B3.9	B5.9
Coolant Capacity (engine only) Standard Modulating Thermostat Range	7 liters [7.4 qt] Start 83°C [181°F]	10.5 liters [11.1 qt] Fully Open 95°C [203°F]
Pressure Cap: 104°C [220°F] Systems	103 kPa [15 psi]	400 l/D- (45 - 1)
99°C [210°F] Systems	48 kPa [7 psi]	103 kPa [15 psi] 48 kPa [7 psi]

Specifications Page E-19

Air Intake System

4B Air Intake System (nonautomotive)



	4B3.9	4BT3.9	4BTA3.9
Maximum Allowable Intake Restriction at Rated Speed and Loaded with Dirty Air Filter Element	508 mm H ₂ O [20 in H ₂ O]	635 mm H ₂ O [25 in H ₂ O]	635 mm H ₂ O [25 in H ₂ O]

6B Air Intake System (nonautomotive)

	6B5.9	6BT5.9	6BTA5.9
Maximum Allowable Intake Restriction at Rated Speed and Loaded with Dirty Air Filter Element	508 mm H ₂ O	635 mm H ₂ O	635 mm H ₂ O
	[20 in H ₂ O]	[25 in H ₂ O]	[25 in H ₂ O]

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B3.9 and B5.9 Series Engines Section E - Engine Identification

Air Intake System Data (automotive)

	B3.9	B5.9
Maximum Allowable Intake Restriction at Rated Speed and Loaded with Dirty Air Filter Element	635 mm H ₂ O [25 in H ₂ O]	635 mm H ₂ O [25 in H ₂ O]

Specifications Page E-21

Exhaust System

4B Exhaust System Data (nonautomotive)

	4B3.9	4BT3.9	4BTA3.9
Maximum Allowable Exhaust Restriction at Rated Speed and Loaded	76.2 mm Hg [3.0 in Hg]	76.2 mm Hg [3.0 in Hg]	76.2 mm Hg [3.0 in Hg]



6B Exhaust System Data (nonautomotive)

	6B5.9	6BT5.9	6BTA5.9
Maximum Allowable Exhaust Restriction at Rated Speed and Loaded	76.2 mm Hg [3.0 in Hg]	76.2 mm Hg [3.0 in Hg]	76.2 mm Hg [3.0 in Hg]

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B3.9 and B5.9 Series Engines Section E - Engine Identification

Exhaust System Data (automotive)

	B3.9	B5.9
Maximum Allowable Exhaust Restriction at Rated Speed and Loaded (1991 to 1993 EPA certified)	114.3 mm Hg [4.5 in Hg]	114.3 mm Hg [4.5 in Hg]
Maximum Allowable Exhaust Restriction at Rated Speed and Loaded (1994 to 1998 EPA certi- fied)	152.4 mm Hg [6 in Hg] with oxidation catalyst	152.4 mm Hg [6 in Hg] with oxidation catalyst

Specifications Page E-23

Electrical System

4B Electrical System Data (nonautomotive)

	4B3.9	4BT3.9	4BTA3.9
Minimum Recommended Battery			
Capacity @ -18°C [0°F]			
With Light Accessories*	625CCA	625CCA	625CCA
12-VDC Starter	·	400CCA	400CCA
24-VDC Starter	312CCA	400CCA	40000,1
With Heavy Accessories**			000004
12-VDC Starter	800CCA	800CCA	800CCA
24-VDC Starter	400CCA	400CCA	400CCA
Maximum Allowable Resistance			
of Starting Circuit	0.0040	0.0012	0.0012
With 12-VDC Starter - Ohms	0.0012	0.0012	0.0072
With 24-VDC Starter - Ohms	0.0020	0.0020	0.0020

^{*} Typical light accessories include alternator, small steering pump, and disengaged clutch.

^{**} Typical heavy accessories include hydraulic pump and torque converter.

Specifications Page E-24

B3.9 and B5.9 Series Engines Section E - Engine Identification

6B Electrical System Data (nonautomotive)

	6B5.9	6BT5.9	6BTA5.9
Minimum Recommended Battery Capacity @ -18°C [0°F] With Light Accessories*			
12-VDC Starter	800CCA	800CCA	800CCA
24-VDC Starter	400CCA	400CCA	400CCA
With Heavy Accessories**			
12-VDC Starter	950CCA	950CCA	950CCA
24-VDC Starter	475CCA	475CCA	475CCA
Maximum Allowable Resistance of Starting Circuit			
With 12-VDC Starter - Ohms	0.0012	0.0012	0.0012
With 24-VDC Starter - Ohms	0.0020	0.0020	0.0012

^{*} Typical light accessories include alternator, small steering pump, and disengaged clutch.

^{**} Typical heavy accessories include hydraulic pump and torque converter.

Specifications Page E-25

Electrical System Data (automotive)

	B3.9	B5.9
Minimum Recommended Battery Capacity @ -18°C [0°F]		
With Light Accessories* 12-VDC Starter 24-VDC Starter	625CCA 400CCA	800CCA 400CCA
With Heavy Accessories** 12-VDC Starter 24-VDC Starter	800CCA 400CCA	950CCA 475CCA
Maximum Allowable Resistance of Starting Circuit With 12-VDC Starter - Ohms With 24-VDC Starter - Ohms	0.0012 0.0020	0.0012 0.0020

^{*}Typical light accessories include alternator, small steering pump, and disengaged clutch.

^{**}Typical heavy accessories include hydraulic pump and torque converter.

Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

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B3.9 and B5.9 Series Engines Section E - Engine Identification

Batteries (Specific Gravity)

Specific Gravity at 27°C [80°F]	State of Charge
1.260 to 1.280	100%
1.230 to 1.250	75%
1.200 to 1.220	50%
1.170 to 1.190	25%
1.110 to 1.130	Discharged

Engine Diagrams Page E-27

Engine Diagrams

Engine Views

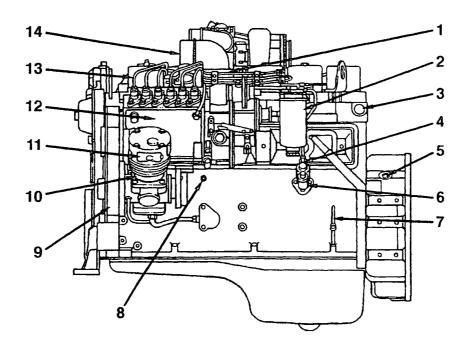
The following illustrations show the locations of the major external engine components, filters, and other service and maintenance points. Some external components will be at different locations for different engine models.

NOTE: The illustrations are only a reference to show a typical engine.



Engine Diagrams Page E-28

B3.9 and B5.9 Series Engines Section E - Engine Identification



00900280

Side View

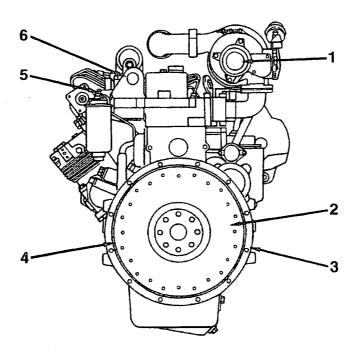
- 1. Intake air preheater (optional)
- 2. Fuel filter/water separator
- 3. Water heater (3/4-inch NPTF)
- 4. Fuel inlet connection (1/4-inch NPTF)
- 5. Magnetic pickup location (3/4-16UNF)
- 6. Fuel lift pump
- 7. Dipstick
- 8. Oil pressure (1/8-inch NPTF)

Engine Diagrams Page E-29

- 9. Engine dataplate
- 10. Air compressor
- 11. Air compressor intake
- 12. In-line fuel injection pump
- 13. High pressure fuel lines
- 14. Engine air inlet.



Engine Diagrams Page E-30 B3.9 and B5.9 Series Engines Section E - Engine Identification



00900279

Rear View

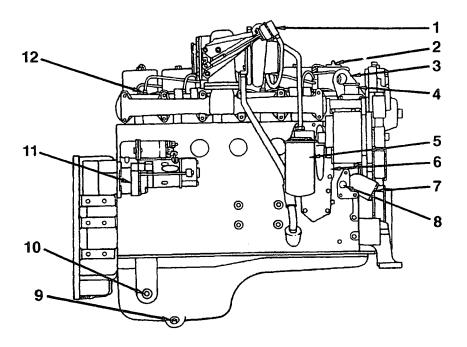
- 1. Turbocharger exhaust outlet
- 2. Clutch mounting plate
- 3. Flywheel housing
- 4. Flywheel flexplate

Engine Diagrams Page E-31

- 5. Fuel return connection
- 6. Rear engine lifting bracket.



Engine Diagrams Page E-32 B3.9 and B5.9 Series Engines Section E - Engine Identification



00900278

Turbocharger Side View

- 1. Turbocharger wastegate actuator
- 2. Oil fill
- 3. Front engine lifting bracket
- 4. Water outlet
- 5. Lubricating oil filter
- 6. Lubricating oil cooler
- 7. Water inlet

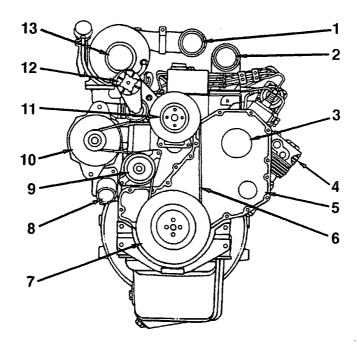
Engine Diagrams Page E-33

- 8. Water heater return (1/2-inch NPTF)
- 9. Oil drain
- 10. Provision for oil immersion heater
- 11. Starter motor solenoid
- 12. Fuel injection nozzles.



Engine Diagrams Page E-34

B3.9 and B5.9 Series Engines Section E - Engine Identification



00900277

Front View

- 1. Turbocharger air outlet
- 2. Engine air inlet
- 3. Fuel pump drive cover
- 4. Air compressor air outlet
- 5. Front gear cover
- 6. Fan drive belt
- 7. Vibration damper

Engine Diagrams Page E-35

- 8. Water inlet
- 9. Water pump
- 10. Alternator
- 11. Fan pulley
- 12. Automatic belt tensioner
- 13. Turbocharger air inlet.



Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Engine Diagrams Page E-36 B3.9 and B5.9 Series Engines Section E - Engine Identification **NOTES**

Q-Pulse Id TM\$1367 Active 29/07/2015

B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

Page 1-a

Section 1 - Operating Instructions Section Contents

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B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

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B3.9 and B5.9 Series Engines Section 1 - Operating Instructions Operating Instructions - Overview Page 1-1

Operating Instructions - Overview

General Information

Correct care of your engine will help result in longer life, better performance, and more economical operation.

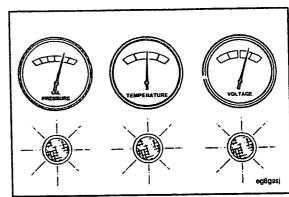
Follow the daily maintenance checks listed in Maintenance Guidelines, Section 2.

The **new** Cummins engine associated with this manual does **not** require a "break-in" procedure. Section 1 of this manual provides all of the necessary information required for proper engine operation.

Check the oil pressure indicator, temperature indicator, warning lights, and other gauges daily to make sure they are operational.

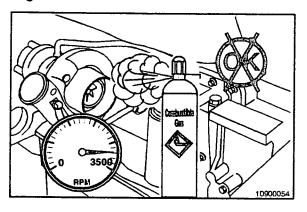
Avoid exposure of your engine to corrosive chemicals.







Operating Instructions - Overview Page 1-2



WARNING A

DO NOT OPERATE A DIESEL ENGINE WHERE THERE ARE OR CAN BE COMBUSTIBLE VAPORS. These vapors can be sucked through the air intake system and cause engine acceleration and overspeeding that can result in a fire, an explosion, and extensive property damage. Numerous safety devices are available, such as air intake shutoff devices, to minimize the risk of overspeeding where an engine, due to its application, might operate in a combustible environment, such as due to a fuel spill or gas leak. Remember, Cummins has no way of knowing the use you have for your engine. THE EQUIPMENT OWNER AND OPERATOR ARE RESPONSIBLE FOR SAFE OPERATION IN A HOSTILE ENVIRONMENT. CONSULT YOUR CUMMINS AUTHORIZED REPAIR LOCATION FOR FURTHER INFORMATION.

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Normal Starting Procedure

General Information

A CAUTION A

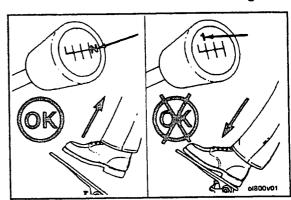
To prevent damage to the starting motor, do not engage the starting motor for more than 30 seconds. Wait 2

the starting motor for more than 30 seconds. Wait 2 minutes between each attempt to start (electrical starting motors only).

- Disengage the driven unit, or if equipped, put the transmission in neutral.
- With the throttle in the idle position, turn the key to the ON position, and wait for the WAIT-TO-START lamp to go out; then, turn the key to the START position.
- If the engine does not start after three attempts, check the fuel supply system. Absence of blue or white exhaust smoke during cranking indicates no fuel is being delivered.

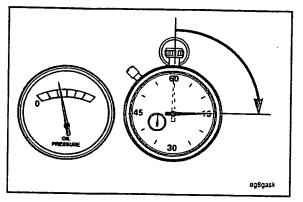
Normal Starting Procedure Page 1-3







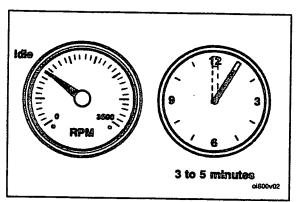
Normal Starting Procedure Page 1-4



B3.9 and B5.9 Series Engines Section 1 - Operating Instructions



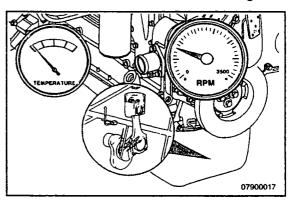
The engine **must** have adequate oil pressure within 15 seconds after starting. If the WARNING lamp indicating low oil pressure has **not** gone out or there is no oil pressure indicated on a gauge within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm the correct oil level in the oil pan.



Idle the engine 3 to 5 minutes before operating with a load.

Increase the engine speed (rpm) slowly to provide adequate lubrication to the bearings and to allow the oil pressure to stabilize.

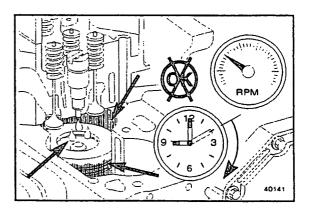
Normal Starting Procedure Page 1-5





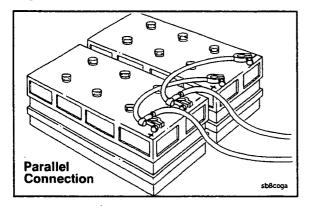
A CAUTION A

Do not operate engine at low idle for long periods (more than 10 minutes). Operating engine for long periods at low idle can damage engine because combustion chamber temperatures will decrease and the fuel will not completely burn. This will cause carbon to build up around the injector spray holes and piston rings that can cause the valves to stick. To avoid damage, operate the engine at a higher idle.



Normal Starting Procedure Page 1-6

B3.9 and B5.9 Series Engines Section 1 - Operating Instructions





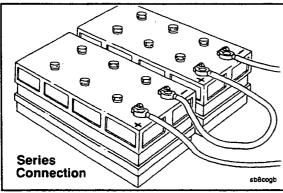


WARNING A



Batteries can emit explosive gases. To avoid personal injury, always ventilate the compartment before servicing the batteries. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

The accompanying illustration shows a typical parallel battery connection. This arrangement doubles the cranking amperage.







A CAUTION A



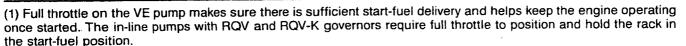
When using jumper cables to start the engine, make sure to connect the cables in parallel: Positive (+) to positive (+) and negative (-) to negative (-). When using an external electrical source to start the engine, turn the disconnect switch to the OFF position. Remove the key before attaching the jumper cables to prevent unintentional starter engagement.

This illustration shows a typical series battery connection. This arrangement, positive (+) to negative (-), doubles the voltage.

Normal Starting Procedure Page 1-7

Starting Procedure Matrix

Starting Procedure Matrix				
Automotive/Industrial	idle Throttle			
All pumps - above 16°C [60°F]	X (after 5 seconds, see Note)			
Automotive/Industrial Full Throttle				
All pumps - below 16°C [60°F]	X Note			



NOTE: Full throttle is applied after engaging the starter.

- Disengage the driven unit, or if equipped, put the transmission in neutral.
- Position the fuel shutoff, electrical switch, or mechanism control to the RUN position.



Cold Weather Operation Page 1-8

B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

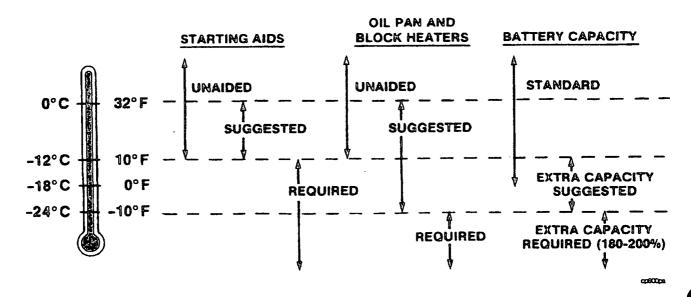
Cold Weather Operation

Operating Aids

Use the following chart as a reference for required cold weather starting aids.

Operation in ambient temperatures below 0°C [32°F] will possibly require special consideration be given to engine starting.

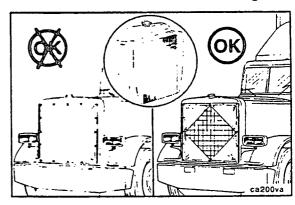
At temperatures below 0°C [32°F], operate the engine at moderate speeds for 5 minutes before full loads are applied.



Winterfronts

Winterfronts can be used on a vehicle equipped with charge air cooling (CAC) but **must** be designed to cover part of the frontal area of the cooling system. A minimum of 387 cm² [60 in²] of frontal area **must** be left open to allow airflow for the CAC to function correctly.

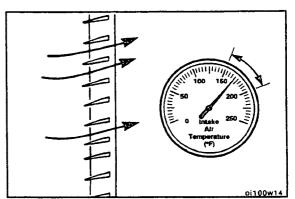
Cold Weather Operation Page 1-9





Shutters

Installations of charge air cooler (CAC) engines with shutters also require an intake manifold air temperature switch to open the shutters to prevent excessive intake manifold temperatures. This prevents engine damage due to high intake manifold temperatures as a result of blocked airflow across the CAC.



Cold Weather Starting Aids Page 1-10

B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

Cold Weather Starting Aids

With Mechanical or Electrical Metering Equipment (Ether)

- · Set the throttle at half speed.
- Disengage the driven unit, or if equipped, put the transmission in neutral.
- · Activate the switch to open the fuel pump shutoff valve.
- · While cranking the engine, inject metered amounts of starting fluid.
- Engine oil pressure must be indicated on the gauge within 30 seconds after starting.

Cold Weather Starting Aids Page 1-11

Ether Starting Aids



Because of the potential for an explosion, do not use volatile cold starting aids in underground mine or tunnel operations. Ask the local U.S. Bureau of Mines inspector for instructions.



Starting fluid is highly flammable and explosive. Keep flames, sparks, and arcing switches away from starting fluid.



Do not breathe starting fluid fumes. Starting fluid fumes can be hazardous to your health.



Do not use excessive amounts of starting fluid when starting an engine. The use of too much starting fluid will cause damage to the engine.

• Spray starting fluid into the air cleaner intake while another person cranks the engine.

Cold Weather Starting Aids Page 1-12

B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

Grid Heater

A WARNING A

To avoid personal injury and property damage, never use starting fluid if the grid heater option is used. Starting fluid, which contains ether, can cause an explosion.

A grid heater is available that improves cold weather starting characteristics by heating the intake air. It is available for B Series automotive ratings with an in-line injection fuel pump and industrial jacket water aftercooled with a Bosch[®] in-line injection pump. It can also serve to reduce white smoke if it is energized during cold ambient temperatures while the engine is at idle.

The electric grid heater operates in a preheat and postheat mode. The length of heater on-time is a function of the engine temperature.

If the engine ambient air temperature is greater than 7°C [45°F], the electric grid air heater system will **not** be activated. If the engine ambient air temperature is below 7°C [45°F], the system will operate as follows:

Engine Starting Cycle

 Turn the ignition key to the RUN position. When the key is in this position, the WAIT-TO-START light will be illuminated for approximately 25 seconds.
 Do not crank the engine until the WAIT-TO-START light shuts off.

NOTE: The controller is rest each time the ignition is turned off and the cycle will start over.

- 2. When the WAIT-TO-START lamp goes out, the preheat cycle is complete. Depress the accelerator pedal and crank the engine. Crank the starter as soon as the WAIT-TO-START lamp goes out.
- 3. Postheat Cycle:
 - Postheating occurs as the grid heater elements are cycled for a while with the engine running. Postheating helps warm the engine up faster and eliminates white smoke. Postheating is determined by the engine ambient air temperature upon start-up.

Starting Procedure After Extended Shutdown or Oil Change Page 1-13

Starting Procedure After Extended Shutdown or Oil Change

General Information

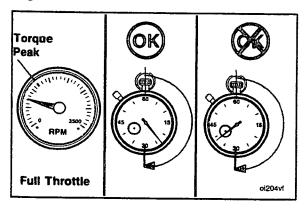
Complete the following steps after each oil change, or after the engine has been shut down for more than 30 days to make sure the engine receives the correct oil flow through the lubricating oil system.

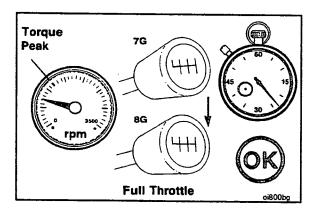
- 1. Disconnect the electrical wire from the fuel pump solenoid.
- 2. Rotate the crankshaft, using the starting motor, until oil pressure appears on the gauge or the warning lamp goes out.



- 3. Connect the electrical wire to the fuel pump solenoid valve.
- 4. Start the engine; refer to normal starting procedures in this section.
- 5. Refer to fuel system bleeding, section 5 for instruction to vent fuel system.

Engine Operating Range Page 1-14





B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

Engine Operating Range General Information

A CAUTION A

Do not operate the engine at excessive full-throttle operation below peak torque rpm (refer to engine dataplate for peak torque rpm) for more than 30 seconds. This condition will shorten engine life to overhaul, can cause serious engine damage, and is considered driver abuse.

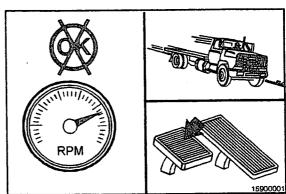
Cummins engines are designed to operate successfully at full throttle under transient conditions down to peak torque engine speed. This is consistent with recommended operating practices.

Operation of the engine below peak torque rpm can occur during gear shifting due to the difference of ratios between transmission gears, but engine operation **must not** be sustained for more than 30 seconds at full throttle below peak torque rpm.

Operating the Engine Page 1-15



Do not operate the engine beyond high idle speed under any circumstances. Operating the engine beyond high idle speed can cause severe engine damage. When descending a steep grade, use a combination of transmission gears and engine or service brakes to control the vehicle and engine speed.





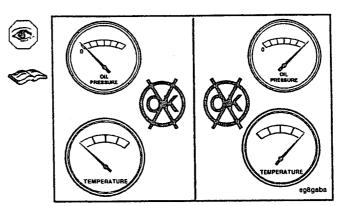
Operating the Engine

General Information

▲ CAUTION ▲

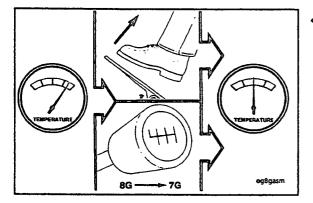
Continuous operation with a low coolant temperature below 60°C [140°F], or a high coolant temperature above 100°C [212°F], can damage the engine.

Monitor the oil pressure and coolant temperature gauges frequently. Refer to Lubricating Oil System Specifications and Cooling System Specifications, in Section V, for recommended operating pressures and temperatures. Shut off the engine if any pressure or temperature does **not** meet the specifications.



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Operating the Engine Page 1-16



B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

If an overheating condition starts to occur, reduce the power output of the engine by releasing the throttle pedal pressure or shifting the transmission to a lower gear, or both, until the temperature returns to the normal operating range. If the engine temperature does **not** return to normal, shut off the engine and refer to Troubleshooting Symptoms, Section TS, or contact a Cummins Authorized Repair Location.

Page 159 of 542

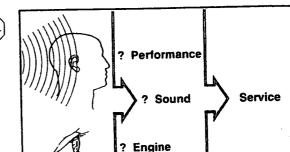
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B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

Most failures give an early warning. Look and listen for changes in performance, sound, or engine appearance that can indicate service or engine repair is needed. Some changes to look for are as follows:

- Engine misfires
- Vibration
- Unusual engine noises
- Sudden changes in engine operating temperatures or pressures
- Excessive smoke
- · Loss of power
- · An increase in oil consumption
- · An increase in fuel consumption
- · Fuel, oil, or coolant leaks.

Operating the Engine Page 1-17

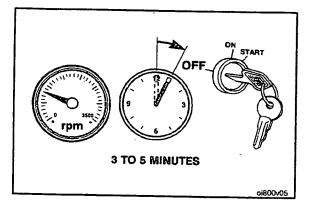


Appearance



oi800k01

Engine Shutdown Page 1-18



B3.9 and B5.9 Series Engines Section 1 - Operating Instructions

Engine Shutdown

General Information

- Allow the engine to idle 3 to 5 minutes before shutting it off after a full-load operation. This allows adequate cooldown of pistons, cylinders, bearings, and turbocharger components.
- 2. Turn the ignition keyswitch to the OFF position.

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Page 2-a

Dage

Section 2 - Maintenance Guidelines Section Contents

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2-1	Maintenance Guidelines - Overview
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B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

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B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines Maintenance Guidelines - Overview Page 2-1

Maintenance Guidelines - Overview

General Information

Cummins Engine Company, Inc. recommends that the engine be maintained according to the Maintenance Schedule in this section.

If the engine is operating in ambient temperatures consistently below -18°C [0°F] or above 38°C [100°F], perform maintenance at shorter intervals. Shorter maintenance intervals are also required if the engine is operated in an abnormally dusty environment or if frequent stops are made. See your Cummins Authorized Repair Location for recommended intervals.



If your engine is equipped with a component or an accessory **not** manufactured by Cummins Engine Company, Inc., refer to the component manufacturer's maintenance recommendations. Suppliers' addresses and telephone numbers are provided in Component Manufacturers (Section M).

Use the chart provided at the end of this section as a convenient way to keep a record of maintenance performed.

Tool Requirements
Page 2-2

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Tool Requirements

General Information

In the text, a symbol followed by the wrench size or tool description is used to identify the tooling required to perform each step. More than one tool is needed.

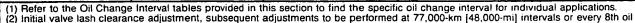
Sockets	Wrenches	Other Tools
19 mm	19 mm	Filter wrenches (75 to 80 mm and 90 to 95 mm)
17 mm	17 mm	Ratchet (1/2-inch drive)
15 mm	15 mm	Flat-blade screwdriver
	14 mm	Torque wrench
	13 mm	Allen wrench (5/16 inch)
	10 mm	Feeler gauges (0.25 mm and 0.51 mm) Engine barring gear, Part No. 3824591

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines Maintenance Schedule Page 2-3

Maintenance Schedule

General Information

B3.9 and B5.9 Series En	B3.9 and B5.9 Series Engine Maintenance Schedule:						
Daily or Refueling	Every 10,000 km [6000 mi] 250 Hours, or 3 Months	Every 19,000 km [12,000 mi], 500 Hours, or 6 Months	Every 38,000 km [24,000 mi], 1000 Hours, or 1 Year	Every 77,000 km [48,000 mi], 2000 Hours, or 2 Years			
Maintenance Check	Check/Inspect	Change/Replace/Inspect	Check/Inspect	Check/Inspect/ Replace			
Oil level Coolant level Fan Drive belt Fuel-water separator.	Change lubricating oil (1). Replace lubricating oil filter. Inspect air cleaner. Inspect intake system. Check charge air cooler (4).	Change lubricating oil (1). Replace lubricating oil filter. Replace fuel filter (5). Inspect air cleaner. Inspect air intake system. Check antifreeze (3). Check charge air cooler (4).	Change lubricating oil (1). Replace lubricating oil filter. Replace fuel filter (5). Adjust valve lash clearance (2). Inspect air cleaner. Inspect intake system. Check charge air cooler (4). Check antifreeze (3). Inspect fan hub. Inspect belt tensioner.	Change lubricating oil (1) Replace lubricating oil filter. Replace fuel filter (5). Change antifreeze (3). Inspect air cleaner. Check charge air cooler (4). Inspect intake system. Inspect fan hub. Inspect belt tensioner. Check belt tension.			



change for automotive engines or 2000-hour, 2-year intervals for industrial engines.

(3) Heavy-duty year-around antifreeze that meets the critical composition of GM6038M must be used. The change interval is 2 years or 320,000 km [200,000 mi], whichever occurs first. Antifreeze is essential for freeze, overheat, and corrosion protection.

(4) Service interval is 2 years or 320,000 km [200,000 mi], whichever occurs first.

(5) Service interval is every other oil change or 19,000 km [12,000 mi], 500 hours, or 6 months, whichever occurs first.



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Maintenance Schedule Page 2-4

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Lubricating Oil Drain Interval

Refer to the following flowchart to determine the maximum recommended oil change and filter change intervals in kilometers, miles, hours, or months, whichever occurs first.

Is the vehicle an on-highway application?

If Yes -

Refer to Table 1

If No -

Is the vehicle used in a construction, mining, or logging operation?

If Yes -

Refer to Table 2

If No -

Is the vehicle used in an agricultural or stationary power application?

If Yes -

Refer to Table 3

If No -

Use the following oil change interval, 10,000 km [6000 mi], 250 hours, or 3 months, whichever occurs first.

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Maintenance Schedule Page 2-5

Table 1 Use the following oil drain intervals for your application (1):					
Vehicle/Equipment	km	mi	Hours	Months	
Refuse Truck	10,000	6000	250	3	
Mixer/Dumper	10,000	6000	250	3	
Delivery Truck	10,000	6000	250	6	
Shuttle or Transit Bus	10,000	6000	250	3	
School Bus	10,000	6000	250	6	
Fire Truck	10,000	6000	250	3	
Recreational Vehicle	10,000	6000	250	6	
Regional Haul Truck	17,000	10,000	250	3	
Coach Bus	17,000	10,000	250	3	

⁽¹⁾ Or whichever occurs first. If your application accumulates high hours and low mileage, the change interval is determined by hours.

Note: If the vehicle accumulates 12,875 km [8000 mi] in a month, the oil change interval will be 17,000 km [10,000 mi] or 250 hours, whichever occurs first.



Maintenance Schedule Page 2-6

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Table 2 Use the following oil drain intervals for your application (1):						
Vehicle/Equipment	km	mi	Hours	Months		
Truck Crane	10,000	6000	250	3		
Yard Spotter	10,000	6000	250	3		
Paver	N/A	N/A	250	6		
Cranes	N/A	N/A	250	6		
Backhoe	N/A	N/A	250	6		
Dozer	N/A	N/A	250	6		
Scraper	N/A	N/A	250	6		
Skidder	N/A	N/A	250	6		

(1) Or whichever occurs first. If the application accumulates high hours and low mileage, the change interval is determined by hours.

Table 3 Use the following oil drain intervals for your application (1):					
Vehicle/Equipment	Hours	Months			
Farm Tractors	250	6			
Combines	250	6			
Irrigation Equipment	250	6			
Generator Set	250	6			
Air Compressor	250	6			
Fire Pump	250	6			
Pleasure Boat	250	6			
Work Boat	250	3			

(1) Or whichever occurs first. If the application accumulates high hours and low mileage, the change interval is determined by hours.

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines Maintenance Schedule Page 2-7

Arctic Operation

▲ CAUTION ▲

The use of a synthetic-base oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as corrosion, deposits, and wear.

If an engine is operated in ambient temperatures consistently below -23°C [-10°F] and there are no provisions to keep the engine warm when it is **not** in operation, use a synthetic CE/SF or higher API classification engine oil with adequate low-temperature properties, such as 5W-20 or 5W-30.

The oil supplier is responsible for meeting the performance service specifications represented with its product.



Page References for Maintenance Instructions Page 2-8

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Page References for Maintenance Instructions

General Information

For your convenience, listed below are the page numbers that contain specific instructions for performing the maintenance checks listed in the maintenance schedule.

Daily	or Refueling - Maintenance Check	
۰	Coolant Level - Inspect	3-
0	Drive Belts - Inspect	3-
•	Fan Cooling - Inspect	3-
•	Fuel-Water Separator - Drain	3_
	Lubricating Oil Level - Check	2
	Educating Oil Ecvoi Oilook	J
Every	10,000 km [6000 mi], 250 Hours, or 3 Months - Maintenance Check	
•	Air Cleaner Restriction - Inspect	1-1
0	Air Intake Piping - Inspect	4-
٥	Charge Air Cooler - Check/Correct	7
•	Lubricating Oil and Filters - Change	4-1
·	Lubricating Oil and Filters - Change	4-
Every	19,000 km [12,000 mi], 500 Hours, or 6 Months - Maintenance Check	
	Cooling System - Antifreeze Check	5-
۰	Fuel Filter (spin-on type) - Replace	5-
٥	Fuel Supply Lines - Vent	5
_	I dot duppy Lines - vent	5-
•	Injector Supply Lines (high pressure) - Vent	5-

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Page References for Maintenance Instructions Page 2-9

very	38,000 km [24,000 mi], 1000 Hours, or 1 Year - Maintenance Check	6.0
0	Drive Belt - Test	6-0
•	Drive Belt and Tensioner - Inspect	0-0
•	Overhead Set - Measure	6-2
Every	77,000 km [48,000 mi], 2000 Hours, or 2 Years - Maintenance Check	7-9
	Air Compressor Inspect	7-9 7-2
ó	Air Compressor - Inspect	1-2
•	77,000 km [48,000 mi], 2000 Hours, or 2 Years - Maintenance Check Air Compressor - Inspect Cooling System - Drain/Flush/Fill Vibration Damper - Inspect	7-2 7-8



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Maintenance Record Form Page 2-10

B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Maintenance Record Form General Information

Maintenance Record				
Engine Serial No.: Engine Model:				
Owner's Name:	Equipment Name/Number:			

Key to table headings:

A = Date

B = km [Miles], Hours or Time Interval

C = Actual km [Miles] or Hours

D = Maintenance Check Performed

E = Check Performed By

F = Comments

Α	В	С	D	E	F

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B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines

Maintenance Record Form Page 2-11

Α	В	С	D	E	F
	·				
	·				
				·	
				_	



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Maintenance Record Form Page 2-12		B3.9 and B5.9 Series Engines Section 2 - Maintenance Guidelines
	NOTES	
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B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval

Page 3-a

Section 3 - Maintenance Procedures at Daily Interval Section Contents

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Coolant Level	3-4 3-4
Daily Maintenance Procedures - Overview	3-1 3-1
Drive Belts	3-7 3-7
Fan, Cooling	3-8 3-8
Fuel-Water Separator	3-2 3-2
Lubricating Oil Level Maintenance Check	3-3 3-3



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B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval

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B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval Daily Maintenance Procedures - Overview Page 3-1

Daily Maintenance Procedures - Overview

General Information

Preventative maintenance begins with day-to-day awareness of the condition of the engine and its systems.

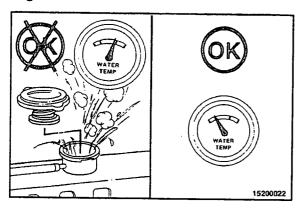
Before starting the engine, check the oil and coolant levels. Look for

- Leaks
- · Loose or damaged parts
- Worn or damaged belts
- Any change in engine appearance.



Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Coolant Level Page 3-4



B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval



Coolant Level

Maintenance Check



WARNING



Do not remove a pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Never use a sealing additive to stop leaks in the cooling system. This can result in cooling system plugging and inadequate coolant flow, causing the engine to overheat.

The coolant level must be checked daily.

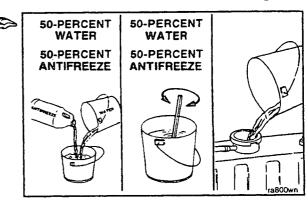
B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval Coolant Level Page 3-5

A CAUTION A

Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50°C [122°F] before adding coolant.

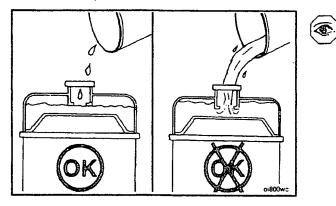
If additional coolant is added to the cooling system, a 50-percent mixture of water and antifreeze **must** be premixed before being added to the system. Since the ability of antifreeze to remove heat from the engine is **not** as good as water, pouring antifreeze into the engine first could contribute to an overheated condition before the liquids are completely mixed. Refer to Coolant Recommendations and Specifications in Section V.

NOTE: On applications that use a coolant recovery system, check to make sure the coolant is at the appropriate level on the coolant recovery tank, depending on engine temperature.





Coolant Level Page 3-6



B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval

Fill the cooling system with coolant to the bottom of the fill neck in the radiator fill or expansion tank.

NOTE: Some radiators have two fill necks, both of which must be filled when the cooling system is drained.

B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval

Drive Belts

Maintenance Check

Inspect the belts daily. Check the belt for intersecting cracks. Traverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are not acceptable. Replace the belt if it is frayed or has pieces of material missing. Refer to Section A for belt adjustment and replacement procedures.

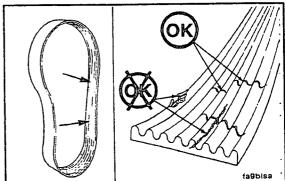
Belt damage can be caused by:

- Incorrect tension
- · Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- · Oil or grease on the side of belts.

Drive Belts Page 3-7



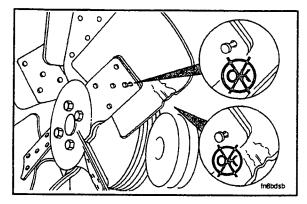






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Fan, Cooling Page 3-8



B3.9 and B5.9 Series Engines Section 3 - Maintenance Procedures at Daily Interval



Fan, Cooling

Maintenance Check



WARNING



Do not straighten a bent fan blade or continue to use a damaged fan. A bent or damaged fan blade can fail during operation and cause personal injury or property damage.

NOTE: Rotate the crankshaft by using the engine barring gear.

An inspection of the cooling fan is required daily. Check for cracks, loose rivets, and bent or loose blades. Check the fan to make sure it is securely mounted. Tighten the capscrews if necessary. Replace any fan that is damaged.

B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

Page 4-a

Maintenance Procedures at 10,000 Kilometers [6000 Miles], 250 Hours, or 3 Months

Section Contents

	Page
Air Cleaner Restriction	
Air Intake Piping	
Charge-Air Cooler (CAC)	. 4-8 . 4-9 . 4-8
Lubricating Oil and Filters Drain Fill Install Remove	4-/
Maintenance Procedures - Overview	. 4-1



Page 4-b

B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

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B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi] Maintenance Procedures - Overview Page 4-1

Maintenance Procedures - Overview

General Information



A WARNING A



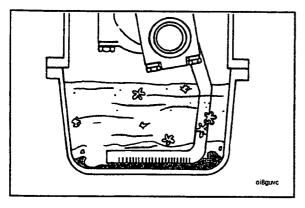
Some state and federal agencies have determined that used engine oil can be carcinogenic and cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.

Protect the environment:

Handling and disposal of used engine oil is subject to federal, state, and local laws and regulations. Use authorized waste disposal facilities, including civic amenity site and garages providing authorized facilities for receipt of used oil. If in doubt, contact state and environmental authorities or the Environmental Protection Agency for guidance about proper handling and disposal of used engine oil.



Lubricating Oil and Filters Page 4-2



B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]



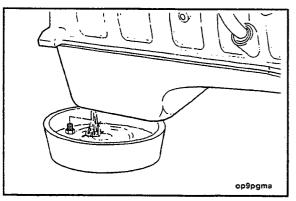
Lubricating Oil and Filters

Drain

NOTE: If the engine is in service, the oil drain interval of 10,000 km [6000 mi], 250 hours, or 3 months (or approved extended interval from the table in Section 2) **must** be used.

Change the oil filters to remove the contaminants suspended in the oil.

NOTE: Drain the oil **only** when it is hot and the contaminants are in suspension.







WARNING



To avoid personal injury, avoid direct contact of hot oil with your skin.



17 rhm

Operate the engine until the water temperature reaches 60°C [140°F]. Shut the engine off. Remove the oil drain plug.

NOTE: Use a container that can hold at least 20 liters [15 qt] of oil.

B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

Remove

90- to 95-mm Filter Wrench

Clean the area around the lubricating oil filter head. Remove the filter. Clean the gasket surface of the filter head.

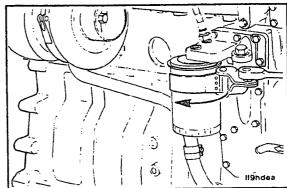
NOTE: The o-ring can stick on the filter head. Make sure it is removed before installing the new filter.

Lubricating Oil and Filters Page 4-3









Install

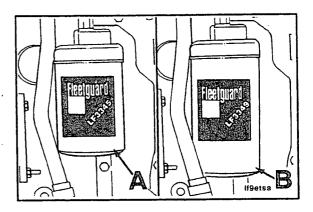
A CAUTION A

A six-cylinder oil filter can be used on a four-cylinder engine. Do not use a four-cylinder oil filter on a sixcylinder engine. Use of a four-cylinder oil filter on a six-cylinder engine will result in engine damage.

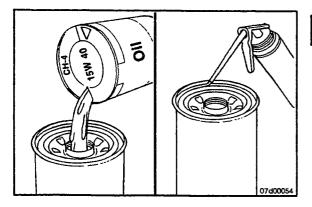
Make sure the correct oil filter is used.

The filter for the six-cylinder engine is longer than the filter for the four-cylinder engine.

- A = Standard for four-cylinder applications
- B = Standard for six-cylinder applications.



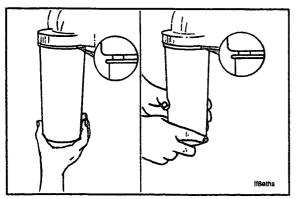
Lubricating Oil and Filters Page 4-4



B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

NOTE: Fill the filter with clean lubricating oil before installation.

Apply a light film of lubricating oil to the gasket sealing surface before installing the filter.





A CAUTION A

Mechanical overtightening of filter can distort the threads or damage the filter element seal.

Install the filter as specified by the filter manufacturer.

Page 189 of 542

B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

Clean the sealing surface.

Check the oil drain plug threads.

Install the drain plug.

Steel Pan

Torque Value: 80 Nom

[59 ft-lb]

Aluminum Pan

Torque Value: 60 Nom

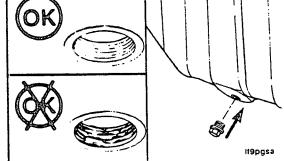
[44 ft-lb]

Lubricating Oil and Filters Page 4-5





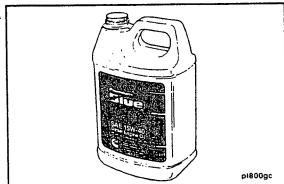




Fill

NOTE: Use a high-quality 15W-40 multiviscosity lubricating oil, such as Valvoline Premium Blue[®], or its equivalent in Cummins engines. Choose the correct lubricating oil for your operating climate as outlined in Section 2.

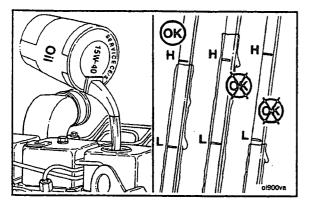






Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Lubricating Oil and Filters Page 4-6



B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

Fill the engine with clean lubricating oil to the proper level.

NOTE: Total system capacity assumes lubricating oil pan plus lubricating oil filter.

Some applications use a slightly different lubricating oil pan capacity, and all lubricating oil quantities **must** be adjusted accordingly. Contact your local Cummins Distributor if you have any questions.

	Cylinder	Six Cylinder
Pan Capacity	9.5 liters [10 qt]	14.2 liters [15 qt]
Total system Capacity	10.2 liters [10.8 qt]	15.1 liters [16 qt]

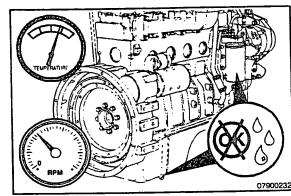
NOTE: Some 6B applications use a reduced capacity pan 10.4 liters [11 qts], and some have increased capacity of 16 liters [17 qt]. Fill quantities **must** be adjusted accordingly.

B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

Operate the engine, and check for leaks at the filters and oil drain plug.

Air Intake Piping Page 4-7





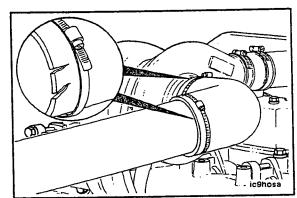
Air Intake Piping

Inspect for Reuse

Inspect the intake piping for cracked hoses, loose clamps, or punctures that can allow dirt and debris to enter the engine.

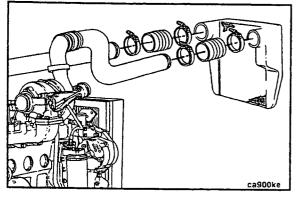
Tighten or replace parts as necessary to make sure the air intake system does **not** leak.







Charge-Air Cooler (CAC) Page 4-8



B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]



Charge-Air Cooler (CAC)

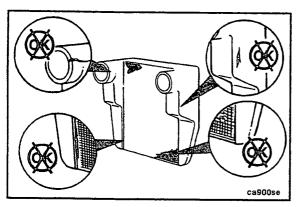
Inspect for Reuse



If the engine experiences a turbocharger failure or any other occasion where oil or debris is put into the charge air cooler, the charge air cooler must be cleaned.



Remove the charge air cooler from the vehicle. Refer to the vehicle manfacturer's instructions.





Inspect the charge air cooler for cracks, holes, or damage.

Inspect the tubes, fins, and welds for tears, breaks, or other damage.



Refer to Section A for the leak check procedure.

B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

Clean



MARNING M



When using solvents, acids, or alkaline materials for cleaning, follow manufacturer's recommendations for use. Wear goggles and protective clothing to avoid personal injury.



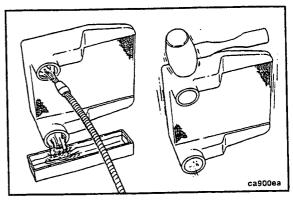
▲ CAUTION ▲



Do not use caustic cleaners to clean the charge air cooler. Damage to the charge air cooler will result.

Flush the charge air cooler internally with solvent in the opposite direction of normal airflow. Shake the charge air cooler and lightly tap on the end tanks with a rubber mallet to dislodge trapped debris. Continue flushing until all debris or oil is removed.

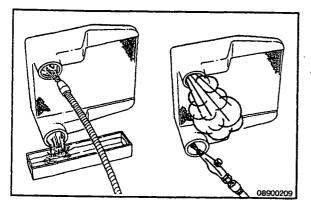






Page 4-9

Charge-Air Cooler (CAC) Page 4-10



B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mil







WARNING



When using solvents, acids, or alkaline materials for cleaning, follow manufacturer's recommendations for use. Wear goggles and protective clothing to avoid personal injury.



WARNING



Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause bodily injury.

After the charge air cooler has been thoroughly cleaned of all oil and debris with solvent, wash the charge air cooler internally with hot, soapy water to remove the remaining solvent. Rinse thoroughly with clean water.

Blow compressed air into the charge air cooler in the opposite direction of normal airflow until the charge air cooler is dry internally.

Refer to the vehicle manufacturer's instructions for installation procedures.

B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]

Air Cleaner Restriction

Maintenance Check

Maximum intake air restriction is 635 mm [25.0 in] of water for turbocharged engines. Naturally aspirated engines have a maximum restriction of 510 mm [20.0 in] of water.

Turbocharged engines **must** be operated at a rated rpm and full load to check maximum intake air restriction. Replace the air cleaner element when the restriction reaches the maximum allowable limit, or clean according to the manufacturer's recommendations.

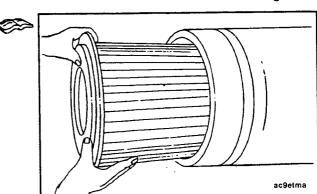
NOTE: Follow the manufacturer's instructions when cleaning or replacing the air cleaner element.

Check the air cleaner service indicator, if equipped. Change the filter element when the red indicator flag (2) is at the raised position in the window (1).

After the air cleaner has been serviced, push the button (3) to reset the service indicator.

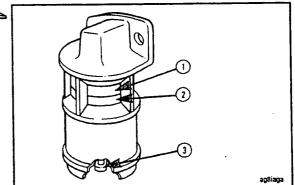
NOTE: Never operate the engine without an air cleaner. Intake air must be filtered to prevent dirt and debris from entering the engine and causing premature wear.

Air Cleaner Restriction Page 4-11











Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Air Cleaner Restriction Page 4-12	B3.9 and B5.9 Series Engines Maintenance Procedures at 10,000 km [6000 mi]
NOT	ES
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B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

Page 5-a

Maintenance Procedures at 19,000 Kilometers [12,000 Miles], 500 Hours, or 6 Months

Section Contents

F F	Page
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Fuel Filter (Spin-On Type)	5-2 5-2 5-2
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Page 5-b

B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

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B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi] Maintenance Procedures - Overview Page 5-1

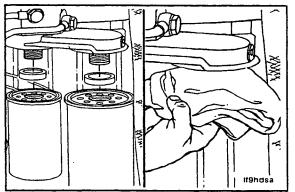
Maintenance Procedures - Overview

General Information

All checks or inspections listed under daily or previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.



Fuel Filter (Spin-On Type) Page 5-2



B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

Fuel Filter (Spin-On Type)



Remove



75 to 80 mm and 90 to 95 mm

Clean the area around the fuel filter head. Remove the filters. Clean the gasket surface of the filter head.

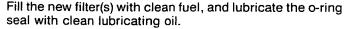


Replace the o-ring.

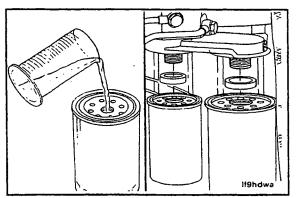




Install



- Standard filter used as secondary filter in dual-filter applications
- Fuel-water separator used as primary filter in dualfilter applications
- Fuel-water separator used in single-filter applications.



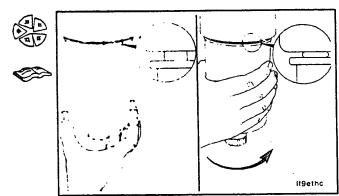
B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

Fuel Filter (Spin-On Type) Page 5-3

A CAUTION A

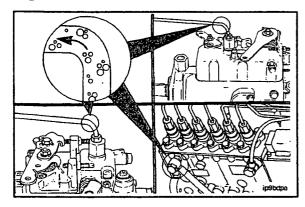
Mechanical overtightening will distort threads, filter element seal, or filter can.

Install the filter as specified by the filter manufacturer.





Fuel Supply Lines Page 5-4



B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

Fuel Supply Lines

Vent

Controlled venting is provided at the injection pump through the fuel drain manifold. Small amounts of air introduced by changing the filters or injection pump supply line will be vented automatically if the fuel filter is changed in accordance with the instructions. No manual bleeding is required.

NOTE: Manual bleeding is required if:

- The fuel filter is **not** filled prior to installation
- · Injection pump is replaced
- High-pressure fuel line connections are loosened or lines replaced
- Initial engine start-up or start-up after an extended period of no engine operation
- · Vehicle fuel tank has run empty.

B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

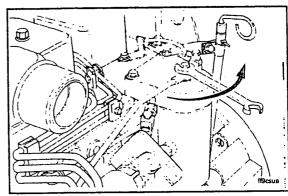
Low-Pressure Lines and Fuel Filter(s)

8 mm

Open the vent screw.

Fuel Supply Lines Page 5-5





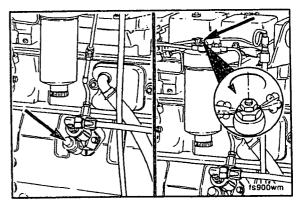
Operate the priming button on the lift pump until the fuel flowing from the fitting is air free.

Tighten the bleed screw.

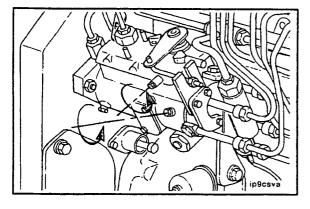
Torque Value: 9 N•m [80 in-lb]







Fuel Supply Lines Page 5-6



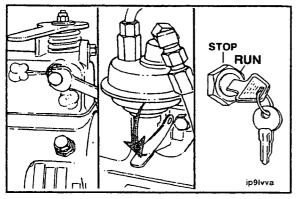
B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

Injection Pump Venting



8 mm

Bleed the Lucas CAV pump at the location shown in the illustration.



Air/fuel can be pumped from this location with the hand lever on the lift pump if the fuel solenoid valve is energized.

Q-Pulse Id TMS1367 Active 29/07/2015 Page 205 of 542

B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

WARNING



It is necessary to put the engine in the RUN position. Because the engine can start, be sure to follow all of the safety precautions. Use normal engine starting procedure.

A CAUTION A

When using the starting motor to vent the system, do not engage it for more than 30 seconds at a time: Wait 2 minutes between engagements.

Air can vented from both pumps through the fuel drain manifold line by operating the starting motor.

Injector Supply Lines (High Pressure) Vent

WARNING

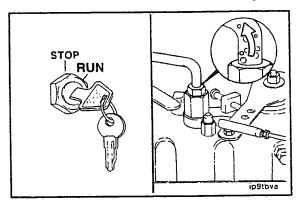


While testing the injectors, keep hands and body parts away from the injector nozzle. Fuel coming from the injector is under extreme pressure and can cause serious injury by penetrating the skin.

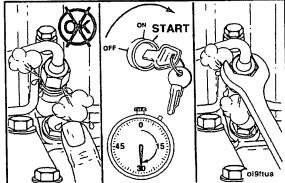
17 mm, 19 mm

Venting is accomplished by loosening one or more fittings at the injectors and cranking the engine to allow entrapped air to bleed from the lines.

Injector Supply Lines (High Pressure) Page 5-7

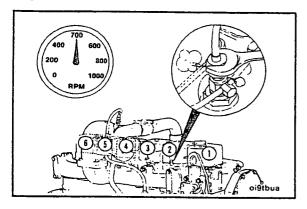








Injector Supply Lines (High Pressure) Page 5-8



B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]





WARNING



Do not bleed the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause fire.

Start the engine and vent one line at a time until the engine runs smoothly.

Tighten the line fittings.

Torque Value: 30 Nom

[22 ft-lb]

B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi]

Cooling System

Maintenance Check

A CAUTION A

Overconcentration of antifreeze or use of high-silicate antifreeze can cause damage to the engine.

Refractometer, Part No. C2800

Check the antifreeze concentration. Use a mixture of 50-percent water and 50-percent ethylene glycol or propylene glycol-base antifreeze to protect the engine to -32°C [-25°F] year-around.

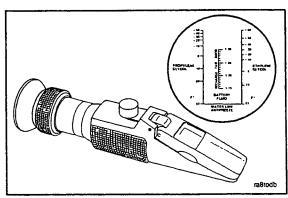
The Fleetguard® refractometer, Part No. C2800, provides a reliable, easy-to-read, and accurate measurement of freezing point protection and glycol (antifreeze) concentration.

Antifreeze is essential in every climate.

Use of antifreeze broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point.

The corrosion inhibitors also protect the cooling system components from corrosion and provide longer component life.

Cooling System Page 5-9





Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Page 5-10	B3.9 and B5.9 Series Engines Maintenance Procedures at 19,000 km [12,000 mi

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

Page 6-a

Maintenance Procedures at 38,000 Kilometers [24,000 Miles], 1000 Hours, or 1 Year

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Overhead Set Adjust	. 6-2	



Page 6-b

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

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B3.9 and B5.9 Series Engines
Maintenance Procedures at 38,000 km [24,000 mi]

Maintenance Procedures - Overview Page 6-1

Maintenance Procedures - Overview

General Information

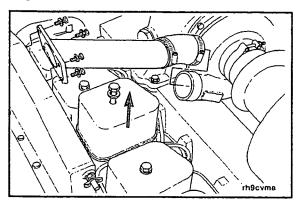
All checks or inspections listed under daily or previous maintenance intervals **must** also be performed at this time, in addition to those listed under this maintenance interval.

The procedures given in this section for valve lash adjustment are to be performed at the initial 38,000 km [24,000 mi] adjustment. Subsequent adjustments are to be performed at 77,000 km [48,000 mi].



Overhead Set Page 6-2

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]





Overhead Set

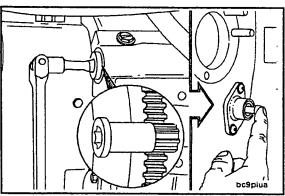
Adjust



Remove

15 mm

Remove the valve cover.





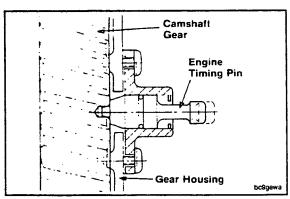
1/2-Inch Drive, Engine Barring Tool, Part No. 3824591

Locate top dead center (TDC) for cylinder No. 1 by barring the crankshaft slowly while pressing on the engine timing pin. Barring the engine is recommended from the flywheel on the rear of the engine.

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

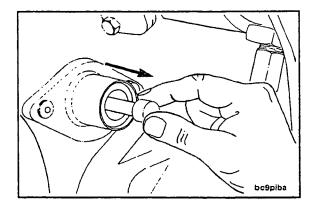
When the timing pin engages in the hole in the camshaft gear, cylinder No. 1 is at TDC on the compression stroke.

Overhead Set Page 6-3



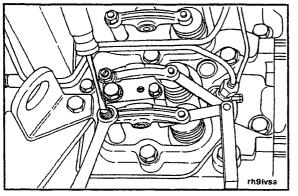
A CAUTION A

To avoid engine or timing pin damage, you must disengage the timing pin after locating top dead center.





Overhead Set Page 6-4



B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]



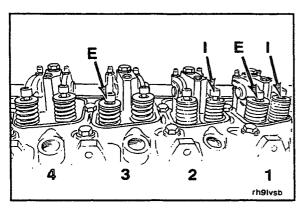
Feeler Gauge

NOTE: The clearance is correct when some resistance is "felt" when the feeler gauge is slipped between the valve stem and the rocker lever.



NOTE: Caution **must** be used when setting the exhaust valve lash on marine cylinder heads with rotators. The top of the valve stem is slightly recessed below the top of the valve rotator.

Intake Clearance: 0.254 mm [0.010 in]
Exhaust Clearance: 0.508 mm [0.020 in]





14-mm Wrench, Flat-Blade Screwdriver Four-Cylinder Engine Adjustment



Locate top dead center (TDC) for cylinder No. 1.

Set **only** valves indicated by the arrows (E = exhaust, I = intake). Do **not** set valves that are **not** indicated.



Holding the locknut steady with the wrench, adjust the valve clearance with the screwdriver or Allen wrench.

Tighten the locknut, and measure the valve lash again.

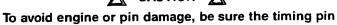
Torque Value: 24 Nom [18 ft-lb]

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

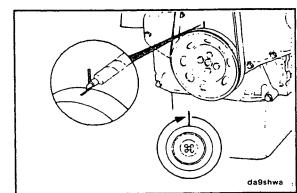
Overhead Set Page 6-5



CAUTION A



Mark the vibration damper, and rotate the crankshaft 360 degrees.



14-mm Wrench, Flat-Blade Screwdriver, or 5-mm Allen Wrench

Adjust the valves as indicated in the illustration.

Torque Value: 24 Nom

is disengaged.

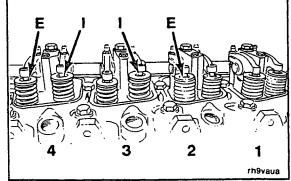
[18 ft-lb]

Set only valves indicated by the arrows (E = exhaust, I = intake). Do not set valves that are not indicated.



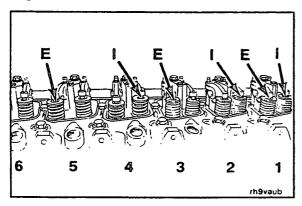


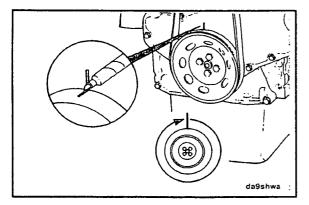






Overhead Set Page 6-6





B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]



14-mm Wrench, Flat-Blade Screwdriver

Six-Cylinder Engine Valve Adjustment



Locate top dead center (TDC) for cylinder No. 1.

Set only the valves indicated by the arrows in the illustration (E = exhaust, I = intake).



Holding the locknut steady with the wrench, adjust the valve clearance with the screwdriver or Allen wrench.

Tighten the locknut, and measure the valve lash again.

Torque Value: 24 Nom [18 ft-lb]



To avoid engine or pin damage, be sure timing pin is disengaged.

Mark the pulley, and rotate the crankshaft 360 degrees.

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

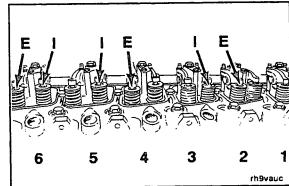
Adjust the valves as indicated in the illustration.

Set only the valves indicated by the arrows in the illustration (E = exhaust, I = intake). Do not set valves that are not indicated.

Torque Value: 24 Nom [18 ft-lb]







15 mm

install the rocker lever covers, and tighten the capscrews.

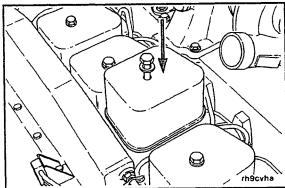
Torque Value: 24 Nom

[18 ft-lb]







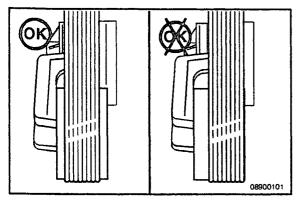




Overhead Set

Page 6-7

Drive Belts Page 6-8



B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

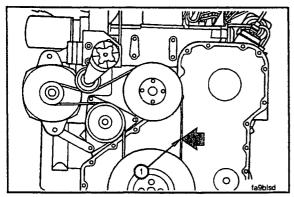


Drive Belts

Test

Drive Belt and Tensioner Inspection

Check the location of the drive belt on the belt tensioner pulley. The belt **must** be centered on, or centered close to the middle of, the pulley. Belts aligned, either too far forward or backward, can cause belt wear, belt roll-off failures, or increase uneven tensioner wear.





Check the belt deflection at the longest span of the belt. The deflection **must** be checked at the center (1) of the span. The maximum deflection allowed in the belt is 9.5 to 12.7 mm [3/8 to 1/2 in].

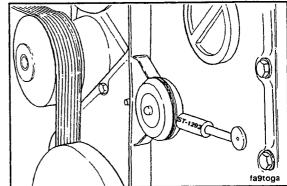
B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

Belt Tensioner Gauge, Part No. ST-1293

Use the Cummins belt tensioner gauge, Part No. ST-1293, to measure the tension in the drive belt.





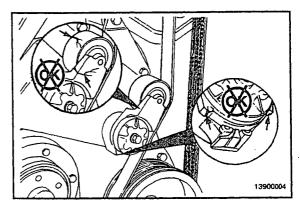


Drive Belts

Page 6-9

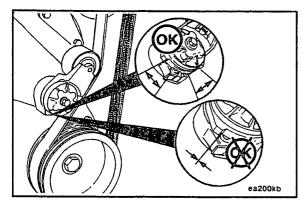
Check the tensioner arm, pulley, and stops for cracks. If any cracks are noticed, the tensioner **must** be replaced.







Drive Belts Page 6-10



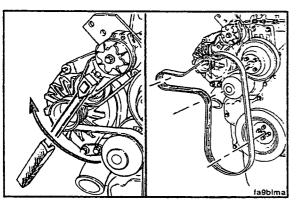
B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]



With the belt on, verify that neither tensioner arm stops are in contact with the spring casing stop. If either stop is touching, the drive belt **must** be replaced.



After replacing the belt, if the tensioner arm stops are still in contact with the spring casing stop, replace the tensioner.





3/8-Inch Breaker Bar, Extension

Remove the drive belt, and check torque of the tensioner capscrew.



Torque Value: 43 Nom [32 ft-lb]



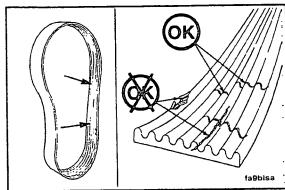
After checking the torque, use a 3/8-inch breaker bar with an extension to rotate the tensioner slowly away from the area of belt contact. If the arm rotates with any roughness or hesitancy, replace the tensioner.

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

Check the belt for damage. Transverse (across the belt width) cracks are acceptable. Longitudinal (direction of the belt length) cracks that intersect with transverse cracks are **not** acceptable. If the belt is frayed or has any piece of material missing, the belt is unacceptable and needs to be replaced.

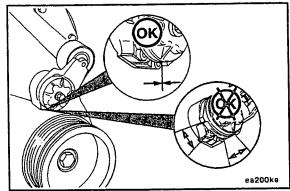






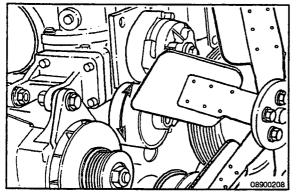
With the belt removed, verify that the tensioner arm stop is in contact with the spring case stop. If these two are **not** touching, the tensioner **must** be replaced.







Drive Belts Page 6-12



B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]



With the drive belt removed, check to be sure that the tensioner pulley rotates freely.

B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]

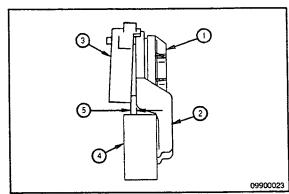
Measure the clearance between the tensioner spring case and the tensioner arm to verify wear-out and uneven bearing wear. If the clearance exceeds 3 mm [0.12 in] at any point, the tensioner has failed and **must** be replaced as a complete assembly. Experience has revealed that tensioners generally will show a larger clearance gap near the lower portion of the spring case, resulting in the upper portion rubbing against the tensioner arm. **Always** replace the belt when the tensioner is replaced.

Below is a breakdown of the tensioner.

- 1. Tensioner cap
- 2. Tensioner arm
- 3. Spring case
- 4. Tensioner pulley
- 5. Clearance gap.

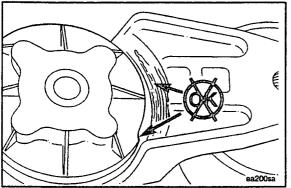
Drive Belts Page 6-13







Drive Belts Page 6-14



B3.9 and B5.9 Series Engines Maintenance Procedures at 38,000 km [24,000 mi]



Inspect the tensioner for evidence of the tensioner arm contacting the tensioner cap. If there is evidence of the two areas making contact, the pivot tube bushing has failed and the tensioner **must** be replaced.



B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

Page 7-a

Maintenance Procedures at 77,000 Kilometers [48,000 Miles], 2000 Hours, or 2 Years

Section Contents

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Air Compressor	7-9 7-9
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Maintenance Procedures - Overview	7-1
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B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

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B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi] Maintenance Procedures - Overview Page 7-1

Maintenance Procedures - Overview

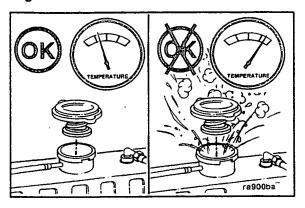
General Information

All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time, in addition to those listed under this maintenance interval.



Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Cooling System Page 7-2



B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

Cooling System

Drain



WARNING



Avoid prolonged and repeated skin contact with used antifreeze. Such prolonged, repeated contact can cause skin disorders or other bodily injury. Keep out of reach of children.

A CAUTION A



Protect the environment: Handling and disposing of used antifreeze is subject to federal, state, and local regulations. Use authorized waste disposal facilities, including civic amenity sites and garages providing authorized facilities for the receipt of used antifreeze. If in doubt, contact your local authorities of the EPA for quidance as to proper handling of used antifreeze.



▲ WARNING **▲**



Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

Cooling System Page 7-3



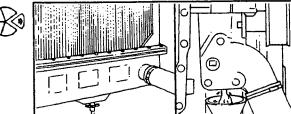
WARNING

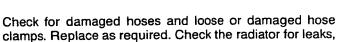


Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

Drain the cooling system by opening the drain valve on the radiator and removing the plug in the bottom of the water inlet. A drain pan with a capacity of 19 liters [5 gal] will be adequate in most applications.

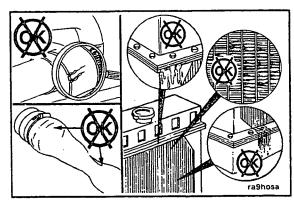
damage, and buildup of dirt. Clean and replace as required.







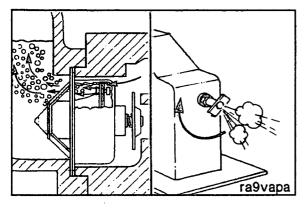


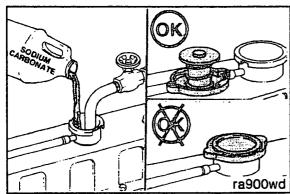




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Cooling System Page 7-4





B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

Flush

A CAUTION A

During filling, air must be vented from the engine coolant passages. The air vents through the "jiggle pin" openings to the top radiator hose and out the fill opening. Additional venting is provided for engines equipped with an aftercooler. Open petcock during filling.

NOTE: Adequate venting is provided for a fill rate of 19 liters [5 gal] per minute.

A CAUTION A

Do not install the radiator cap. The engine is to be operated without the cap for this process.

Fill the system with a mixture of sodium carbonate and water (or commercially available equivalent).

NOTE: Use 0.5 kg [1.0 lb] of sodium carbonate for every 23 liters [6.0 gal] of water.

B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

Cooling System Page 7-5



WARNING



Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

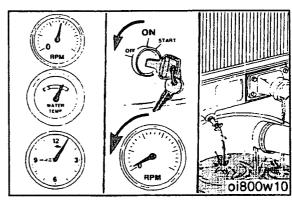
Operate the engine for 5 minutes with the coolant reaching the temperature of above 80°C [176°F].

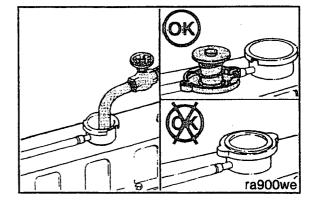
Shut the engine off and drain the cooling system.

Fill the cooling system with clean water.

NOTE: Be sure to vent the engine and aftercooler for complete filling.

NOTE: Do not install the radiator cap or the new coolant filter.

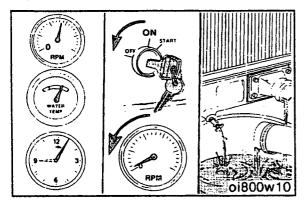


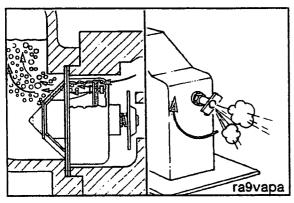




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Cooling System Page 7-6





B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]



WARNING



Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

Operate the engine for 5 minutes with the coolant reaching the temperature of above 80°C [176°F].

Shut the engine off and drain the cooling system.

NOTE: If the water being drained is still dirty, the system must be flushed again until the water is clean.

Fill

▲ CAUTION ▲



The system must be filled properly to prevent air locks. During filling, air must be vented from the engine coolant passages. Be sure to open the petcock on the aftercooler for aftercooled engines. Wait 2 to 3 minutes to allow air to be vented; then add mixture to bring level to the top.

NOTE: The system has a design fill rate of 19 liters [5 gal] per minute.

B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

▲ CAUTION ▲

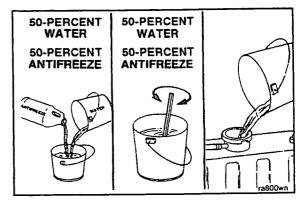
Never use water alone for coolant. Damage from corrosion can be the result of using water alone for coolant.

Use a mixture of 50-percent water and 50-percent ethylene glycol antifreeze to fill the cooling system.

Coolant Capacity (engine only)			
	liters	_	U.S.gal
4B3.9, 4BT3.9	7	MAX	1.85
4BTA3.9*	7.9	MAX	2.1
6B5.9, 6BT5.9	9	MAX	2.38
6BTA5.9*	9.9	MAX	2.61

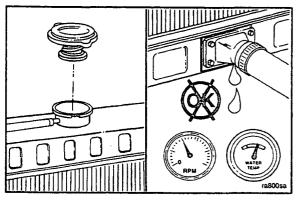
^{*} Jacket-water aftercoolers are used on the 4BTA and 6BTA engines. If a charge air cooler is used, the coolant capacity is the same as the naturally aspirated or turbocharged-**only** engines.

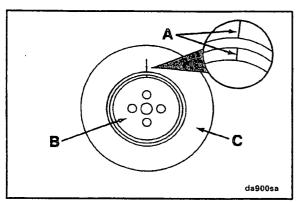
Cooling System Page 7-7





Vibration Damper Page 7-8





B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]





WARNING



Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F]. Failure to do so can cause personal injury from heated coolant.

Install the pressure cap. Operate the engine until it reaches a temperature of 80°C [180°F], and check for coolant leaks.

Check the coolant level again to make sure system is full of coolant, or that the coolant level has risen to the hot level in the recovery bottle on the system, if equipped.





Vibration Damper

Inspect

Check the index lines (A) on the damper hub (B) and the inertia member (C). If the lines are more than 1.59 mm [1/16 in] out of alignment, replace the damper.

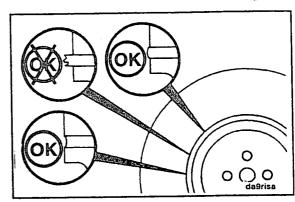
B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

Inspect the rubber member for deterioration. If pieces of rubber are missing or if the elastic member is more than 3.18 mm [1/8 in] below the metal surface, replace the damper.

NOTE: Also, look for forward movement of the damper ring on the hub. Replace the damper if any movement is detected.

Air Compressor Page 7-9



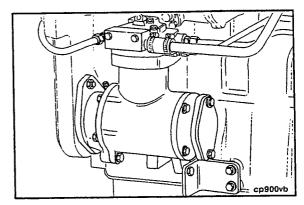


Air Compressor

Inspect

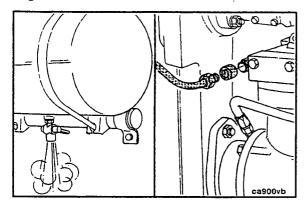
NOTE: All air compressors have a small amount of lubricating oil carryover that lubricates the piston rings and moving parts. When this lubricating oil is exposed to normal air compressor operating temperatures over time, the lubricating oil will form varnish or carbon deposits. If the following inspections are **not** done, the air compressor piston rings will be affected by high operating temperatures and pressures and will **not** seal correctly.







Air Compressor Page 7-10

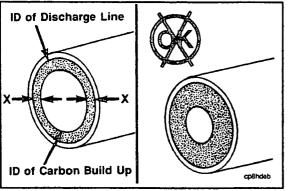


B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

Air '

Air Compressor Discharge Inspection

Drain the air system wet tank to release the system air pressure. Remove the air discharge line from the air compressor.







Measure the total carbon deposit thickness inside the air discharge line as shown. If the total carbon deposit (X + X) exceeds 2 mm [1/16 in], clean and inspect the cylinder head, the valve assembly, and the discharge line. Replace if necessary. Contact the Cummins Authorized Repair Location for procedures.





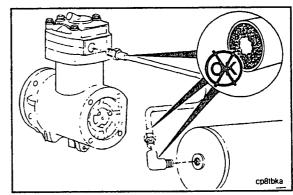
B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]

If the total carbon deposit exceeds specifications, continue checking the air discharge line connections up to the first tank until total carbon deposit is less than 2 mm [1/16 in]. Clean or replace any lines or connections that exceed this specification.









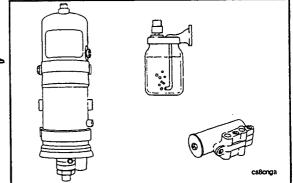
Air Compressor

Page 7-11

Inspect any air driers, splitter valves, pressure relief valves, and alcohol injectors for carbon deposits or malfunctioning parts. Inspect for air leaks. Maintain and repair the parts according to the manufacturer's specifications.









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Air Compressor Page 7-12	B3.9 and B5.9 Series Engines Maintenance Procedures at 77,000 km [48,000 mi]
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B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

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Tool Requirements Page A-1

Tool Requirements

General Information

Tool Requirements

Repair Tools Requ	uired	
Sockets	Wrenches	Other
10 mm	8 mm	Allen wrench (8 mm)
12 mm	10 mm	Breaker bar (1/2-in sq. drive)
13 mm	13 mm	Flat screwdriver
15 mm	15 mm	Ratchet (3/8-in sq. drive)
17 mm	17 mm (open end)	Ratchet (1/2-in sq. drive)
18 mm	19 mm	Filter wrenches (75 to 80 mm and 90 to 95 mm)
19 mm	22 mm	Drill motor (1/4-in)
22 mm	24 mm	Drill bit (3 mm)
27 mm		Slide hammer
		Flat chisel
		T-bar puller (75 mm)
		Sheet metal screw (No. 10)
		Torque wrench
		Pliers
		Engine barring gear, Part No.3824591



Cooling System Page A-2

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Cooling System

General Information



🛕 WARNING 🛕



Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.



WARNING A



Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap. Heated coolant spray or steam can cause personal injury.

Components to Be Replaced	Tools	Preparatory Steps
Drive belt	Breaker bar (3/8-in sq. drive)	
Belt tensioner	Ratchet (3/8-in sq. drive), 13-mm socket, and torque wrench	Remove drive belt
Fan hub	13-mm socket/wrench	Remove drive belt and fan pulley
Water pump	10-mm socket/wrench	Drain coolant and remove drive belt
Thermostat	10-mm, 18-mm, and 19-mm socket/wrench	Drain coolant, remove drive belt, loosen alternator link, remove alternator mounting capscrew, remove thermostat housing

Drive Belt, Cooling Fan Page A-3

Drive Belt, Cooling Fan

Remove

3/8-Inch Square Drive

Lift the tensioner to remove the drive belt.

NOTE: The belt tensioner is spring-loaded and **must** be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.







Install

A CAUTION A

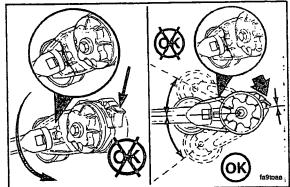
Applying excessive force in the opposite direction of windup or after the tensioner has been wound up to the positive stop can cause the tensioner arm to break.

3/8-Inch Square Drive

Lift and hold the belt tensioner. Install the drive belt; release the tensioner.

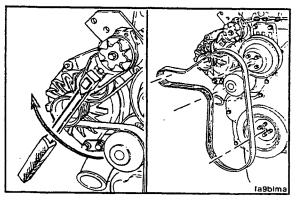








Belt Tensioner, Automatic Page A-4



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Belt Tensioner, Automatic

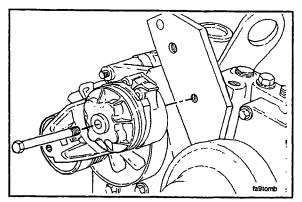
Remove



3/8-Inch Square Drive

Lift belt tensioner to relieve tension in the belt, and remove the belt.

NOTE: The belt tensioner is spring-loaded and **must** be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.





13 mm

Remove the belt tensioner.



Install

3/8-Inch Square Drive, 15-mm Wrench

Install the belt tensioner and tighten the capscrew.

Torque Value: 43 Nom

[32 ft-lb]

Lift and hold the tensioner. Install the drive belt and release the tensioner.

Service Tip: If difficulty is experienced installing the drive belt; for example, the belt seems too short; position the belt over the grooved pulleys first; then, while holding the tensioner up, slide the belt over the water pump pulley.

Fan Spacer and Pulley

Remove

3/8-Inch Square Drive

Lift belt tensioner to relieve tension in the belt, and remove the belt.

NOTE: The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.

Fan Spacer and Pulley Page A-5



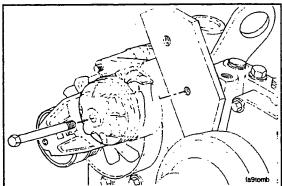


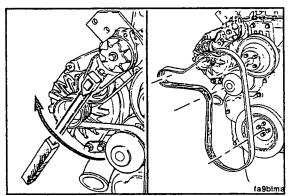






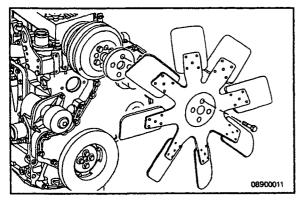








Fan Spacer and Pulley Page A-6



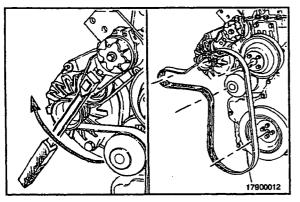


13 mm

Remove the four capscrews, fan, and spacer.









install

3/8-Inch Square Drive



Lift the tensioner, and install the belt.

Service Tip: If difficulty is experienced installing the drive belt (the belt seems too short), position the belt over the grooved pulleys first; then, while holding the tensioner up, slide the belt over the water pump pulley.

10 mm, 13 mm

Install the four capscrews, fan, and spacer.

10-mm Wrench

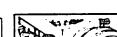
Torque Value: 24 Nom

[18 ft-lb]

13-mm Wrench

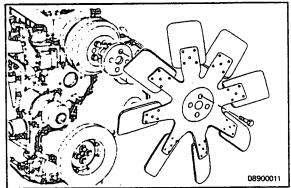
Torque Value: 43 Nom

[32 ft-lb]









Water Pump

Preparatory

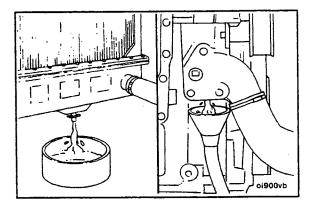


WARNING



Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

Drain the coolant.

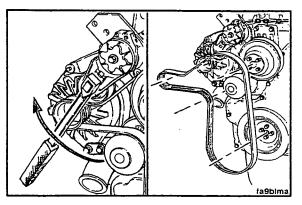




Water Pump

Page A-7

Water Pump Page A-8

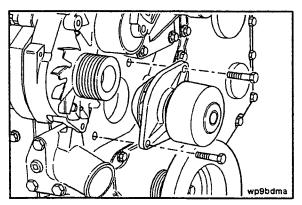


B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Remove

Remove the drive belt.





13 mm

Remove the two capscrews and water pump.

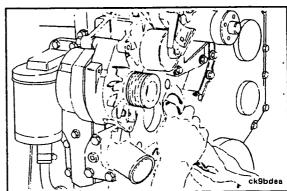


Clean

Clean the sealing surface on the cylinder block.



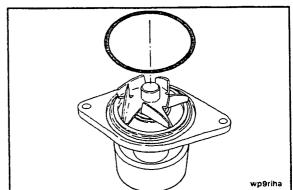




Clean o-ring sealing surface on the water pump housing. Install the o-ring onto the water pump housing.



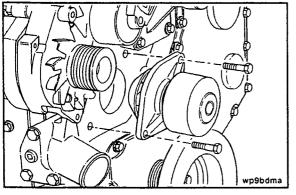






Water Pump Page A-10

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement





Install

10 mm



Install the water pump.

Torque Value: 24 Nom [18 ft-lb]







3/8-Inch Square Drive

Lift the tensioner and install the belt.



Service Tip: If difficulty is experienced installing drive belt. such as the belt seems too short, position the belt over the grooved pulleys first: then, while holding the tensioner up, slide the belt over the water pump pulley.



Coolant Thermostat Page A-11

Coolant Thermostat

Preparatory



WARNING



Batteries can emit explosive gases. To avoid personal injury, always ventilate the compartment before servicing the batteries. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.



WARNING

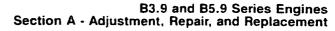


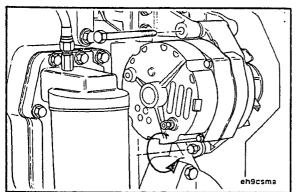
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

- · Disconnect the negative (-) battery cable.
- Drain 2 liters [2.1qt] of coolant.
- Remove the radiator hose from the outlet connection.
- · Remove the drive belt.



Coolant Thermostat Page A-12







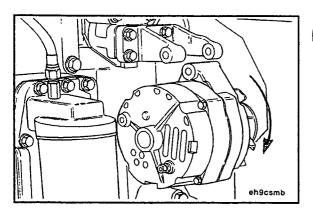
] Remove

14 mm, 16 mm



Loosen the lower alternator link capscrew.

Remove the upper alternator mounting capscrew.





Lower and remove the alternator.

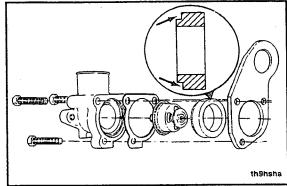
Coolant Thermostat Page A-13

ዛዐ mm

Remove the thermostat housing, lifting bracket, thermostat, and thermostat seal.





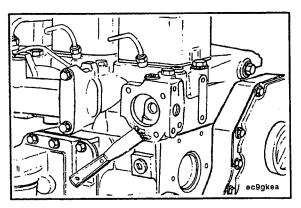


Clean

Clean the gasket surfaces.

NOTE: Do **not** let any debris fall into the thermostat cavity when cleaning gasket surfaces.

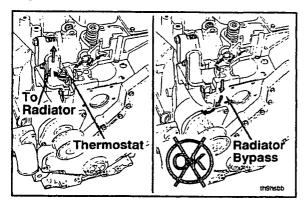






Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Coolant Thermostat Page A-14

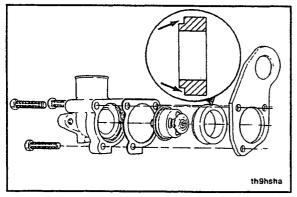


B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Install



Always use the correct thermostat and never operate the engine without a thermostat. An incorrect thermostat can cause the engine to overheat or run too cold. The engine will overheat if operated without a thermostat because the coolant flows back to the inlet of the water pump instead of through the radiator for cooling.





Assemble the removed parts in the reverse order of removal.

Make sure the gasket is aligned with the capscrew holes. Install the capscrews and finger-tighten.

The notched end of the rubber thermostat seal points away from the cylinder head.

Q-Pulse Id TMS1367 Active 29/07/2015 Page 259 of 542

10 mm

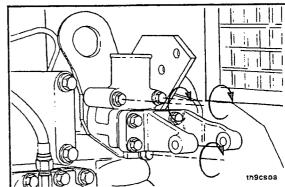
Tighten the capscrews.

Torque Value: 24 Nom [18 ft-lb]

Coolant Thermostat Page A-15







14 mm, 16 mm

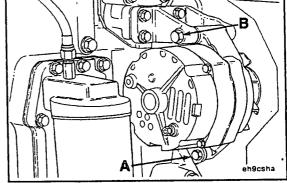
Position the alternator and install the mounting capscrews.

Torque Value: (A) 24 Nom [18 ft-lb]
Torque Value: (B) 43 Nom [32 ft-lb]





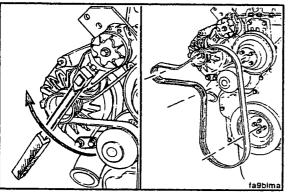






Coolant Thermostat Page A-16

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement





13 mm

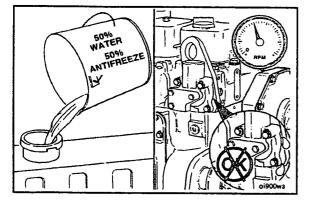
Install the drive belt.



NOTE: After the tensioner has been raised to remove/ install the belt, check the tensioner capscrew for the correct torque.



Torque Value: 43 Nom [32 ft-lb]





Fill

A CAUTION A

Be sure to vent the engine and aftercooler during filling, to remove air from the coolant system, or overheating will result.

Fill the cooling system. Operate the engine and check for leaks.

Fuel System - Overview Page A-17

Fuel System - Overview

General Information

Fuel System Repair Summary



A WARNING A



Do not mix gasoline, alcohol, or gasohol with diesel fuel. This mixture can cause an explosion.

Components to Be Replaced	Tools	Preparatory Steps
Lift Pump	13-, 14-, and 17-mm wrenches	Clean debris.
High-Pressure Lines	10-mm socket, 14-, 17-, and 19-mm open- end wrenches, torque wrench	Clean debris.
Injector Fuel	10- and 19-mm open-end wrenches	
Drain Manifold	10- and 13-mm sockets, torque wrench	
Injectors	Ratchet, 24-mm deep well socket, torque wrench	Disconnect the high-pressure lines and fuel drain manifold.
Injection Pump	10-mm wrench, ratchet, 22-mm socket, 75-mm T-bar puller, 8-mm capscrews, 1/2-inch open-end wrench, flat screwdriver, 13-mm socket, 13-mm wrench, hammer, flat chisel, torque wrench	Remove high-pressure line, supply line, and return line. Remove the AFC air line, oil line(s), fuel shutoff solenoid, and control linkage.
Fuel Solenoid (Rotary Pump)	Bosch® 24-mm wrench, Lucas CAV 22-mm wrench	Label and disconnect wiring.
Fuel Filter Head	24-mm, 75- to 80-mm and 90- to 95-mm filter wrench.	Clean debris.



Fuel Supply Lines Page A-18

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

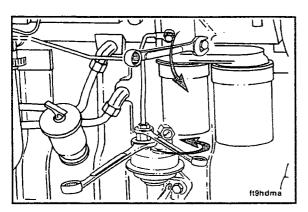




Preparatory

Low Pressure Fuel Line

Thoroughly clean all fittings and components before removal. Make sure that the debris, water, steam, or cleaning solution does **not** reach the inside of the fuel system.





Remove

Diaphragm Style Lift Pump





Disconnect the fuel line from the lift pump and filter head. Use two wrenches to disconnect the line from the lift pump.

Piston Style Lift Pump

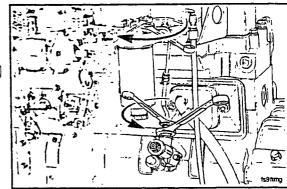
14 mm, 17 mm, 20 mm

Disconnect the fuel line from the lift pump and filter head. Use two wrenches to disconnect the line from the lift pump.

Fuel Supply Lines Page A-19







Install

Diaphragm Style Lift Pump

14 mm, 17 mm

Install the fuel line to the lift pump and filter head. Use two wrenches to tighten the connection to the lift pump.

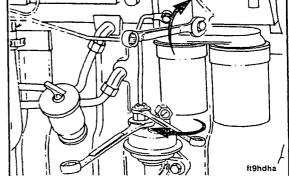
Torque Value: 24 Nom [18 ft-lb]

NOTE: Do **not** overtighten the connection. Fuel leaks can result from overtightening.



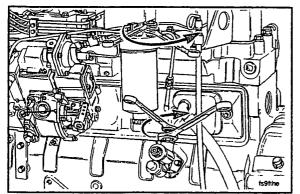








Fuel Supply Lines Page A-20



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

3

Piston Style Lift Pump

14 mm, 17 mm, 20 mm

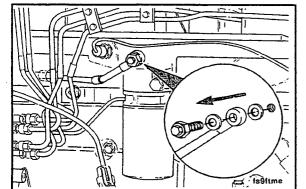


Install the fuel line to the lift pump and filter head. Use two wrenches to tighten the connection to the lift pump.

Torque Value: 24 Nom

Nom [18 ft-lb]







Injection Pump Supply Line Replacement

17 mm



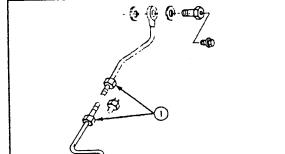
Remove the bleed screw banjo fitting.

14 mm, 16 mm, and 24 mm

Remove the supply line (Bosch® injection pump).

NOTE: Replace the seals (1) in the fittings if the line is disassembled.





Page A-21

ts9ftmf

14 mm, 16 mm, 19 mm, and 24 mm

Remove the supply line (Lucas CAV injection pump). The Lucas CAV pump has two fittings for the supply line.

Replace fitting sealing washers (1), and ferrules (2) each time they are removed.

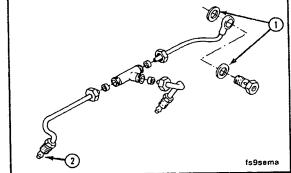
Torque Value: 32 Nom [24 ft-lb]

NOTE: Replace the seals in the fittings if the line is disassembled.



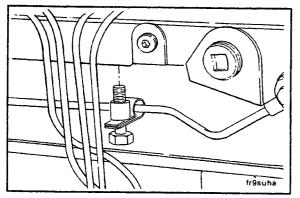








Fuel Filter Adapter Page A-22





17 mm

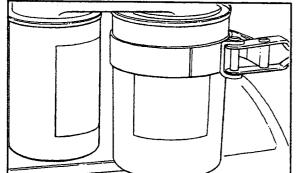
Engines rated at 2500 rpm and above require additional fuel line support. Install as illustrated.



Torque Value: 24 Nom

[18 ft-lb]







Fuel Filter Adapter Preparatory



- · Clean debris
- · Remove fuel filters

ff9etma

Remove

24 mm

Remove the retaining nut, filter head adapter, and sealing washers.

Install in reverse order of removal.

Torque Value: 32 Nom

[24 ft-lb]

Fuel Lift Pump Page A-23

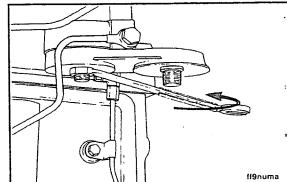












Fuel Lift Pump

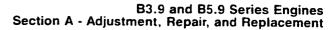
Preparatory

- · Clean debris from around the lift pump.
- · Disconnect the fuel supply lines.



Fuel Lift Pump Page A-24



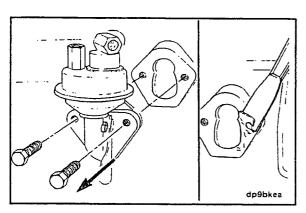




Clean

Piston Style

Clean the mounting surface on the cylinder block.





Diaphragm Style

10 mm



Remove the lift pump.

Clean the mounting surface on the cylinder block.



0

Install

Diaphragm Style

10 mm

Install the lift pump and a new gasket.

Torque Value: 24 Nom [18 ft-lb]

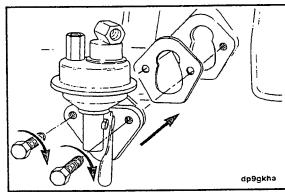
Connect the fuel lines.

Fuel Lift Pump Page A-25









Piston Style

A CAUTION A

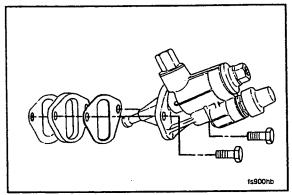
Alternately tighten the mounting capscrews. As the capscrews are tightened, the fuel transfer pump plunger is pushed into the pump. Failure to tighten the capscrews evenly can result in the plunger being bent or broken.

Install the pump

Torque Value: 24 N•m [18 ft-lb]









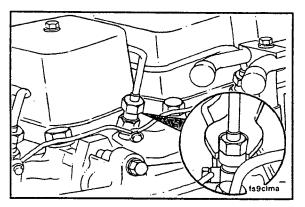
Injector Supply Lines (High Pressure) Page A-26

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Injector Supply Lines (High Pressure) Preparatory

· Clean all debris from around the fittings.





Remove

Rotary Pumps



17 mm

Disconnect the fuel line(s) from the injector.

NOTE: If individual lines are to be replaced, remove the support clamp from the set of lines containing the line to be replaced.

Page 271 of 542

17 mm

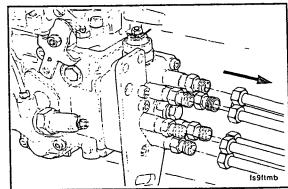
Disconnect the fuel line(s) from the fuel pump. Install protective covers onto the injectors and delivery valves to prevent entry of dirt into the system.

Injector Supply Lines (High Pressure) Page A-27









Inline Pumps

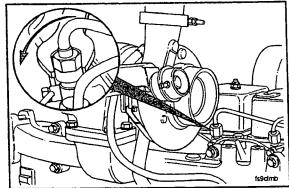
8 mm, 17 mm, and 19 mm

Disconnect the line(s) from the injector(s).

NOTE: If individual lines are to be replaced, remove the support clamp from the set of lines containing the line to be removed.

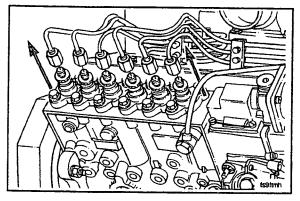








Injector Supply Lines (High Pressure) Page A-28



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

19 mm



Disconnect the line(s) from the fuel pump.



Install

Rotary Pumps

A CAUTION A

Install the support clamp in the original position and, to prevent damage from high-frequency vibration, make sure the lines have not been bent or do not contact each other or another component.

A CAUTION A

To prevent damage to the fuel lines, they must be connected to the injectors and fuel injection pump in a free state without forcing the connecting nuts. The fuel lines are correctly sized for each application. Bending the lines is not acceptable and can cause fuel leaks.

17 mm

Install the fuel lines in reverse order of removal.

Torque Value: (Line Fittings)

24 N°m [18 ft-lb]

Torque Value: (Support Clamp)

6 Nom [53 in-lb]

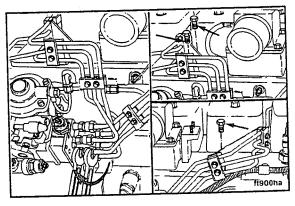
Torque Value: (Support Bracket)

24 Nem [18 ft-lb]



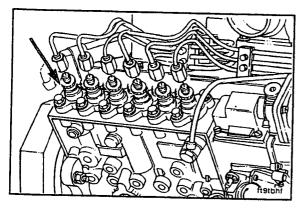








Injector Supply Lines (High Pressure) Page A-30



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Inline Pumps

19 mm



Install the lines in reverse order of removal.

Torque Value: (Line Fittings)

(P)

24 N•m [18 ft-lb]

Torque Value: (Support Clamp)

6 Nom

[52 in-lb]

Torque Value: (Support Bracket)

24 N•m

[18 ft-lb]

NOTE: If removed, reinstall the support clamp in the original position, and make sure the lines do **not** contact each other or another component. Install a protective cover on the injectors and fuel delivery valves to prevent the entry of dirt into the system.

Fuel Manifold (Drain) Page A-31

Fuel Manifold (Drain)

Preparatory

· Clean debris.

Remove

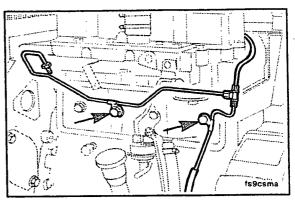
Rotary Pumps

10 mm

Remove the capscrew from the hold-down clamp.



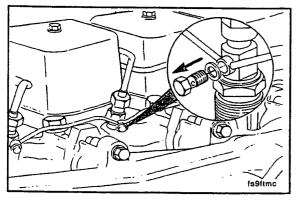






Fuel Manifold (Drain) Page A-32

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

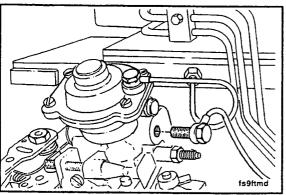




10 mm

Remove the banjo fitting screws and washers.







17 mm

Disconnect the drain line fitting from the injection pump.



Fuel Manifold (Drain) Page A-33

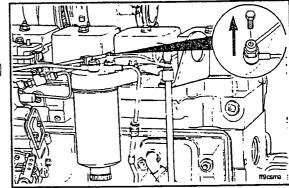
Inline Pumps

10 mm

Remove the drain line banjo capscrew from the fuel filter head. Remove the capscrew from the bracket on the intake cover.





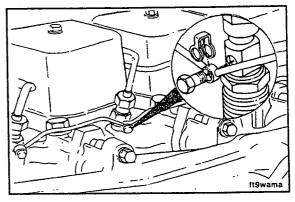


10 mm

Remove the banjo capscrews from the injectors.

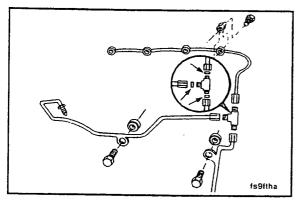








Fuel Manifold (Drain) Page A-34



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Install

Rotary Pumps



NOTE: Use new seals and sealing washers.

Assemble the drain line and fuel drain manifold in the reverse order of removal.

Torque Value: (Banjo Fitting Screw)

15 N•m [133 in-lb]

Torque Value: (Banjo Fitting)

9 Nom [80 in-lb]

Torque Value: (Clamp Screw)

24 N°m [18 ft-lb]

Inline Pumps

10 mm

NOTE: Use new seals and sealing washers.

Assemble the drain line and drain manifold in the reverse order of removal.

Torque Value: (Banjo Fitting Screw)

15 N•m [133 in-lb]

Torque Value: (Banjo Fitting)

9 N•m [80 in-lb]

Torque Value: (Bracket Capscrew)

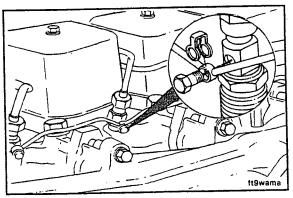
24 Nom [18 ft-lb]

Fuel Manifold (Drain) Page A-35











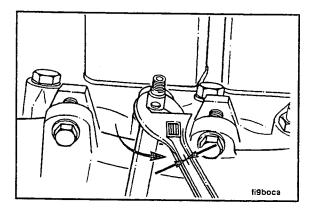
Injector Page A-36

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Injector

Preparatory

- · Thoroughly clean around the injectors.
- · Disconnect the high-pressure fuel lines.
- · Disconnect the fuel drain manifold.





Remove

16-mm and 24-mm Box Wrenches



▲ CAUTION ▲

The injector must not rotate in the bore of the cylinder head. This will damage the cylinder head.

Remove the injectors.

NOTE: Hold the injector body with a 16-mm wrench while loosening the hold-down nut with a 24-mm end wrench.

Injector Page A-37

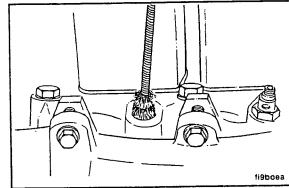
Clean

Injector Bore Brush, Part No. 3822509

Clean the injector nozzle bore using service tool No. 3822509.



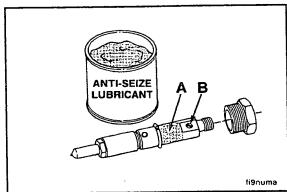




Install

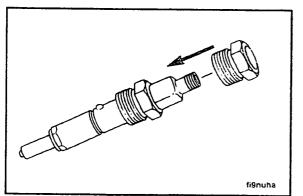
Remove the injector hold-down nut, and apply a coat of anti-seize compound to injector surface (A). Avoid getting anti-seize compound in the fuel drain hole (B).







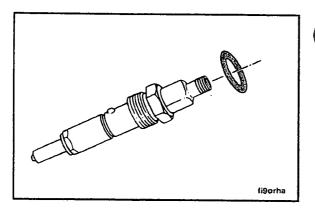
Injector Page A-38



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Install the hold-down nut on the injector body.



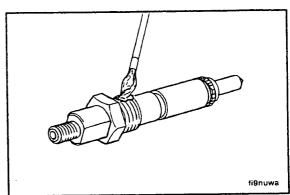


Install a new o-ring into the recessed groove on the top of the hold-down nut. Make sure the o-ring is **not** cut or twisted when installing (Bosch® and Stanadyne).

NOTE: CAV injectors retain the o-ring inside the hold-down nut.

Apply a light coat of anti-seize compound to the threads of the injector hold-down nut.

Injector Page A-39



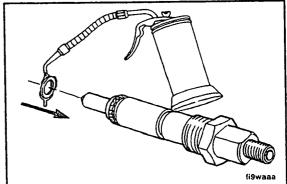
Assemble the injector and new copper washer.

Use only one copper washer.

NOTE: A light coat of clean lubricating engine oil between the washer and injector can help to keep the washer from falling during installation.

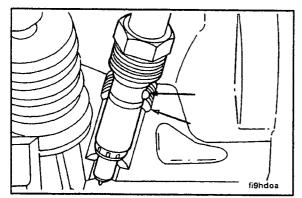








Injector Page A-40



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

3

24 mm

Install the injectors.



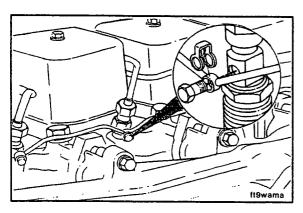
The protrusion on the side of the nozzle fits into a notch in the head to orient the injector.

Tighten the injector nozzle nuts.



Torque Value: 60 Nom

[44 ft-lb]





10 mm

Install the fuel drain manifold.



Torque Value: 9 Nom

[80 in-lb]



17 mm

Install the high-pressure fuel lines.

Torque Value: 24 Nom [18 ft-lb]

Fuel Shutoff Valve

Page A-41

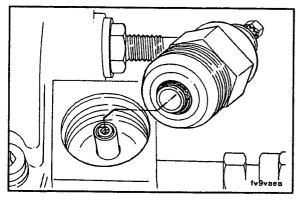
Fuel Shutoff Valve

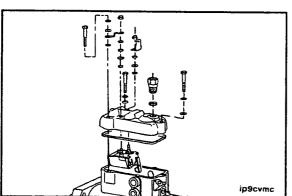
Preparatory

· Label and disconnect wiring.



Fuel Shutoff Valve Page A-42





B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Clean

Rotary Pumps



22 mm - CAV, 24 mm - Bosch®

Clean around the valve.

Remove the valve.



NOTE: Be careful **not** to drop the piston and spring when removing the valve.

Replace the valve and connect the electrical wire.



Torque Value: 43 Nom

[32 ft-lb]



Remove

- · Remove the electrical wiring.
- · Remove the fuel drain line.
- Remove the throttle shutoff linkage.
- · Remove the fuel injection pump top cover.
- · Disassemble the fuel injection pump top cover.

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install

5/16 Inch

Install new insulating tubes onto the terminals on the terminal studs of the new solenoid.

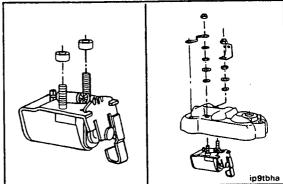
Install the valve into the cover.

Torque Value: 14 Nom [124 in-lb]









Fuel Shutoff Valve

Page A-43

5/16 Inch

Install the cover and gasket onto the fuel injection pump.

NOTE: Extreme care **must** be taken in assembling the cover to the fuel injection pump to make sure the shutoff arm is in proper contact with the linkage hook tab.

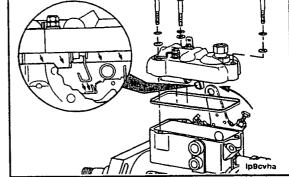
Install the cover to the pump at a downward angle from the driveshaft end of the fuel injection pump; then slide the cover horizontally into position.

Torque Value: 5 Nom [44 in-lb]



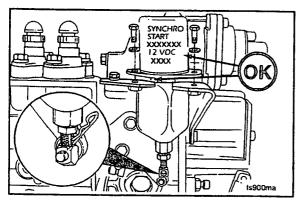


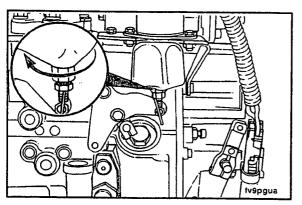






Fuel Shutoff Valve Page A-44





B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Inline Pumps

RQVK Governor Shutoff Solenoid



10 mm

Remove the hitch pin clip, mounting capscrews, and the fuel shutoff solenoid.



Install the new solenoid in reverse order of removal and connect the wires. Make sure the part number and cable tie block is facing away from the engine.



Torque Value: 10 Nom

[89 in-lb]



10 mm, 16 mm

Adjust the solenoid linkage as necessary so that the plunger is magnetically held in with the shutoff lever in the absolute full-run position. Turn the large hex on the end of the plunger to make adjustments.

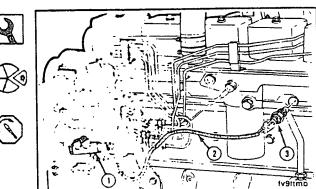
B3.9 and B5.9 Series Engines Cold Start Timing Advance System (KSB) Temperature Switch Section A - Adjustment, Repair, and Replacement Page A-45

Cold Start Timing Advance System (KSB) Temperature Switch

Remove

27 mm

Disconnect the KSB (1) wiring harness (2) from the switch (3).



Install

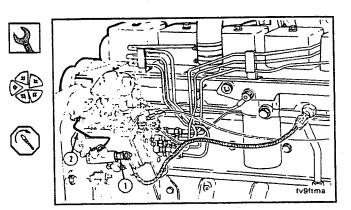
T30 TORX, 12 mm

Replace the KSB, and wiring harness.

Torque Value: KSB Mounting Nuts:

9 Nom

[80 in-lb]



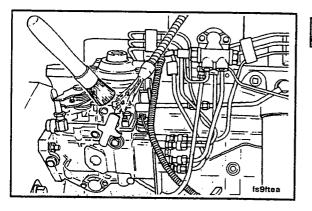


Fuel Injection Pump, Rotary Page A-46

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Fuel Injection Pump, Rotary Preparatory

- Remove all fuel lines
 - · Remove control linkage.
 - · Remove fuel shutoff solenoid.





▲ CAUTION ▲

A diesel engine can not tolerate dirt or water in the fuel system. A tiny piece of dirt or a few drops of water in the injection system can stop the engine.

Clean all external surfaces of the injection pump, including all line connections and fittings that are to be disconnected. Clean the area around the injection pump gear cover to prevent dirt from entering the crankcase.

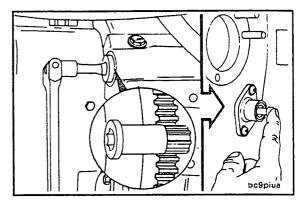
Remove

A CAUTION A

To prevent damage to the timing pin, be sure to disengage the pin after locating top dead center.

Locate top dead center for cylinder No. 1. Push the top dead center pin into the hole in the camshaft gear while slowly barring the engine.

Fuel Injection Pump, Rotary Page A-47



14 mm

Loosen the CAV injection pump lock screw and position the special lock washer.

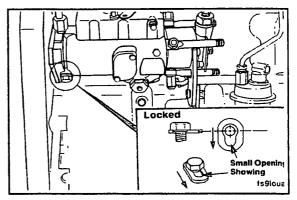
Tighten the lock screw against the driveshaft.

Torque Value: 7 Nom

[62 in-lb]

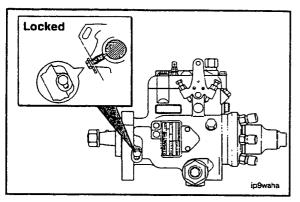








Fuel Injection Pump, Rotary Page A-48



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



3/8 Inch

Loosen the Stanadyne DB4 fuel injection pump lock screw and position the special washer.

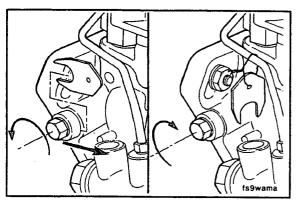


Tighten the lock screw until contact is made with the fuel injection pump driveshaft.



Torque Value: 12 Nom

[106 in-lb]





10 mm

The special washer on the Bosch® injection pump must be removed so the lock screw can be tightened against the driveshaft.



Tighten the lock screw.



m [22 ft-lb]



Fuel Injection Pump, Rotary Page A-49

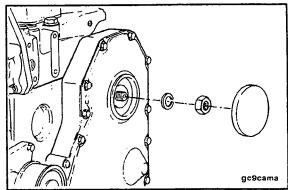
22 mm

Remove the gear cover access cap.

Remove the nut and washer from the fuel pump shaft.





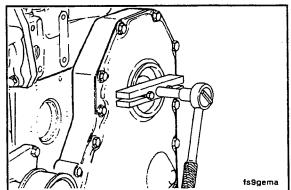


75-mm T-Bar Puller

Pull the fuel pump drive gear loose from the shaft.

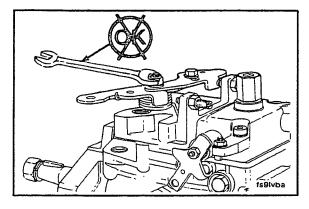








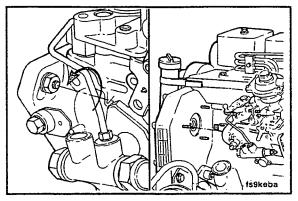
Fuel Injection Pump, Rotary Page A-50



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

CAUTION A

Do not remove the control lever. The lever is indexed to the shaft during pump calibration. Removal of the lever will alter the fuel pump calibration and affect engine performance.





13 mm

NOTE: Do **not** drop the drive gear key when removing the pump.



Remove the three mounting nuts.

Remove the fuel pump.

Install

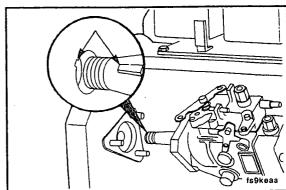
Make sure the engine has cylinder No. 1 at top dead center.

The keyway in the shaft of new reconditioned pumps will be locked in a position corresponding to the keyway in the drive gear when cylinder No. 1 is at top dead center on the compression stroke.

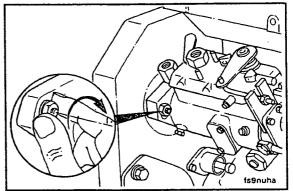
After verifying that cylinder No. 1 is at top dead center, install the pump. Make sure the key does **not** fall into the gear housing.

Attach the pump by finger-tightening the three mounting nuts. The pump **must** be free to move in the slots.



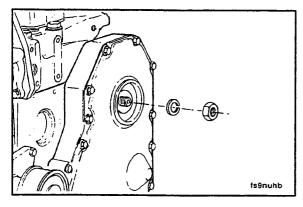








Fuel Injection Pump, Rotary Page A-52



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



22 mm (CAV, Stanadyne), 24 mm (Bosch®)

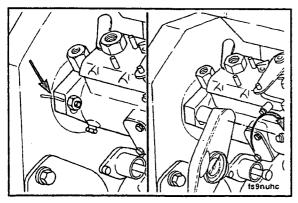
Attach the pump driveshaft nut and spring washer. The pump can rotate slightly due to gear helix and clearance. This is acceptable provided the pump is free to move on the flange slots and the crankshaft does **not** move.



NOTE: Do not overtighten. This is not the final torque.



Torque Value: 15 to 20 Nom [133 to 177 in-lb]





🛕 CAUTION 🛕

The pump shaft must be unlocked after installation to prevent pump damage.



13 mm

If reinstalling the removed pump, install the pump onto the engine. Rotate the pump to align the scribe marks. Tighten the three mounting nuts.



Torque Value: 24 Nom [18 ft-lb]

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Fuel Injection Pump, Rotary Page A-53

13 mm

If installing a new or rebuilt pump without scribe marks, take up the gear lash by rotating the pump against the direction of drive rotation.

Tighten pump retaining nuts.

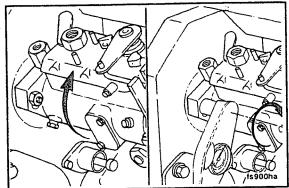
Torque Value: 24 Nom

[18 ft-lb]



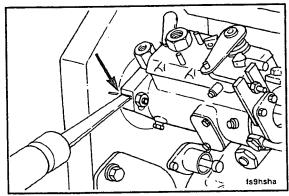






If a new or rebuilt pump is being installed, permanently mark the injection pump flange to match the mark on the gear housing.







Fuel Injection Pump, Rotary Page A-54

Unlocked Large Opening Showing fs9|oub

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



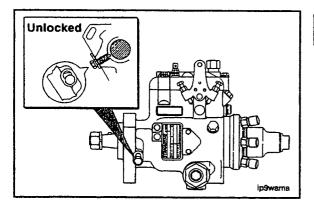
14 mm

Loosen the CAV pump lock screw, and position the special washer behind the lock screw head.



Tighten the pump lock screw.

Torque Value: 20 Nom [15 ft-lb]





3/8 Inch

Loosen the Stanadyne DB4 fuel injection pump lock screw, and position the special washer behind the lock screw.

Tighten the lock screw.

10 mm

NOTE: On the Bosch® pump, the special washer is wired to the pump and **must** be installed under the lock screw.

Tighten the pump lock screw.

Torque Value: 13 Nom

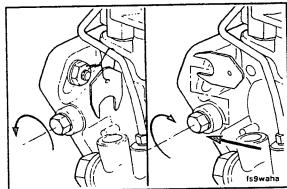
[115 in-lb]



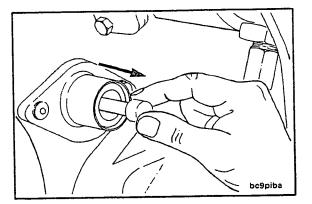






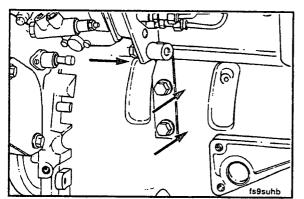


NOTE: Be sure to disengage the timing pin.





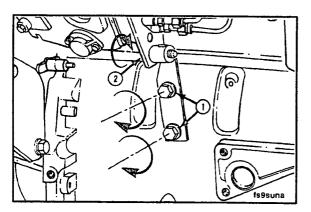
Fuel Injection Pump, Rotary Page A-56



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Install the injection pump support bracket. Finger-tighten all capscrews before final tightening.





Tighten the capscrews.

Torque Value: 24 Nom [18 ft-lb]

NOTE: Tighten the bracket-to-block mounting capscrews (1) before tightening the bracket-to-injection-pump capscrew (2).

22 mm

Tighten the drive gear mounting nut.

Torque Value: Bosch®

65 Nom [48 ft-lb]

Torque Value: Stanadyne

65 Nom [48 ft-lb]

Install the access cap.

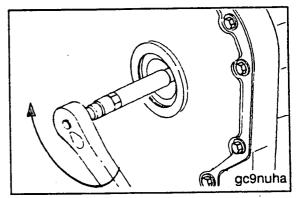
8 mm

Install the solenoid wiring and all fuel lines.

Fuel Injection Pump, Rotary Page A-57

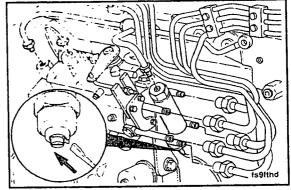






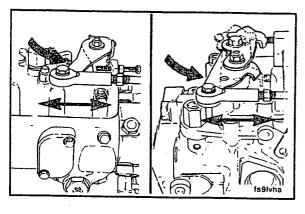






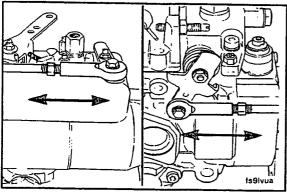


Fuel Injection Pump, Rotary Page A-58



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

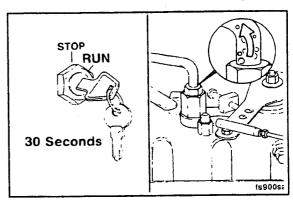
NOTE: When connecting the cable/rod to the control lever, adjust the length so the lever has stop-to-stop movement.



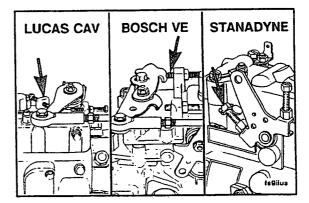
NOTE: Similarly, adjust the length of the cable/rod to the mechanical shutdown lever so there is a stop-to-stop movement.

Bleed all air from the fuel system.

Fuel Injection Pump, Rotary Page A-59



If necessary, adjust the idle speed.



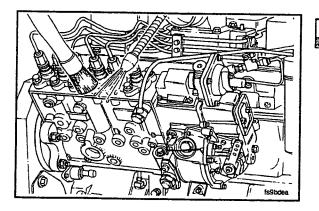


Fuel Injection Pumps, In-Line Page A-60

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Fuel Injection Pumps, In-Line Preparatory

- · Clean debris
- · Remove all fuel lines.
- Remove control linkage.
- · Remove fuel shutoff solenoid.
- · Remove AFC air line.
- · Remove oil line(s).





Remove

A CAUTION A

A diesel engine can not tolerate dirt or water in the fuel system. A tiny piece of dirt or a few drops of water in the injection system can stop the unit.

Clean all external surfaces of the injection pump, including all line connections and fittings that are to be disconnected. Clean the area around the injection pump gear cover to prevent dirt from entering the crankcase.

Engine Barring Gear, 1/2-Inch Ratchet or Breaker Bar

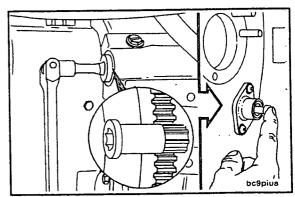
Locate top dead center for cylinder No. 1. Push the top dead center pin into the hole in the camshaft gear while slowly barring the engine.

NOTE: Be sure to disengage the pin after locating top dead center.

The barring gear inserts into the flywheel housing and engages the flywheel ring gear. The engine can then be rotated by hand using a 1/2-inch ratchet or breaker bar.

Fuel Injection Pumps, In-Line Page A-61



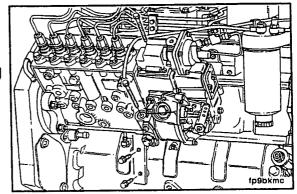


10 mm

Remove the fuel pump mounting bracket.

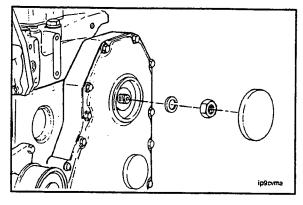








Fuel Injection Pumps, In-Line Page A-62



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

30 mm (P Pump)



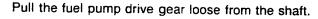
Remove the gear cover access cap.



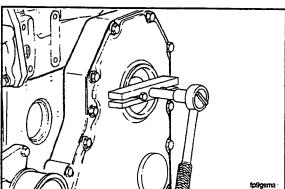
Remove the nut and washer from the fuel pump shaft.



75-mm T-Bar







Fuel Injection Pumps, In-Line Page A-63

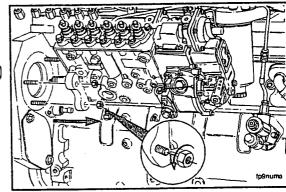
115 mm

Remove the four mounting nuts.

Remove the fuel pump.







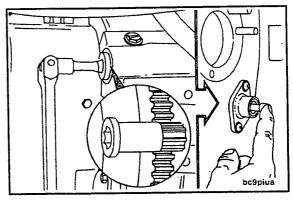
Install

Engine Barring Tool, Part No. 3824591

Make sure the engine has cylinder No. 1 at top dead center.

The barring gear inserts into the flywheel housing and engages the flywheel ring gear. The engine can then be rotated by hand using a 1/2-inch ratchet or breaker bar.

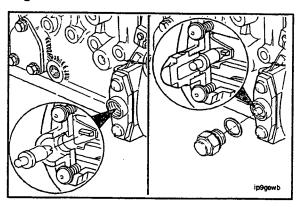






Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

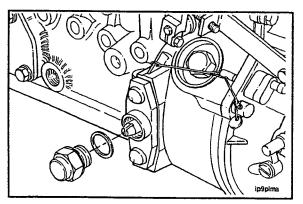
Fuel Injection Pumps, In-Line Page A-64



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Injection Pump Timing

The injection pump also has a timing pin, located in the governor housing, to position the pump shaft to correspond with top dead center for cylinder No. 1.





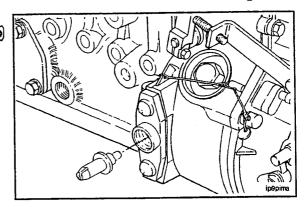
24 mm

Remove the access plug.

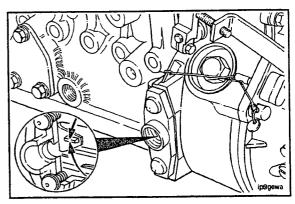


Fuel Injection Pumps, In-Line Page A-65

Remove the timing pin.



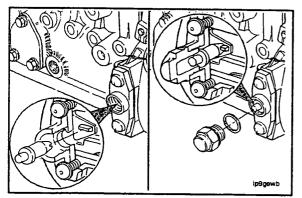
If the timing tooth is **not** aligned with the timing pin hole, rotate the pump shaft until the timing tooth aligns.





Standby Diesel Generator - Model C150D5-STK1-CPY - Operation and Maintenance Manual - Vendor Manual

Fuel Injection Pumps, In-Line Page A-66



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Reverse the position of the pin so the slot of the pin will fit over the timing tooth in the pump.

Install and secure the pin with the access plug.

A CAUTION A

The fuel pump drive inside diameter and the shaft outside diameter must be clean and dry before installing the shaft into the gear. A nonpetrolum-based cleaner can be used to clean the drive gear and shaft mounting surfaces. Failure to do so will result in gear slippage in the retarded direction.

Clean the drive gear and shaft with a nonpetrolum-based cleaner.

NOTE: If the mounting flange o-ring has a colored stripe, it can **not** be reused. Replace with a new o-ring. Furthermore, do **not** lubricate the new-type o-ring. Instead, lubricate the seating area of the gear housing.

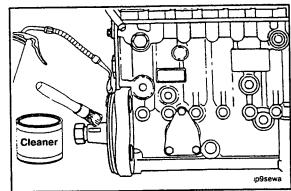
Lubricate the mounting flange of the fuel injection pump with clean lubricating engine oil.

NOTE: The P7100 fuel injection pump driveshaft has a provision for a Woodruff key; however, it is **not** required for the P7100 drive gear.

Fuel Injection Pumps, In-Line Page A-67









Fuel Injection Pumps, In-Line Page A-68

igenula

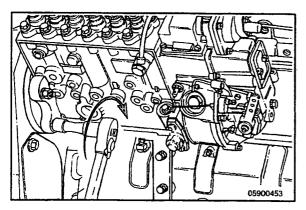
B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Slide the pump shaft through the drive gear, and position the pump flange onto the mounting studs.

Push the pump forward until the mounting flange and o-ring are properly fitted into the gear housing bore.

If equipped, finger-tighten the capscrews for the support bracket.





15 mm

Tighten the mounting nuts.



Tighten the capscrews for the rear support bracket.

Torque Value: Mounting Nuts

44 N°m [32 ft-lb]

Torque Value: Support Bracket

14 Nom [124 in-lb]

Q-Pulse Id TMS1367 Active 29/07/2015 Page 313 of 542

22 mm (A Pump), 30 mm (P Pump)

Install the fuel injection pump retaining nut and washer.

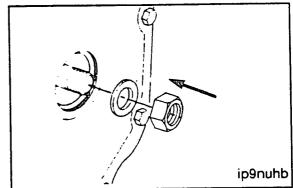
Torque Value: 10 to 15 Nom [89 to 133 in-lb]

Fuel Injection Pumps, In-Line Page A-69

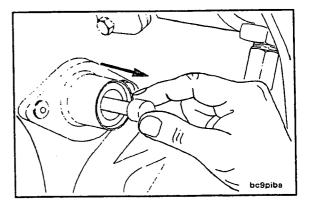








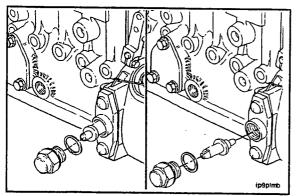
Disengage the engine timing pin.





Fuel Injection Pumps, In-Line Page A-70

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement





24 mm

Remove the fuel pump timing pin plug. Reverse the position of the pin and install the pin, plug, and sealing washer.



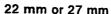
Torque Value: 24 Nom

[18 ft-lb]









Tighten the fuel pump drive nut.

Torque Value: P7100 Pump



178 Nom

[131 ft-lb]





95 Nom

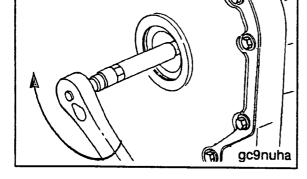
[70 ft-lb]

Torque Value: EP9 Pump

127 Nom

[94 ft-lb]

Install the gear cover access cap hand-tight.



10 mm

Install the fuel pump mounting bracket capscrews finger-tight.

Install support mounting capscrews finger-tight.

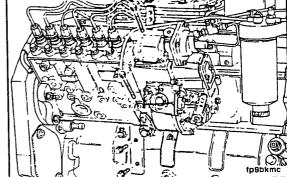
Make sure alignment is correct and tighten capscrews.

Torque Value: 24 Nom [18 ft-lb]

Fuel Injection Pumps, In-Line Page A-71

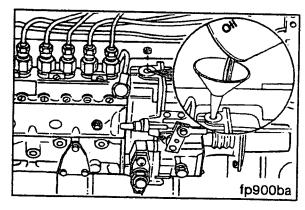








Fuel Injection Pumps, In-Line Page A-72



B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement







If a replacement or repaired pump was installed, be sure to fill the governor housing with clean lubricating engine oil before starting the engine. Failure to do so will result in damage to the governor fly weights.



Remove the access plug, and fill the governor housing with clean lubricating engine oil using specifications in the table below.

Oil	Capa	city
-----	------	------

RQVK Governor	750 ml [0.71 qt]
RQV Governor	750 ml [0.71 qt]
RSV Governor	450 ml [0.48 qt] Bosch
RSV-H Governor	500 ml [0.53 qt] Denso

Install the access plug.

Torque Value: 28 Nom [21 ft-lb]

Page 317 of 542

Fuel Pump

Adjust

Idle Speed Adjustment, RQVK Governor

10-mm Screwdriver and Tachometer

Idle adjustment for the RQVK governor requires setting of the idle adjustment screw.

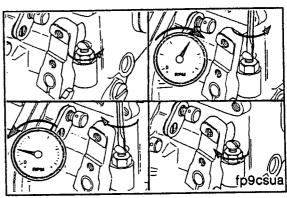
Loosen the locknut and turn the screw **counterclockwise** to raise the rpm; **clockwise** to decrease idle speed until the dataplate-specified idle speed is attained with normal idle operation accessory loads (i.e., transmission, hydraulic, air conditioning). Tighten the lock screw.

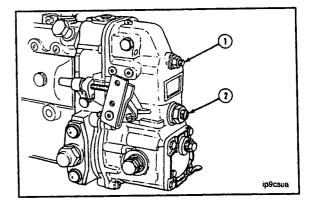
RSV Governor

Idle adjustment for industrial engines requires the setting of both the low-idle screw (1) and the bumper spring screw (2).

Fuel Pump Page A-73









Air Intake System - Overview Page A-74

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Air Intake System - Overview

General Information

Air System Repair Summary

Component to be Replaced	Tools	Preparatory Steps*
Air Crossover Tubing	8-mm socket, screwdriver, torque wrench	
Intake Manifold Cover and Gasket	10-mm socket	Remove high-pressure fuel lines: disconnect cold starting aid, if used, and air crossover tubing.
Aftercooler Gasket	8 -mm and 10-mm sockets	Disconnect cold starting aid if used; remove air cross- over tube and drain coolant.
Turbocharger and Gasket	10-mm, 15-mm, 16-mm, and 7/16-inch wrenches	Disconnect intake and exhaust piping and remove crossover tubing.
Exhaust Manifold and Gasket	15-mm socket	Disconnect intake and exhaust piping; remove air crossover tube and remove the turbocharger.
*Removal of come chancie	name la sessioni	and the trib the tarboonarger.

^{*}Removal of some chassis parts is sometimes necessary to gain access to some engine components. Follow the equipment manufacturer's procedures and precautions for removing chassis parts.

Air Crossover

Remove

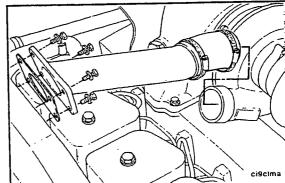
8 mm or Screwdriver

Loosen the hose clamps, and position the hose so the crossover tube can be removed.









Install

8 mm or Screwdriver

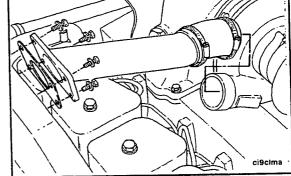
Use new hose and clamps as required to install the crossover tube.

Torque Value: 8 Nom [71 in-lb]











Aftercooler Page A-76

B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Aftercooler

Preparatory



WARNING



Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

- · Disconnect the cold starting aid, if used
- · Remove the air crossover tube
- Remove the high-pressure fuel lines
- · Drain 2 liters [2.1 qt] of coolant.

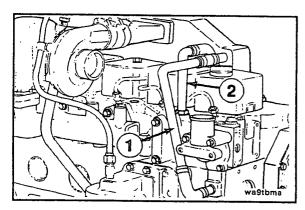


Remove

8 mm



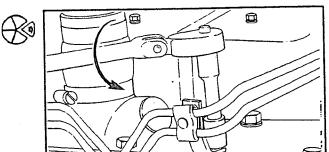
Remove the coolant supply tube (1) and the coolant return tube (2).



Remove the high-pressure fuel lines.

Aftercooler Page A-77

ff9ftma



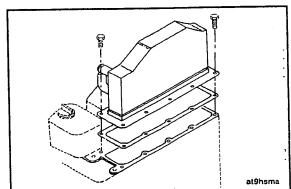
10 mm

Remove the aftercooler housing and gasket.

Plug the opening with a clean shop rag to prevent foreign material from entering the air intake.

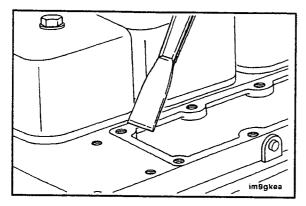








Aftercooler Page A-78



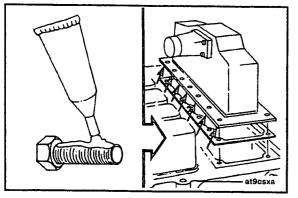
B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement



Clean

Clean the sealing surface.

NOTE: Keep the gasket material and any other material out of the air intake.





Install

10 mm



NOTE: The holes shown in the illustration are drilled through. Apply liquid Teflon™ sealant to the capscrews.

[18 ft-lb]

Install the aftercooler housing and a new gasket.



Torque Value: 24 Nom

Aftercooler Page A-79

8 mm

Install the coolant supply tube (1) and coolant return tube (2). Install the air crossover tube (3).

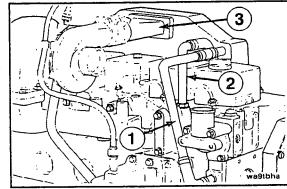
Torque Value: 8 Nom

[71 in-lb]







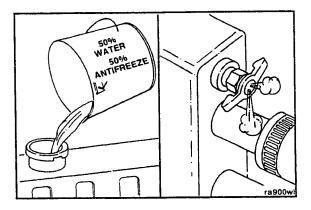


Fill

▲ CAUTION ▲

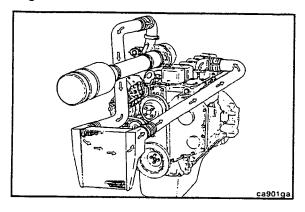
During filling, air must be vented from the engine cooling passages. Open the engine vent petcock. Make sure to open the petcock on the aftercooler for aftercooled engines. The system must be filled slowly to prevent air locks. Wait 2 to 3 minutes to allow air to be vented; then add coolant to bring the level to the bottom of the radiator filler neck. Failure to do so will cause entrapment of air in cooling system and will cause engine to overheat.

Fill the coolant system with a premixture of 50-percent water and 50-percent ethylene-glycol-type antifreeze.





Charge-Air Cooler (CAC) Page A-80

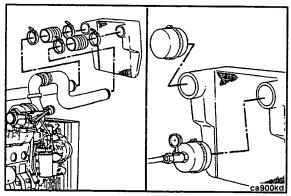


B3.9 and B5.9 Series Engines Section A - Adjustment, Repair, and Replacement

Charge-Air Cooler (CAC)

Leak Test

NOTE: The long-term integrity of the charge air cooler system is the responsibility of the vehicle and component manufacturers; however, the following symptoms can be checked by any Cummins Authorized Repair Location.





To check the charge air cooler for cracked tubes or header, remove the inlet and outlet hoses from the cooler.

Remove the charge air cooler.



Install a cap over the outlet side of the cooler. Install a pressure gauge and a shop air supply line to the inlet side of the cooler.

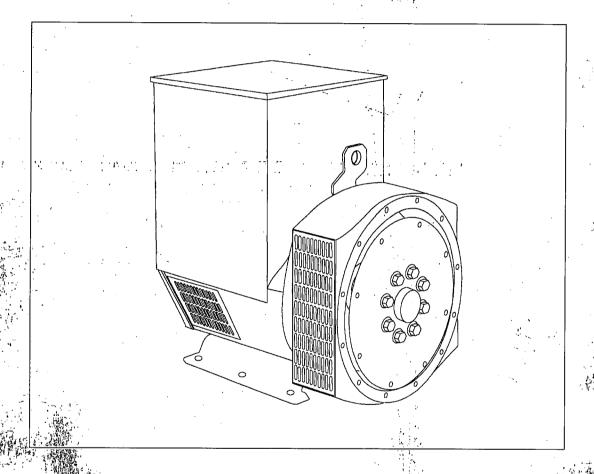
Standby Diesel General	or - Model C150D5-51K1-CPY - Operation and Maintenance Manual - Vendor Manual
No.	•
Qummins Engine Company, l Box 3005 Columbus, Indiana, U.S.A., 477	0
Registered Office Cummins Engine Comany, Li 46-50 Coombe Road New Malden	් ම්.
Summey KT3 4QL. England Registration No. 573951 Engla	
Copyright © 2000 Cummins Engine Company, In	·



Printed in Singapore

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STAMFORD[®]



Installation, Service & Maintenance Manual

AC generators with the following for prefixes: UCI; UCM; UCD 224 & 274.

SAFETY PRECAUTIONS

Before operating the generating set, read the generating set operation manual and this generator manual and become familiar with it and the equipment.

SAFE AND EFFICIENT OPERATION CAN ONLY BE ACHIEVED IF THE EQUIPMENT IS CORRECTLY OPERATED AND MAINTAINED.

Many accidents occur because of failure to follow fundamental rules and precautions.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

Observe all WARNING/CAUTION notices.

- Ensure installation meets all applicable safety and local electrical codes. Have all installations performed by a qualified electrician.
- Do not operate the generator with protective covers, access covers or terminal box covers removed.
- Disable engine starting circuits before carrying out maintenance.
- Disable closing circuits and/or place warning notices on any circuit breakers normally used for connection to the mains or other generators, to avoid accidental closure.

Observe all IMPORTANT, CAUTION, WARNING, and DANGER notices, defined as:

Important! Important refers to hazard or unsafe method or practice which can result in product damage or related equipment damage.

Caution! Caution refers to hazard or unsafe method or practice which can result in product damage or personal injury.



Warning refers to a hazard or unsafe method or practice which CAN result in severe personal injury or possible death.



Danger refers to immediate hazards which WILL result in severe personal injury or death.

Danger!

Due to our policy of continuous improvement, details in this manual which were correct at time of printing, may now be due for amendment. Information included must therefore not be regarded as binding.

Front Cover Photograph

This photograph is representative only. Several variations are available within the range of generators covered by this manual.

Active 29/07/2015

FOREWORD

The function of this book is to provide the user of the Stamford generator with an understanding of the principles of operation, the criteria for which the generator has been designed, and the installation and maintenance procedures. Specific areas where the lack of care or use of incorrect procedures could lead to equipment damage and/or personal injury are highlighted, with WARNING and/or CAUTION notes, and it is important that the contents of this book are read and understood before proceeding to fit or use the generator.

STAMFORD Service, Sales and Technical staff of are always ready to assist and reference to the company foradvice is welcomed.



Warning!

installation, operation, Incorrect servicing or replacement of parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be qualified to perform electrical and mechanical service.

EC DECLARATION OF INCORPORATION

All Stamford generators are supplied with a declaration of incorporation for the relevant EC legislation, typically in the form of a label as below.

EC DECLARATION OF INCORPORATION

IN ACCORDANCE WITH THE SUPPLY OF MACHINERY (SAFETY) REGULATIONS 1992 AND THE SUPPLY OF MACHINERY (SAFETY) (AMENDMENT) REGULATIONS 1994 IMPLEMENTING THE EC MACHINERY DIRECTIVE 99/392/EEC AS AMENDED BY 91/368/EEC.

THIS STAMFORD A.C. GENERATOR WAS MANUFACTURED BY OR ON BEHALF OF NEWAGE INTERNATIONAL LTD BARNACK ROAD STAMFORD LINCOLNSHIRE ENGLAND.

THIS COMPONENT MACHINERY MUST NOT BE PUT INTO SERVICE UNTIL THE MACHINERY INTO WHICH IT IS TO BE INCORPORATED HAS BEEN DECLARED IN CONFORMITY WITH THE PROVISIONS OF THE SUPPLY OF MACHINERY (SAFETY) REGULATIONS 1995/MACHINERY DIRECTIVE.

FOR AND ON BEHALF OF NEWAGE INTERNATIONAL LIMITED

NAME: POSITION:

LAWRENCE HAYDOCK TECHNICAL DIRECTOR

SIGNATURE:

THIS COMPONENT MACHINERY CARRIES THE CE MARK FOR COMPLIANCE WITH THE STATUTORY REQUIREMENTS FOR THE IMPLEMENTATION OF THE FOLLOWING DIRECTIVES

The EMC Directive 89/338/EEC
This Component Machinery shall not be used in the Residential, Commercial and WARNING! Light Industrial environment unless it also conforms to the relevant standard (EN 5081 - 1) REFER TO FACTORY FOR DETAILS

ii) The Low Voltage Directive 73/23/EEC as amended by 93/68/EEC

Under the EC Machinery Directive section 1.7.4. It is the responsibility of the generator set builder to ensure the generator identity is clearly displayed on the front cover of this book.



ELECTROMAGNETIC COMPATIBILITY

Additional Information

European Union Council Directive 89/336/EEC

For installations within the European Union, electrical products must meet the requirements of the above directive, and STAMFORD ac generators are supplied on the basis that:

- They are to be used for power-generation or related function.
- They are to be applied in one of the following environments:

Portable (open construction - temporary site supply) Portable (enclosed - temporary site supply) Containerised (temporary or permanent site supply) Ship-borne below decks (marine auxiliary power) Commercial vehicle (road transport / refrigeration etc) Rail transport (auxiliary power)

Industrial vehicle (earthmoving, cranes etc) Fixed installation (industrial - factory / process plant) Fixed installation (residential, commercial and light

industrial - home / office / health)

Energy management (Combined heat and power and/or peak lopping)

Alternative energy schemes.

- The standard generators are designed to meet the 'industrial' emissions and immunity standards. Where the generator is required to meet the residential, commercial and light industrial emissions and immunity standards reference should be made to document reference N4/X/011, as additional equipment may be required.
- The installation earthing scheme involves connection of the generator frame to the site protective earth conductor using a minimum practical lead length.
- Maintenance and servicing with anything other than factory supplied genuine STAMFORD parts will invalidate warranty and our liability for EMC compliance.
- Installation, maintenance and servicing is carried out by adequately trained personnel fully aware of the requirements of the relevant EC directives

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SECTION 1 INTRODUCTION

1.1 INTRODUCTION

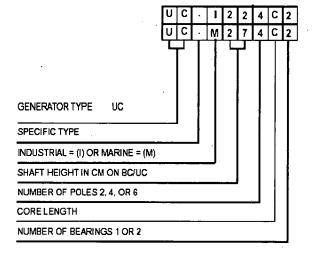
The UC22/27 range of generators is of brushless rotating field design, available up to 660V/50Hz (1500 rpm) or 60Hz (1800 rpm), and built to meet BS5000 Part 3 and international standards.

All the UC22/27 range are self-excited with excitation power derived from the main output windings, using either the SX460/SX440/SX421 AVR. The UC22 is also available with specific windings and a transformer controlled excitation system.

A permanent magnet generator (PMG) powered excitation system is available as an option using either the MX341 or MX321 AVR.

Detailed specification sheets are available on request.

1.2 DESIGNATION



1.3 SERIAL NUMBER LOCATION AND IDENTITY NUMBER LOCATION

Each generator is metal stamped with it's own unique serial number, the location of this number is described below.

UCI and UCM generators have their serial number stamped into the upper section of the drive end frame to end bracket adaptor ring, shown as item 31 in the parts lists at the back of this book.

UCD generators have their serial number stamped into the top of the drive end adaptor /fan shroud casting. If for any reason this casting is removed, it is imperative that care is taken to refit it to the correct generator to ensure correct identification is retained.

Inside the terminal box two adhesive rectangular labels have been fixed, each carrying the generators unique identity number. One label has been fixed to the inside of the terminal box sheet metal work, and the second label fixed to the main frame of the generator.

1.4 RATING PLATE

The generator has been supplied with a self adhesive rating plate label to enable fitting after final assembly and painting.

It is intended that this label will be stuck to the outside of the terminal box on the left hand side when viewed from the N.D.E. To assist with squarely positioning the label, location protrusions have been made in the sheet metalwork.

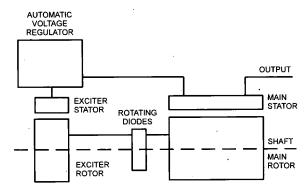
A CE Mark label is also supplied loose for fitment after final assembly and painting. This should be attached to an external surface of the Generator at a suitable location where it will not be obscured by the customer's wiring or other fittings.

The surface in the area where a label is to be stuck must be flat, clean, and any paint finish be fully dry before attempting to attach label. Recommended method for attaching label is peel and fold back sufficient of the backing paper to expose some 20 mm of label adhesive along the edge which is to be located against the sheet metal protrusions. Once this first section of label has been carefully located and stuck into position the backing paper can be progressively removed, as the label is pressed down into position. The adhesive will achieve a permanent bond in 24 hours.

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SECTION 2 PRINCIPLE OF OPERATION

2.1 SELF-EXCITED AVR CONTROLLED

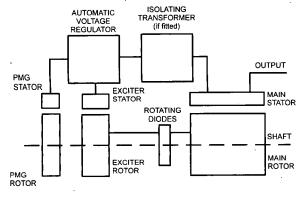


The main stator provides power for excitation of the exciter field via the SX460 (SX440 or SX421) AVR which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The SX460 or SX440 AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides voltage fall off with speed, below a preselected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine.

The SX421 AVR in addition to the SX440 features has three phase rms sensing and also provides for over voltage protection when used in conjunction with an external circuit breaker (switchboard mounted).

2.2 PERMANENT MAGNET GENERATOR (PMG) EXCITED - AVR CONTROLLED GENERATORS



The permanent magnet generator (PMG) provides power for excitation of the exciter field via the AVR (MX341 or MX321) which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived, via an isolating transformer in the case of MX321 AVR, from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The PMG system provides a constant source of excitation power irrespective of main stator loading and provides high motor starting capability as well as immunity to waveform distortion on the main stator output created by non linear loads, e.g. thyristor controlled dc motor.

The MX341 AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides an adjustable voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine. It also provides over-excitation protection which acts following a time delay, to de-excite the generator in the event of excessive exciter field voltage.

The MX321 provides the protection and engine relief features of the MX341 and additionally incorporates 3 phase rms sensing and over-voltage protection.

The detailed function of all the AVR circuits is covered in the load testing (subsection 4.7).

2.3 AVR ACCESSORIES

The SX440, SX421, MX341 and MX321 AVRs incorporate circuits which, when used in conjunction with accessories, can provide for parallel operation either with 'droop' or 'astatic' control, VAR/PF control and in the case of the MX321 AVR, short circuit current limiting.

Function and adjustment of the accessories which can be fitted inside the generator terminal box are covered in the accessories section of this book.

Separate instructions are provided with other accessories available for control panel mounting.

2.4 TRANSFORMER CONTROLLED GENERATORS

The main stator provides power for excitation of the exciter field via a transformer rectifier unit. The transformer combines voltage and current elements derived from the main stator output to form the basis of an open-loop control system, which is self regulating in nature. The system inherently compensates for load current magnitude and power factor and provides short circuit maintenance in addition to a good motor starting performance.

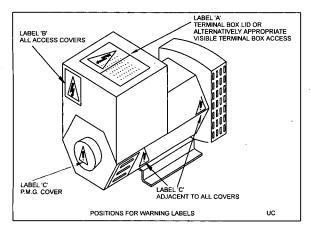
Three phase generators normally have a three phase transformer control for improved performance with unbalanced loads but a single phase transformer option is available.

No accessories can be provided with this control system.

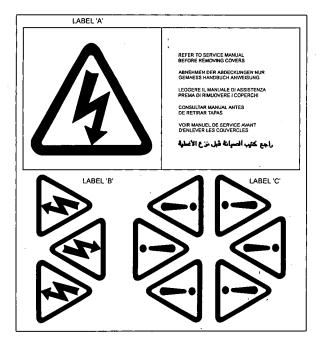
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SECTION 3 APPLICATION OF THE GENERATOR

The generator is supplied as a component part for installation in a generating set. It is not, therefore, practicable to fit all the necessary warning/hazard labels during generator manufacture. The additional labels required are packaged with this Manual, together with a drawing identifying their locations. (See below).



SIDE 'A



It is the responsibility of the generating set manufacturer to ensure that the correct labels are fitted, and are clearly visible.

The generators have been designed for use in a maximum ambient temperature of 40°C and altitude less than 1000m above sea level in accordance with BS5000.

Ambients in excess of 40°C and altitudes above 1000m can be tolerated with reduced ratings - refer to the generator nameplate for rating and ambient. In the event that the generator is required to operate in an ambient in excess of the nameplate value or at altitudes in excess of 1000 metres above sea level, refer to the factory.

The generators are of air-ventilated screen protected dripproof design and are not suitable for mounting outdoors unless adequately protected by the use of canopies. Anticondensation heaters are recommended during storage and for standby duty to ensure winding insulation is maintained in good condition.

When installed in a closed canopy it must be ensured that the ambient temperature of the cooling air to the generator does not exceed that for which the generator has been rated.

The canopy should be designed such that the engine air intake to the canopy is separated from the generator intake, particularly where the radiator cooling fan is required to draw air into the canopy. In addition the generator air intake to the canopy should be designed such that the ingress of moisture is prohibited, preferably by use of a 2 stage filter.

The air intake/outlet must be suitable for the air flow given in the following table with additional pressure drops less than or equal to those given below:

	Air Flow		Additional
Frame	50Hz	60Hz	(intake/outlet) Pressure Drop
UC22	0.216m³/sec	0.281m³/sec	6mm water gauge
0022	458cfm	595cfm	(0.25")
UCD22	0.25m³/sec	0.31m³/sec	6mm water gauge
UUDZZ	530cfm	657cfm	(0.25")
UC27	0.514m³/sec	0.617m³/sec	6mm water gauge
0021	1090cfm	1308cfm	(0.25")
UCD27	0.58m³/sec	0.69m³/sec	6mm water gauge
	1230cfm	1463cfm	(0.25")

Important! Reduction in cooling air flow or inadequate protection to the generator can result in damage and/or failure of windings.

Dynamic balancing of the generator rotor assembly has been carried out during manufacture in accordance with BS 6861 Part 1 Grade 2.5 to ensure vibration limits of the generator are in accordance with BS 4999 Part 142.

The main vibration frequencies produced by the component generator are as follows:-:

4 pole 1500 rpm 25 Hz 1800 rpm 30 Hz

However, vibrations induced by the engine are complex and contain frequencies of 1.5, 3, 5 or more times the fundamental frequency of vibration. These induced vibrations can result in generator vibration levels higher than those derived from the generator itself. It is the responsibility of the generating set designer to ensure that the alignment and stiffness of the bedplate and mountings are such that the vibration limits of BS5000 Part 3 are not exceeded.

Active 29/07/2015

In standby applications where the running time is limited and reduced life expectancy is accepted, higher levels than specified in BS5000 can be tolerated, up to a maximum of 18mm/sec.

Two bearing generators open coupled require a substantial bedplate with engine/generator mounting pads to ensure a good base for accurate alignment. Close coupling of engine to generator can increase the overall rigidity of the set. For the purposes of establishing set design the bending moment at the engine flywheel housing to generator adaptor interface should not exceed 1000ft.lb. (140 kgm). A flexible coupling, designed to suit the specific engine/generator combination, is recommended to minimise torsional effects.

Belt driven applications of two bearing generators require the pulley diameter and design to be such that the side load or force applied to the shaft is central to the extension and does not exceed the values given in the table below: -

Frame	Side	Shaft Extension	
,	kgf	N	mm
UC22	408	4000	110
UC27	510	5000	140

In instances where shaft extensions greater than specified in the table have been supplied reference must be made to the factory for appropriate loadings.

Alignment of single bearing generators is critical and vibration can occur due to the flexing of the flanges between the engine and generator. As far as the generator is concerned the maximum bending moment at this point must not exceed (140kgm). A. substanial bedplate engine/generator mounting pads is required.

It is expected that the generator will be incorporated into a generating set operating in an environment, where the maximum shock load experienced by the generator will not exceed 3g. in any plane. If shock loads in excess of 3g are to be encountered, anti-vibration mountings must be incorporated into the generating set to ensure they absorb the excess.

The maximum bending moment of the engine flange must be checked with the engine manufacturer.

Generators can be supplied without a foot, providing the option for customers own arrangement. See SECTION 4.2.1 for assembly procedure.

Torsional vibrations occur in all engine-driven shaft systems and may be of a magnitude to cause damage at certain critical speeds.

It is therefore necessary to consider the torsional vibration effect on the generator shaft and couplings. It is the responsibility of the generator set manufacturer to ensure compatibility, and for this purpose drawings showing the shaft dimensions and rotor inertias are available for customers to forward to the engine supplier. In the case of single bearing generators coupling details are included.

Important! Torsional incompatibility and/or excessive vibration levels can cause damage or failure of generator and/or engine components.

The terminal box is constructed with removable panels for easy adaptation to suit specific glanding requirements. Within the terminal box there are insulated terminals for line and neutral connections and provision for earthing. Additional earthing points are provided on the generator feet.

The neutral is NOT connected to the frame.

The main stator winding has leads brought out to the terminals in the terminal box.

generator and reference



earthing

regulations for earthing must be made. protection Incorrect or arrangements can result in personal injury or death. ,

No earth connections are made on the

to site

Fault current curves (decrement curves), together with generator reactance data, are available on request to assist the system designer to select circuit breakers, calculate fault currents and ensure discrimination within the load network.



installation. Incorrect service replacement of parts can result in severe or death, personal injury equipment damage. Service personnel must be qualified to perform electrical Warning! and mechanical service.

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SECTION 4 INSTALLATION - PART 1

4.1 LIFTING



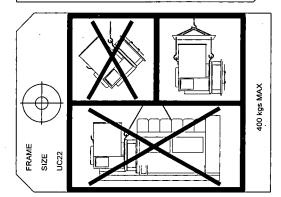
Incorrect lifting or inadequate lifting capacity can result in severe personal injury or equipment damage. MINIMUM LIFTING CAPACITY REQUIRED IS 750Kg. Generator lifting lugs should NOT be used Warning! for lifting the complete generator set.

Two lifting lugs are provided for use with a shackle and pin type lifting aid. Chains of suitable length and lifting capacity must be used. Lifting points are designed to be as close to the centre of gravity of the generator as possible, but due to design restrictions it is not possible to guarantee that the generator frame will remain horizontal while lifting. Care is therefore needed to avoid personal injury or equipment damage. The correct lifting arrangement is shown on the label attached to the lifting lug. (See sample below).

IMPORTANT

REFER TO SERVICE MANUAL BEFORE REMOVING COVERS. IT IS THE GENERATOR SET MANUFACTURER'S RESPONSIBILITY TO FIT THE SELF ADHESIVE WARNING LABELS SUPPLIED WITH THE GENERATOR. THE LABEL SHEET CAN BE FOUND WITH THE INSTRUCTION BOOK.





Single bearing generators are supplied fitted with a rotor retaining bar at the non-drive end of the shaft.

To remove retaining bar:

- Remove the four screws holding the sheet metal cover at the non drive end and remove cover
- Remove central bolt holding the retaining bar to the shaft
- Refit sheet metal cover.

Once the bar is removed, to couple the rotor to engine, the rotor is free to move in the frame, and care is needed during coupling and alignment to ensure the frame is kept in the horizontal plane.

Generators fitted with a PMG excitation system are not fitted with retaining bar. Refer to frame designation to verify generator type (subsection 1.2)

4.2 ASSEMBLY

During the assembly of the generator to the engine it will be necessary firstly to carefully align, then rotate, the combined generator rotor - engine crankshaft assembly, as part of the construction process, to allow location, insertion and tightening of the coupling bolts. This requirement to rotate the combined assemblies exists for both single and two bearing

During the assembly of single bearing units it is necessary to align the generator's coupling holes with the engine flywheel holes; it is suggested that two diametrically opposite location dowel pins are fitted to the engine flywheel, over which the generator coupling can slide into final location into the engine flywheel spigot recess. The dowels must be removed and replaced by coupling bolts before the final bolt tightening sequence.

While fitting and tightening the coupling bolts it will be necessary to rotate the engine crankshaft - generator rotor assembly. Care should be taken to ensure that rotation is carried out in an approved manner that ensures safe working practice when reaching inside the machine to insert or tighten coupling bolts, and that no component of the assembly is damaged by nonapproved methods of assembly rotation.

Engine manufacturers have available a proprietary tool or acility designed to enable manual rotation of the crankshaft assembly. This must always be used, having been engineered as an approved method of assembly rotation, engaging the manually driven pinion with the engine flywheel starter ring-gear.

Caution!

Before working inside the generator, during the aligning and fitting of coupling bolts, care should be taken to lock the assembly to ensure there is no possibility of rotational movement.

4.2.1 NO FOOT OPTION

Generators can be supplied without a foot providing the option for customers own arrangement. For details of mounting this arrangement, see the general arrangement drawing supplied with the generator. Alternatively refer to the STAMFORD factory for a copy of the latest general arrangement drawing showing the 'NO FOOT OPTION' appropriate to your generator.

4.2.2 TWO BEARING GENERATORS

A flexible coupling should be fitted and aligned in accordance with the coupling manufacturer's instruction. If a close coupling adaptor is used the alignment of machined faces must be checked by offering the generator up to the engine. Shim the generator feet if necessary. Ensure adaptor guards are fitted after generator/engine assembly is complete. Open coupled sets require a suitable guard, to be provided by the set builder. In the case of belt driven generators, ensure alignment of drive and driven pulleys to avoid axial load on bearings. Screw type tensioning devices are recommended to allow accurate adjustment of belt tension whilst maintaining pully alignment. Side loads should not exceed values given in SECTION 3. Belt and pulley guards must be provided by the set builder.

Important! Incorrect belt tensioning will result in excessive bearing wear.

guarding and/or generator Incorrect Caution! alignment can result in personal injury and/or equipment damage.

4.2.3 SINGLE BEARING GENERATORS

Alignment of single bearing generators is critical. If necessary shim the generator feet to ensure alignment of the machined surfaces.

For transit and storage purposes the generator frame spigot and rotor coupling plates have been coated with a rust

This MUST BE removed before assembly to engine.

A practical method for removal of this coating is to clean the mating surface areas with a de-greasing agent based on a petroleum solvent.

Care should be taken not to allow any Caution! cleaning agent to come into prolonged contact with skin.

The sequence of assembly to the engine should generally be as follows:

- 1. On the engine check the distance from the coupling mating face on the flywheel to the flywheel housing mating face. This should be within +/-0.5mm of nominal dimension. This is necessary to ensure that a thrust is not applied to the a.c. generator bearing or engine bearing.
- 2. Check that the bolts securing the flexible plates to the coupling hub are tight and locked into position. Torque tightening is 24.9kgfm (244Nm; 180 lb ft).
- 2a. UCD224 Only

Torque tightening is 15.29 kgfm (150Nm; 110 lb ft).

- Remove covers from the drive end of the generator to gain access to coupling and adaptor bolts.
- Check that coupling discs are concentric with adaptor spigot. This can be adjusted by the use of tapered wooden wedges between the fan and adaptor. Alternatively the rotor can be suspended by means of a rope sling through the adaptor opening.

- 5. Offer the a.c. generator to engine and engage both coupling discs and housing spigots at the same time, finally pulling home by using the housing and coupling bolts. Use heavy gauge washers between bolt head and discs on disc to flywheel bolts.
- 6. Tighten coupling disc to flywheel. Refer to engine manual for torque setting of disc to flywheel bolts.
- Remove wooden wedges.

Incorrect guarding and/or generator Caution! alignment can result in personal injury and/or equipment damage.

4.3 EARTHING

The generator frame should be solidly bonded to the generating set bedplate. If antivibration mounts are fitted between the generator frame and its bedplate a suitably rated earth conductor (normally one half of the cross sectional area of the main line cables) should bridge across the antivibration mount.



Refer to local regulations to ensure that the correct earthing procedure has been followed.

Warning!

4.4 PRE-RUNNING CHECKS

4.4.1 INSULATION CHECK

Before starting the generating set, both after completing assembly and after installation of the set, test the insulation resistance of windings. The AVR should be disconnected during this test. A 500V Megger or similar instrument should be used. Disconnect any earthing conductor connected between neutral and earth and megger an output lead terminal U, V or W to earth. The insulation resistance reading should be in excess of 5M? to earth. Should the insulation resistance be less than 5M? the winding must be dried out as detailed in the Service and Maintenance section of this Manual.

Important! The windings have been H.V. tested during manufacture and further H.V. testing may degrade the insulation with consequent reduction in operating life. Should it be necessary to demonstrate H.V. testing, for customer acceptance, the tests must be carried out at reduced voltage levels i.e. Test Voltage= 0.8 (2 X Rated Voltage + 1000)

4.4.2 DIRECTION OF ROTATION

The generator is supplied to give a phase sequence of U V W with the generator running clockwise looking at the drive end (unless otherwise specified at the time of ordering). If the generator phase rotation has to be reversed after the generator has been despatched apply to factory for appropriate wiring diagrams.

UCI224, UCI274, UCM224, UCM274

Machines are fitted with bi-directional fans and are suitable for running in either direction of rotation.

UCD224, UCD274

Machines are fitted with uni-directional fans and are suitable for running in one direction only.

4.4.3 VOLTAGE AND FREQUENCY

Check that the voltage and frequency levels required for the generating set application are as indicated on the generator nameplate.

Three phase generators normally have a 12 ends out reconnectable winding. If it is necessary to reconnect the stator for the voltage required, refer to diagrams in the back of this manual.

4.4.4 AVR SETTINGS

To make AVR selections and adjustments remove the AVR cover and refer to 4.4.4.1, 4.4.4.2, 4.4.4.3, 4.4.4.4 or 4.4.4.5 depending upon type of AVR fitted. Reference to the generator nameplate will indicate AVR type (SX460, SX440, SX421, MX341 or MX321).

Most of the AVR adjustments are factory set in positions which will give satisfactory performance during initial running tests. Subsequent adjustment may be required to achieve optimum performance of the set under operating conditions. Refer to 'Load Testing' section for details.

4.4.4.1 TYPE SX460 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application. Refer to Fig. 1 for location of selection links.

1. Frequency selection

50Hz operation LINK C-50 60Hz operation LINK C-60

2. External hand trimmer selection

No external hand trimmer LINK 1-2

External hand trimmer required -

REMOVE LINK 1-2 and connect trimmer across terminals 1 and 2.

3. AVR Input Selection

High voltage (220/240V) Input NO LINK Low voltage (110/120V) Input LINK 3-4

Refer to diagram in the back of this manual to determine wiring.

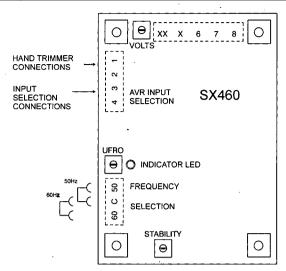


Fig.1

4.4.4.2 TYPE SX440 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 2 for location of selection links.

1. Frequency selection terminals

50Hz operation LINK C-50 60Hz operation LINK C-60

2. Stability selection terminals

Frame UC22 LINK A-C Frame UC27 LINK B-C

3. Sensing selection terminals

LINK 2-3 LINK 4-5 LINK 6-7

4. Excitation Interruption Link LINK K1-K2

K1-K2 Linked for normal operation.

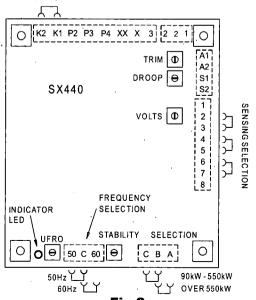


Fig.2

4.4.4.4 TYPE MX341 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 4 for location of setting links.

1. Frequency selection terminals

50Hz operation LINK 2-3 60Hz operation LINK 1-3

2. Stability selection terminals

Frame UC22 LINK A-C Frame UC27 LINK B-C

3. Sensing selection terminals *

LINK 2-3 LINK 4-5 LINK 6-7

4. Excitation Interruption Link

LINK K1-K2

K1-K2 Linked for normal operation.

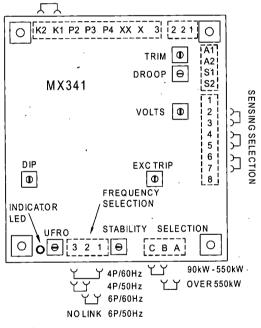
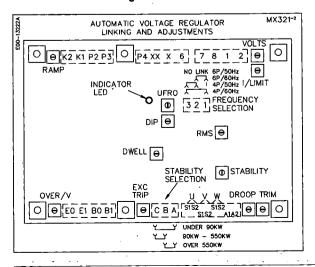


Fig. 4



4.4.4.5 TYPE MX321 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 5 for location of setting links.

Fig. 5

1. Frequency selection terminals

50Hz operation LINK 2-3 60Hz operation LINK 1-3

2. Stability selection terminals

Frame UC22 LINK A-C Frame UC27 LINK B-C

3. Terminals K1 - K2

Excitation circuit breaker closed. If this option not fitted, K1 - K2 linked at auxiliary terminal block.

AS440 AVR

8& Z2 linked for normal remove for auxiliary winding

Output Voltage adjustment

Hand trimmer link when not used

Low voltage selection (110v)

Droop adjustment

To optimise analogue input sensitivity

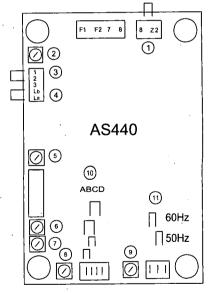
Excitement trip cut off adjustment ...

Stability control

UFRO adjustment

Stability selection

Frequency selection



Stability Selection Table		
No.	Power range	Response
B-D	< 100kW	Slow
A-C	< 100kW	Fast
В-С	100-550kW	Fast
A-B	> 550kW	Fast
L		

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4.4.5 TRANSFORMER CONTROLLED EXCITATION SYSTEM (Series 5)

This control system is identified with the digit 5 as the last digit of the frame size quoted on the nameplate.

The excitation control is factory set for the specific voltage shown on the nameplate and requires no adjustment.

4.5 GENERATOR SET TESTING



During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or Warning! adjustments.

4.5:1 TEST METERING/CABLING

Connect any instrument wiring and cabling required for initial test purposes with permanent or spring-clip type connectors. Minimum instrumentation for testing should be line - line or line to neutral voltmeter, Hz meter, load current metering and kW meter. If reactive load is used a power factor meter is desirable.

Important! When fitting power cables for load testing purposes, ensure cable voltage rating is at least equal to the genrator rated voltage. The load cable termination should be placed on top of the winding lead termination and clamped with the nut provided.

Caution!

Check that all wiring terminations for internal or external wiring are secure, and fit all terminal box covers and guards. Failure to secure wiring and/or covers may result in personal injury and/or equipment failure.

4.6 INITIAL START-UP



During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after Warning! adjustments are completed.

On completion of generating set assembly and before starting the generating set ensure that all engine manufacturer's prerunning procedures have been completed, and that adjustment of the engine governor is such that the generator will not be subjected to speeds in excess of 125% of the rated speed.

Important! Overspeeding of the generator during initial setting of the speed governor can result in the generator rotating damage to components.

In addition remove the AVR access cover (on AVR controlled generators) and turn VOLTS control fully anti-clockwise. Start the generating set and run on no-load at nominal frequency. Slowly turn VOLTS control potentiometer clockwise until rated voltage is reached. Refer to Fig. 6a, 6b, 6c, 6d or 6e for control potentiometer location.

Important! Do not increase the voltage above the rated generator voltage shown on the generator nameplate.

The STABILITY control potentiometer will have been pre-set and should normally not require adjustment, but should this be required, usually identified by oscillation of the voltmeter, refer to Fig. 6a, 6b, 6c, 6d or 6e for control potentiometer location and proceed as follows :-

- Run the generating set on no-load and check that speed is correct and stable
- Turn the STABILITY control potentiometer clockwise, then turn slowly anti-clockwise until the generator voltage starts to become unstable.

The correct setting is slightly clockwise from this position (i.e. where the machine volts are stable but close to the unstable region).

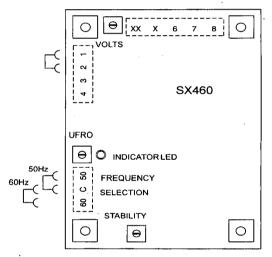


Fig.6a

K1-K2 Linked for

normál operation.

DROOP A SX440 S2 VOLTS 0 3 5 6 7 FREQUENCY INDICATOR LED STABILITY SELECTION 0 0 O ⊖ 50 C 60 ⊖ 90kW - 550kW

Fig.6b

OVER 550kW

60Hz \(\sum_{\text{}}\)

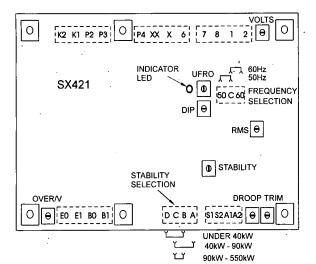


Fig.6c

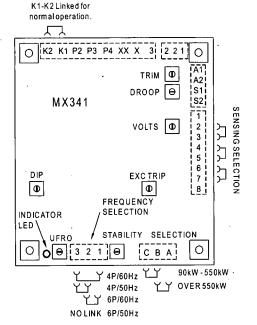


Fig.6d

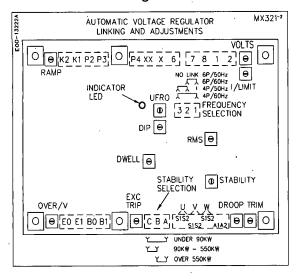


Fig.6e

4.7 LOAD TESTING



Warning!

During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after adjustments are completed.

4.7.1 AVR CONTROLLED GENERATORS – AVR ADJUSTMENTS

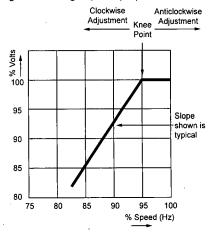
Refer to Fig. 6a, 6b, 6c, 6d or 6e for control potentiometer locations.

Having adjusted VOLTS and STABILITY during the initial startup procedure, other AVR control functions should not normally need adjustment.

If however, poor voltage regulation on-load or voltage collapse is experienced, refer to the following paragraphs on each function to a) check that the symptoms observed do indicate adjustment is necessary, and b) to make the adjustment correctly.

4.7.1.1 UFRO (Under Frequency Roll Off) (AVR Types SX460, SX440, SX421, MX341 and MX321)

The AVR incorporates an underspeed protection circuit which gives a voltage/speed (Hz) characteristic as shown:



The UFRO control potentiometer sets the "knee point".

Symptoms of incorrect setting are a) the light emitting diode (LED) indicator, just above the UFRO Control potentiometer, being permanently lit when the generator is on load, and b) poor voltage regulation on load, i.e. operation on the sloping part of the characteristic.

Clockwise adjustment lowers the frequency (speed) setting of the "knee point" and extinguishes the LED. For Optimum setting the LED should illuminate as the frequency falls just below nominal frequency, i.e. 47Hz on a 50Hz generator or 57Hz on a 60Hz generator.

Important! With AVR Types MX341 and MX321. If the LED is illuminated and no output voltage is present, refer to EXC TRIP and/or OVER/V sections below.

4.7.1.2 EXC TRIP (Excitation Trip) AVR Types MX341 and MX321

An AVR supplied from a permanent magnet generator inherently delivers maximum excitation power on a line to line or line to neutral short circuit or large overload. In order to protect the generator windings the AVR incorporates an over excitation circuit which detects high excitation and removes it after a pre-determined time, i.e. 8-10 seconds.

Symptoms of incorrect setting are the generator output collapses on load or small overload, and the LED is permanently illuminated.

The correct setting is 70 volts +/-5% between terminals X and XX.

4.7.1.3 OVER/V (Over Voltage) AVR Type SX421, MX321

Over voltage protection circuitry is included in the AVR to remove generator excitation in the event of loss of AVR sensing input.

The MX321 has both internal electronic de-excitation and provision of a signal to operate an external circuit breaker.

The SX421 only provides a signal to operate an external breaker, which MUST be fitted if over voltage protection is required.

Incorrect setting would cause the generator output voltage to collapse at no-load or on removal of load, and the LED to be illuminated.

The correct setting is 300 volts +/-5% across terminals E1, E0. Clockwise adjustment of the OVER/V control potentiometer will increase the voltage at which the circuit operates.

4.7.1.4 TRANSIENT LOAD SWITCHING ADJUSTMENTS AVR Types SX421, MX341 and MX321

The additional function controls of DIP and DWELL are provided to enable the load acceptance capability of the generating set to be optimised. The overall generating set performance depends upon the engine capability and governor response, in conjunction with the generator characteristics.

It is not possible to adjust the level of voltage dip or recovery independently from the engine performance, and there will always be a 'trade off' between frequency dip and voltage dip.

DIP AVR Types SX421, MX341 and MX321

AVR Types SX421, MX341 and MX321

The dip function control potentiometer adjusts the slope of the voltage/speed (Hz) characteristic below the knee point as shown below :

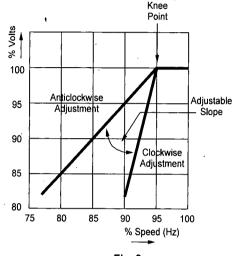


Fig. 8

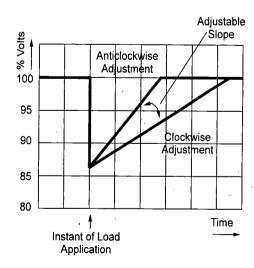
DWELL AVR Type MX321

The dwell function introduces a time delay between the recovery of voltage and recovery of speed.

The purpose of the time delay is to reduce the generator kW below the available engine kW during the recovery period, thus allowing an improved speed recovery.

Again this control is only functional below the "knee point", i.e. if the speed stays above the knee point during load switching there is no effect from the DWELL function setting.

Clockwise adjustment gives increased recovery time.



The graphs shown above are representations only, since it is impossible to show the combined effects of voltage regulator and engine governor performance.

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4.7.1.5 RAMP AVR Type MX321

The RAMP potentiometer enables adjustment of the time taken for the generator's initial build up to normal rated voltage during each start and run up to speed. The potentiometer is factory set to give a ramp time of three seconds, which is considered to be suitable for most applications. This time can be reduced to one second by turning the pot. fully counter clockwise, and increased to eight seconds by turning the pot fully clockwise.

4.7.2 TRANSFORMER CONTROLLED GENERATORS-TRANSFORMER ADJUSTMENT

Normally no adjustment is required but should the no-load voltage and/or on-load voltage be unacceptable, adjustment of the transformer air gap can be made as follows.

Stop the generator. Remove transformer cover box. (Normally left hand side of the terminal box when viewed from the non drive end).

Slacken the three transformer mounting bolts along the top of the transformer.

Start the set with a voltmeter connected across the main output terminals.

Adjust the air gap between the transformer top lamination section and the transformer limbs to obtain required voltage on no-load. Slightly tighten the three mounting bolts. Switch load 'on' and 'off' two or three times. Application of load will normally raise the voltage setting slightly. With the load 'off' recheck the no-load voltage.

Readjust air gap and finally tighten mounting bolts.

Refit the access cover.



Failure to refit covers can result in operator personal injury or death.

Warning!

4.8 ACCESSORIES

Refer to the "ACCESSORIES" - Section 6 of this Manual for setting up procedures related to generator mounted accessories.

If there are accessories for control panel mounting supplied with the generator refer to the specific accessory fitting procedures inserted inside the back cover of this book.

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SECTION 5 INSTALLATION - PART 2

5.1 GENERAL

The extent of site installation will depend upon the generating set build, e.g. if the generator is installed in a canopied set with integral switchboards and circuit breaker, on site installation will be limited to connecting up the site load to the generating set output terminals. In this case reference should be made to the generating set manufacturer's instruction book and any pertinent local regulations. If the generator has been installed on a set without switchboard or circuit breaker the following points relating to connecting up the generator should be noted.

5.2 GLANDING

The terminal box is most conveniently glanded on either the right or left hand side. Both panels are removable for drilling/punching to suit glands/or glanding boxes. If single core cables are taken through the terminal box side panel an insulated or non-magnetic gland plate should be fitted.

Incoming cables should be supported from either below or above the box level and at a sufficient distance from the centre line of the generating set so as to avoid a tight radius at the point of entry into the terminal box panel, and allow movement of the generator set on its anti-vibration mountings without excessive stress on the cable.

Before making final connections, test the insulation resistance of the windings. The AVR should be disconnected during this test.

A 500V Megger or similar instrument should be used. Should the insulation resistance be less than 5M? the windings must be dried out as detailed in the Service and Maintenance section of this manual.

When making connections to the terminals the incoming cable termination should be placed on top of the winding lead termination(s) and clamped with the nut provided.

Important! To avoid the possibility of swarf entering any electrical components in the terminal box, panels must be removed for drilling.

5.3 EARTHING

The neutral of the generator is not bonded to the generator frame as supplied from the factory. An earth terminal is provided inside the terminal box adjacent to the main terminals. Should it be required to operate with the neutral earthed a substantial earth conductor (normally equivalent to one half of the section of the line conductors) must be connected between the neutral and the earth terminal inside the terminal box. Additional earth terminals are provided on the generator feet. These should be already bonded to the generating set bedplate by the generating set builder, but will normally be required to be connected to the site earth system.

Caution! Reference to local electricity regulations or safety rules should be made to ensure correct earthing procedures have been followed.

5.4 PROTECTION

It is the responsibility of the end user and his contractors/subcontractors to ensure that the overall system protection meets the needs of any inspectorate, local electricity authority or safety rules, pertaining to the site location.

To enable the system designer to achieve the necessary protection and/or discrimination, fault current curves are available on request from the factory, together with generator reactance values to enable fault current calculations to be made.



Warning!

Incorrect installation and/or protective systems can result in personal injury and/or equipment damage. Installers must be qualified to perform electrical installation work.

5.5 COMMISSIONING

Ensure that all external cabling is correct and that all the generating set manufacturer's pre-running checks have been carried out before starting the set.

The generator AVR controls will have been adjusted during the generating set manufacturer's tests and should normally not require further adjustment.

Should malfunction occur during commissioning refer to Service and Maintenance section 'Fault Finding' procedure (subsection 7.4).

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SECTION 6 ACCESSORIES

Generator control accessories may be fitted, as an option, in the generator terminal box. If fitted at the time of supply, the wiring diagram(s) in the back of this book shows the connections. When the options are supplied separately, fitting instructions are provided with the accessory.

The following matrix indicates availability of accessories with the differing AVRs.

Note the SX460 is not suitable for operation with accessories.

AVR Model	Paralleling Droop or Astatic	Manual Voltage Regulator	Var/PF Control	Current Limit
SX460	Х	Х	X	Х
AS440	0	0 _	0	
MX341	0	0	0	
MX321	0	0	0	

6.1 REMOTE VOLTAGE ADJUST (ALL AVR TYPES)

A remote voltage adjust (hand trimmer) can be fitted.

SX460

Remove link 1-2 on the AVR and connect adjuster to terminals 1 and 2.

AS440

Remove link 1-2 at the auxiliary

terminals

MX341 and MX321

and connect adjuster to terminals 1

and 2.

6.2 PARALLEL OPERATION

Understanding of the following notes on parallel operation is useful before attempting the fitting or setting of the droop kit accessory. When operating in parallel with other generators or the mains, it is essential that the phase sequence of the incoming generator matches that of the busbar and also that all of the following conditions are met before the circuit breaker of the incoming generator is closed on to the busbar (or operational generator).

- 1. Frequency must match within close limits.
- 2. Voltages must match within close limits.
- Phase angle of voltages must match within close limits.
 A variety of techniques, varying from simple synchronising lamps to fully automatic synchronisers, can be used to ensure these conditions are met.

Important! Failure to meet conditions 1, 2, and 3 when closing the cricuit breaker, will generate excessive mechanical and electrical stresses, resulting in equipment damage.

Once connected in parallel a minimum instrumentation level per generator of voltmeter, ammeter, wattmeter (measuring total power per generator), and frequency meter is required in order to adjust the engine and generator controls to share kW in relation to engine ratings and kVAr in relation to generator ratings.

It is important to recognise that:

 True kW are derived from the engine, and speed governor characteristics determine the kW sharing between sets

and

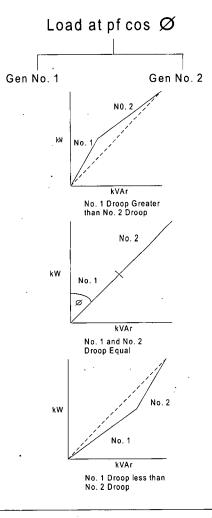
 kVAr are derived from the generator, and excitation control characteristics determine the kVAr sharing. Reference should be made to the generating set manufacturer's instructions for setting the governor controls.

6.2.1 DROOP

The most commonly used method of kVAr sharing is to create a generator voltage characteristic which falls with decreasing power factor (increasing kVAr). This is achieved with a current transformer (C.T.) which provides a signal dependent on current phase angle (i.e. power factor) to the AVR.

The current transformer has a burden resistor on the AVR board, and a percentage of the burden resistor voltage is summed into the AVR circuit. Increasing droop is obtained by turning the DROOP control potentiometer clockwise.

The diagrams below indicate the effect of droop in a simple two generator system : -



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Generally 5% droop at full load current zero p.f. is sufficient to ensure kVAr sharing.

If the droop accessory has been supplied with the generator it will have been tested to ensure correct polarity and set to a nominal level of droop. The final level of droop will be set during generating set commissioning.

The following setting procedure will be found to be helpful.

6.2.1.1 SETTING PROCEDURE

Depending upon available load the following settings should be used - all are based on rated current level.

0.8 P.F. LOAD (at full load current) SET DROOP TO 3% Zero P.F. LOAD (at full load current) SET DROOP TO 5%

Setting the droop with low power factor load is the most accurate. Run each generator as a single unit at rated frequency or rated frequency + 4% depending upon type of governor and nominal voltage. Apply available load to rated current of the generator. Adjust 'DROOP' potentiometer to give droop in line with above table. Clockwise rotation increases amount of droop. Refer to Fig. 9a, 9b, 9c or 9d for potentiometer locations.

Note 1)

Reverse polarity of the C.T. will raise the generator voltage with load. The polarities S1-S2 shown on the wiring diagrams are correct for clockwise rotation of the generator looking at the drive end. Reversed rotation requires S1-S2 to be reversed.

Note 2)

The most important aspect is to set all generators equal. The precise level of droop is less critical.

Note 3)

A generator operated as a single unit with a droop circuit set at rated load 0.8 power factor is unable to maintain the usual +/-0.5% regulation. A shorting switch can be connected across S1-S2 to restore regulation for single running.

Important! LOSS OF FUEL to an engine can cause its generator to motor with consequent damage to the generator windings. Reverse power relays should be fitted to trip main circuit breaker.

> LOSS OF EXCITATION to the generator can result in large current oscillations with consequent damage to generator windings. Excitation loss detection equipment should be fitted on trip main circuit breaker.

6.2.2 ASTATIC CONTROL

The 'droop' current transformer can be used in a connection arrangement which enables the normal regulation of the generator to be maintained when operating in parallel. This feature is only supplied from the factory as a fitted droop kit, however, if requested at the time of order, the diagrams inside the back cover of this book will give the necessary site connections. The end user is required to provide a shorting switch for the droop current transformer secondary.

Should the generator be required to be converted from standard droop to 'astatic' control, diagrams are available on request.

The setting procedure is exactly the same as for DROOP. (Subsection 6.2.1.1)

Important! When using this connection arrangement a shorting switch is required across each C.T. burden (terminals S1 and S2.)The switch must be closed a) when a generating set is not running and b) when a generating set is selected for single running.

6.3 MANUAL VOLTAGE REGULATOR (MVR)-MX341 and MX321 AVR

This accessory is provided as an 'emergency' excitation system, in the event of an AVR failure.

Powered from the PMG output the unit is manually set, but automatically controls the excitation current, independent of generator voltage or frequency.

The unit is provided with 'MANUAL', 'OFF', 'AUTO' switching facility.

'MANUAL'

position connects the exciter field to the MVR output. Generator output is then controlled by the operator adjusting the excitation current.

'OFF'

- disconnects the exciter field from both MVR and the normal AVR.

'AUTO'

- connects the exciter field to the normal AVR and the generator output is controlled at the pre-set voltage under AVR control.

switching mode of operation should be carried out with the generator set stationary to avoid voltage surges on the connected load, although neither the MVR nor AVR will be damaged should the switching be carried out with the set

6.4 OVERVOLTAGE DE-EXCITATION BREAKER MX321 AVR

This accessory provides positive interruption of the excitation power in the event of overvoltage due to loss of sensing or internal AVR faults including the output power device.

With the MX321 AVR this accessory is supplied loose for fitting in the control panel.

Important! When the circuit breaker is supplied loose, the AVR is fitted with a link on terminals K1-K2 to enable operation of the AVR. When connecting the circuit breaker this link must be removed.

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6.4.1 RESETTING THE BREAKER

In the event of operation of the circuit breaker, indicated by loss of generator output voltage, manual resetting is required. When in the "tripped" state the circuit breaker switch lever shows "OFF". To reset move the switch lever to the position showing "ON".

When fitted in the generator, access to the breaker is gained by removal of the AVR access cover.



Danger!

Terminals which are LIVE with the generating set running are exposed when the AVR access cover is removed. Resetting of the circuit breaker MUST be carried out with the generating set stationary, and engine starting circuits disabled.

The circuit breaker is mounted on the AVR mounting bracket either to the left or to the right of the AVR depending upon AVR position. After resetting the circuit breaker replace the AVR access cover before restarting the generating set. Should resetting of the circuit breaker not restore the generator to normal operation, refer to subsection 7.5.

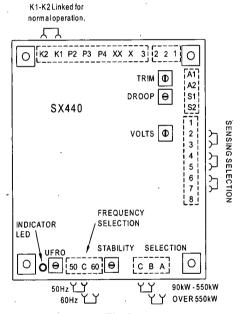


Fig.9a

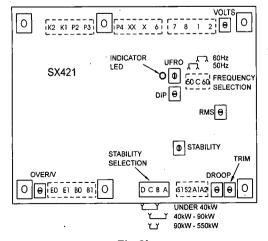


Fig.9b

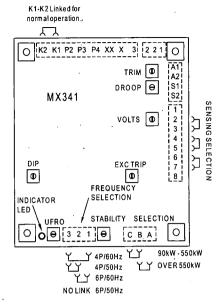


Fig.9c

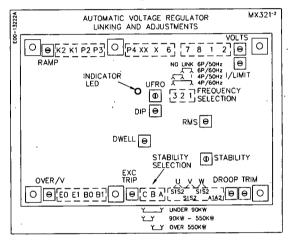


Fig.9d

6.5 CURRENT LIMIT - MX321 AVR

These accessories work in conjunction with the AVR circuits to provide an adjustment to the level of current delivered into a fault. One current transformer (CT) per phase is fitted to provide current limiting on any line to line or line to neutral fault.

Note: The W phase CT can also provide "DROOP". Refer to 6.2.1.1 for setting droop independent of current limit.

Adjustment means is provided with the "I/LIMIT" control potentiometer on the AVR. Refer to Fig. 9d for location. If current limit transformers are supplied with the generator the limit will be set in accordance with the level specified at the time of order, and no further adjustment will be necessary. However, should the level need to be adjusted, refer to the setting procedure given in 6.5.1.

6.5.1 SETTING PROCEDURE

Run the generating set on no-load and check that engine governor is set to control nominal speed.

Stop the generating set. Remove the link between terminals K1-K2 at the auxiliary terminal block and connect a 5A switch across the terminals K1-K2.

Turn the "I/LIMIT" control potentiometer fully anticlockwise. Short circuit the stator winding with a bolted 3 phase short at the main terminals. An AC current clip-on ammeter is required to measure the winding lead current.

With the switch across K1-K2 open start the generating set.

Close the switch across K1-K2 and turn the "I/LIMIT" control potentiometer clockwise until required current level is observed on the clip-on ammeter. As soon as correct setting is achieved open the K1-K2 switch.

Should the current collapse during the setting procedure, the internal protective circuits of the AVR will have operated. In this event shut down the set and open the K1-K2 switch. Restart the set and run for 10 minutes with K1-K2 switch open, to cool the generator windings, before attempting to resume the setting procedure.

Important! Failure to carry out the correct COOLING procedure, may cause overheating and consequent damage to the generator windings.

6.6 POWER FACTOR CONTROLLER (PFC3)

This accessory is primarily designed for those generator applications where operation in parallel with the mains supply is required.

Protection against loss of mains voltage or generator excitation is not included in the unit and the system designer must incorporate suitable protection.

The electronic control unit requires both droop and kVAr current transformers. When supplied with the generator, wiring diagrams inside the back cover of this manual show the connections and the additional instruction leaflet provided gives details of setting procedures for the power factor controller (PFC3).

The unit monitors the power factor of the generator current and adjusts excitation to maintain the power factor constant.

This mode can also be used to control the power factor of the mains if the point of current monitoring is moved to the mains cables. Refer to the factory for appropriate details.

It is also possible to operate the unit to control kVAr of the generator if required. Refer to the factory for appropriate details.

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SECTION 7

SERVICE AND MAINTENANCE

As part of routine maintenance procedures, periodic attention to winding condition (particularly when generators have been idle for a long period) and bearings is recommended. (Refer to subsections 7.1 and 7.2 respectively).

When generators are fitted with air filters regular inspection and filter maintenance is required. (Refer to subsection 7.3).

7.1 WINDING CONDITION



Warning!

Service and fault finding procedures present hazards which can result in severe personal injury or death. Only personnel qualified to perform electrical and mechanical service should carry out these procedures.

Ensure engine starting circuits are disabled before commencing service or maintenance procedures. Isolate any anti-condensation heater supply.

Guidance of Typical Insulation Resistance [IR] Values

The following is offered as general information about IR values and is aimed at providing guidance about the typical IR values for generators from new through to the point of refurbishment.

New Machines

The generators Insulation Resistance, along with many other critical factors, will have been measured during the alternator manufacturing process. The generator will have been transported with an appropriate packaging suitable for the method of delivery to the Generating Set assemblers works. Where we expect it to be stored in a suitable location protected from adverse environmental conditions.

However, absolute assurance that the generator will arrive at the Gen-set production line with IR values still at the factory test levels of above 100 M Ω cannot be guaranteed.

At Generating Set Manufacturers Works

The generator should have been transported and stored such that it will be delivered to the assembly area in a clean dry condition. If held in appropriate storage conditions the generator IR value should typically be 25 M Ω .

If the unused/new generators IR values fall below $10 \, \text{M}\Omega$ then a drying out procedure should be implemented by one of the processes outlined below before being despatched to the end customer's site. Some investigation should be undertaken into the storage conditions of the generator while on site.

Generators in Service

Whilst It is known that a generator will give reliable service with an IR value of just 1.0 M Ω . For a relatively new generator to be so low it must have been subjected to inappropriate operating or storage conditions.

Any temporarily reduction in IR values can be restored to expected values by following one of the drying out procedures.

7.1.1 WINDING CONDITION ASSESSMENT

The AVR should be disconnected and the Caution! Resistance Temperature Detector (R.T.D.) leads grounded during this test.

The condition of the windings can be assessed by measurement of insulation resistance [IR] between phase to phase, and phase to earth.

Measurement of winding insulation should be carried out : -

- 1. As part of a periodic maintenance plan.
- After prolonged periods of shutdown.
- When low insulation is suspected, e.g. damp or wet windings.

Care should be taken when dealing with windings that are suspected of being excessively damp or dirty. The initial measurement of the [IR] Insulation Resistance should be established using a low voltage (500V) megger type instrument. If manually powered the handle should initially be turned slowly so that the full test voltage will not be applied, and only applied for long enough to very quickly assess the situation if low values are suspected or immediately indicated.

Full megger tests or any other form of high voltage test should not be applied until the windings have been dried out and if necessary cleaned.

Procedure for Insulation Testing

Disconnect all electronic components, AVR, electronic protection equipment etc. Ground the [RTD's] Resistance Temperature Detection devices if fitted. Short out the diodes on the rotating diode assembly. Be aware of all components connected to the system under test that could cause false readings or be damaged by the test voltage.

Carry out the insulation test in accordance with the 'operating instructions for the test equipment.

The measured value of insulation resistance for all windings to earth and phase to phase should be compared with the guidance given above for the various 'life stages' of a generator. The minimum acceptable value must be greater than 1.0 M Ω .

If low winding insulation is confirmed use one or more of the methods, given below, for drying the winding should be carried out.

7.1.2 METHODS OF DRYING OUT GENERATORS

Cold Run

Consider a good condition generator that has not been run for some time, and has been standing in damp, humid conditions. It is possible that simply running the gen set unexcited - AVR terminals K1 K2 open circuit - for a period of say 10 minutes will sufficiently dry the surface of the windings and raise the IR sufficiently, to greater than 1.0 M Ω , and so allow the unit to be put into service.

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Blown Air Drying

Remove the covers from all apertures to allow the escape of the water-laden air. During drying, air must be able to flow freely through the generator in order to carry off the moisture.

Direct hot air from two electrical fan heaters of around 1 - 3 kW into the generator air inlet apertures. Ensure the heat source is at least 300mm away from the windings to avoid, over heating and damage to the insulation.

Apply the heat and plot the insulation value at half hourly intervals. The process is complete when the parameters covered in the section entitled, 'Typical Drying Out Curve', are

Remove the heaters, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anticondensation heaters are energised, and retest prior to running.

Short Circuit Method

NOTE: This process should only be performed by a competent engineer familiar with safe operating practices within and around generator sets of the type in question.

Ensure the generator is safe to work on, initiate all mechanical and electrical safety procedures pertaining to the genset and the site.

Bolt a short circuit of adequate current carrying capacity,. across the main terminals of the generator. The shorting link should be capable of taking full load current.

Disconnect the cables from terminals "X" and "XX" of the AVR.

Connect a variable dc supply to the "X" (positive) and "XX" (negative) field cables. The dc supply must be able to provide a current up to 2.0 Amp at 0 - 24 Volts.

Position a suitable ac ammeter to measure the shorting link current.

Set the dc supply voltage to zero and start the generating set. Slowly increase the dc voltage to pass current through the exciter field winding. As the excitation current increases, so the stator current in the shorting link will increase. This stator output current level must be monitored, and not allowed to exceed 80% of the generators rated output current.

After every 30 minutes of this exercise:

Stop the generator and switch off the separate excitation supply, and measure and record the stator winding IR values, and plot the results. The resulting graph should be compared with the classic shaped graph. This drying out procedure is complete when the parameters covered in the section entitled 'Typical Drying Out Curve' are met.

Once the Insulation Resistance is raised to an acceptable level - minimum value 1.0 $M\Omega$ - the dc supply may be removed and the exciter field leads "X" and "XX" re-connected to their terminals on the AVR.

Rebuild the genset, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anticondensation heaters are energised, and retest the generator prior to running.

TYPICAL DRYING OUT CURVE

Whichever method is used to dry out the generator the resistance should be measured every half-hour and a curve plotted as shown. (fig 6.)

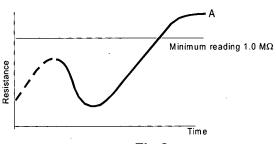


Fig.9

The illustration shows a typical curve for a machine that has absorbed a considerable amount of moisture. The curve indicates a temporary increase in resistance, a fall and then a gradual rise to a steady state. Point 'A', the steady state, must be greater than 1.0 $M\Omega$. (If the windings are only slightly damp the dotted portion of the curve may not appear).

For general guidance expect that the typical time to reach point 'A' will be :

1 hour for a BC16/18,

2 hours for a UC22/27

3 hours for an HC4,5,6&7

Drying should be continued after point "A" has been reached for at least one hour.

It should be noted that as winding temperature increases, values of insulation resistance may significantly reduce. Therefore, the reference values for insulation resistance can only be established with windings at a temperature of approximately 20°C.

If the IR value remains below 1.0 M Ω , even after the above drying methods have been properly conducted, then a Polarisation Index test [PI] should be carried out.

If the minimum value of 1.0 M Ω for all components cannot be achieved rewinding or refurbishment of the generator will be necessary.

The generator must not be put into service until the minimum values can be achieved.

Important! The short circuit must not be applied with the AVR connected in circuit. Current in excess of the rated generator current will cause damage to the windings.

After drying out, the insulation resistances should be rechecked to verify minimum resistances quoted above are

On re-testing it is recommended that the main stator insulation resistance is checked as follows :-Separate the neutral leads

Ground V and W phase and megger U phase to ground Ground U and W phase and megger V phase to ground Ground U and V phase and megger W phase to ground

If the minimum value of $1.0 \text{M}\Omega$ is not obtained, drying out must be continued and the test repeated.

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7.2 BEARINGS

All bearings are supplied sealed for life and are, therefore, not regreasable.

Important! The life of a bearing in service is subject to the working conditions and the

environment.

Important! Long stationary periods in an environment where there is vibration can cause false

brinnelling which puts flats on the ball and grooves on the races. Very humid atmospheres or wet conditions can emulsify

the grease and cause corrosion.

Important! High axial vibration from the engine or misalignment of the set will stress the

bearing.

The bearing, in service, is affected by a variety of factors that together will determine the bearing life. We recommend that the health of the bearings be monitored, using 'spike energy' vibration monitoring equipment. This will allow the timely replacement of bearings, that exhibit a deteriorating trend, during a major engine overhaul.

If excessive heat, noise or vibration is detected, change the bearing as soon as practicable. Failure to do so could result in bearing failure.

In the event that 'spike energy' vibration monitoring equipment is not available, it is strongly recommend that consideration be given to changing the bearing during each 'major engine overhaul'.

Belt driven application will impose an additional load on bearings. The bearing life will therefore be significantly affected. It is important that the side load limits given in SECTION 3 are not exceeded and the health of the bearing is monitored more closely.

7.3 AIR FILTERS

The frequency of filter maintenance will depend upon the severity of the site conditions. Regular inspection of the elements will be required to establish when cleaning is necessary.

7.3.1 CLEANING PROCEDURE



Removal of filter elements enables access to LIVE parts. Only remove elements with the generator out of service.

Danger!

Remove the filter elements from the filter frames. Immerse or flush the element with a suitable detergent until the element is clean. Dry elements thoroughly before refitting.

7.4 FAULT FINDING

Important! Before commencing any fault finding procedure examine all wiring for broken or loose connections.

Four types of excitation control system, involving four types of AVR, can be fitted to the range of generators covered by this manual. The systems can be identified by a combination of AVR type, where applicable, and the last digit of the generator frame size designation. Refer to the generator nameplate then proceed to the appropriate subsection as indicated below:

DIGIT	EXCITATION CONTROL	SUBSECTION
6	SX460 AVR	7.4.1
4	AS440 AVR	7.4.2
4		7.4.3
5	Transformer control	7.4.4
3	MX341 AVR	7.4.5
3	MX321 AVR	7.4.6

7.4.1 SX460 AVR - FAULT FINDING

No voltage build-up when starting set	Check speed Check residual voltage. Refer to subsection 7.4.7. Follow Separate Excitation Test Procedure to check generator and AVR.
Unstable voltage either on no-load or with load	 Check speed stability. Check stability setting. Refer to subsection 4.6.
High voltage either on no-load or with load	 Check speed. Check that generator load is not capacitive (leading power factor).
Low voltage no-load	Check speed. Check link 1-2 or external hand trimmer leads for continuity.
Low voltage on-load	Check speed. Check UFRO setting. Refer to subsection 4.7.1.1. Follow Separate Excitation Procedure to check generator and AVR. Refer to subsection 7.5.

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7.4.2 SX440 AVR - FAULT FINDING

No voltage build-up when starting set	 Check link K1-K2 on auxiliary terminals. Check speed Check residual voltage. Refer to subsection 7.4.7. Follow Separate Excitation Test Procedure to check generator and AVR. Refer to subsection 7.5.
Unstable voltage either on no-load or with load	Check speed stability. Check stability setting. Refer to subsection 4.6.
High voltage either on no-load or with load	Check speed Check that generator load is not capacitive (leading power factor).
Low voltage no-load	Check speed. Check link 1-2 or external hand trimmer leads for continuity.
Low voltage on-load	Check speed. Check UFRO setting. Refer to subsection 4.7.1.1. Follow Separate Excitation Procedure to check generator and AVR. Refer to subsection 7.5.

7.4.3 SX421 AVR - FAULT FINDING

No voltage build-up when starting set	 Check circuit breaker ON. Refer to subsection 6.4.1. Check speed Check residual voltage. Refer to subsection 7.4.7. Follow Separate Excitation Test Procedure to check generator and AVR. Refer to subsection 7.5.
Unstable voltage	Check speed stability.
either on no-load	2. Check stability setting. Refer to
or with load	subsection 4.6.
	Check speed.
	2. Check link 1-2 or external hand
High voltage	trimmers leads for continuity. Check
either on no-load	continuity of leads 7-8 and P3-P2 for
or with load	continuity.
	3. Check that generator load is not
	capacitive (leading power factor).
Low voltage	 Check speed.
no-load	Check link 1-2 or external hand
no-loau	trimmer leads for continuity.
	Check speed.
	Check UFRO setting. Refer to
Low voltage	subsection 4.7.1.1.
on-load	Follow Separate Excitation
,	Procedure to check generator and
	AVR. Refer to subsection 7.5.
Excessive	Check governor response.
voltage/speed	Refer to generating set manual.
dip on load	Check 'DIP' setting. Refer to
switching	subsection 4.7.1.4.

7.4.4 TRANSFORMER CONTROL - FAULT FINDING

No voltage	1.	Check transformers rectifiers.
build-up when	2.	Check transformer secondary
starting set		winding for open circuit.
	1.	Check speed.
Low voltage	2.	Check transformer air gap setting.
		Refer to subsection 4.7.2.
	1.	Check speed.
	2.	Check transformer air gap setting.
High voltage		Refer to subsection 4.7.2.
	3.	Check transformer secondary
		winding for open circuit.
Excessive	1.	Check speed drop on-load.
voltage/speed	2.	Check transformers rectifiers.
dip on load	3.	Check transformer air gap setting.
switching		Refer to subsection 4.7.2.

7.4.5 MX341 AVR - FAULT FINDING

No voltage build-up when starting set	1. 2.	Check link K1-K2 on auxiliary terminals Follow Separate Excitation Test Procedure to check machine and AVR. Refer to subsection 7.5.
Loss of voltage when set running	1.	First stop and restart set. If no voltage or voltage collapses after short time, follow Separate Excitation Test Procedure. Refer to subsection 7.5.
Generator voltage high followed by collapse	1. 2.	Check sensing leads to AVR. Refer to Separate Excitation Test Procedure. Refer to subsection 7.5.
Voltage unstable, either on no-load or with load	1. 2.	Check speed stability. Check "STAB" setting. Refer to Load Testing section for procedure. Refer to subsection 4.6.
Low voltage on-load	1. 2.	Check speed. If correct check "UFRO" setting. Refer to subsection 4.7.1.1.
Excessive voltage/speed dip on load switching	1.	Check governor response. Refer to generating set manual. Check "DIP" setting. Refer to subsection 4.7.1.4.
Sluggish recovery on load switching	1.	Check governor response. Refer to generating set manual.

7.4.6 MX321 AVR - FAULT FINDING

No voltage build-up when starting set	Check link K1-K2 on auxiliary terminals. Follow Separate Excitation Test Procedure to check machin and AVR. Refer to subsection 7.5.		
Voltage very slow to build up	1. Check setting of ramp potentiometer. Refer to 4.7.1.5.		
Loss of voltage when set running	First stop and restart set. If no voltage or voltage collapses after short time, follow Separate Excitation Test Procedure. Refer to subsection 7.5.		
Generator voltage high followed by collapse	Check sensing leads to AVR. Refer to Separate Excitation Test Procedure. Refer to subsection 7.5.		
Voltage unstable, either on no-load or with load	Check speed stability. Check "STAB" setting. Refer to Load Testing section for procedure. Refer to subsection 4.6.		
Low voltage on-load	Check speed. If correct check "UFRO" setting. Refer to subsection 4.7.1.1.		
Excessive voltage/speed dip on load switching	 Check governor response. Refer to generating set manual. Check "DIP" setting. Refer to subsection 4.7.1.4. 		
Sluggish recovery on load switching	 Check governor response. Refer to generating set manual. Check "DWELL" setting. Refer to Load Testing section 4.7.1.4. 		

7.4.7 RESIDUAL VOLTAGE CHECK

This procedure is applicable to generators with either SX460 or SX440 or SX421 AVR.

With the generator set stationary remove AVR access cover and leads X and XX from the AVR.

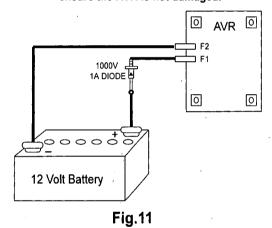
Start the set and measure voltage across AVR terminals 7-8 on SX460 AVR or P2-P3 on SX440 or SX421 AVR.

Stop the set, and replace leads X and XX on the AVR terminals. If the measured voltage was above 5V the generator should operate normally.

If the measured voltage was under 5V follow the procedure below.

Using a 12 volt d. c. battery as a supply clip leads from battery negative to AVR terminal XX, and from battery positive through a diode to AVR terminal X. See Fig. 10.

Important! A diode must be used as shown below to ensure the AVR is not damaged.



Important! If the generating set battery is used for field flashing the generator main stator neutral must be disconnected from earth.

Restart the set and note output voltage from main stator, which should be approximately nominal voltage, or voltage at AVR terminals 7 and 8 on SX460, P2-P3 on SX440 or SX421 which should be between 170 and 250 volts.

Stop the set and unclip battery supply from terminals X and XX. Restart the set. The generator should now operate normally. If no voltage build-up is obtained it can be assumed a fault exists in either the generator or the AVR circuits. Follow the SEPARATE EXCITATION TEST PROCEDURE to check generator windings, rotating diodes and AVR. Refer to subsection 7.5.

7.5 SEPARATE EXCITATION TEST PROCEDURE

The generator windings, diode assembly and AVR can be checked using the appropriate following section.

7.5.1 GENERATOR WINDINGS, ROTATING DIODES and PERMANENT MAGNET GENERATOR (PMG)

7.5.2 EXCITATION CONTROL TEST.

7.5.1 GENERATOR WINDINGS, ROTATING DIODES and PERMANENT MAGNET GENERATOR (PMG)

Important! The resistances quoted apply to a standard winding. For generators having windings or voltages other than those specified refer to factory for details. Ensure all disconnected leads are isolated and free from earth.

Important! Incorrect speed setting will give proportional error in voltage output.

CHECKING PMG

Start the set and run at rated speed. Measure the voltages at the AVR terminals P2, P3 and P4. These should be balanced and within the following ranges :-

> 50Hz generators - 170-180 volts 60Hz generators - 200-216 volts

Should the voltages be unbalanced stop the set, remove the PMG sheet metal cover from the non drive endbracket and disconnect the multipin plug in the PMG output leads. Check leads P2, P3, P4 for continuity. Check the PMG stator resistances between output leads. These should be balanced and within +/-10% of 2.3 ohms. If resistances are unbalanced and/or incorrect the PMG stator must be replaced. If the voltages are balanced but low and the PMG stator winding resistances are correct - the PMG rotor must be replaced.

CHECKING GENERATOR WINDINGS AND ROTATING DIODES

This procedure is carried out with leads X and XX disconnected at the AVR or transformer control rectifier bridge and using a 12 volt d.c. supply to leads X and XX.

Start the set and run at rated speed.

Measure the voltages at the main output terminals U, V and W. If voltages are balanced and within +/-10% of the generator nominal voltage, refer to 7.5.1.1.

Check voltages at AVR terminals 6, 7 and 8. These should be balanced and between 170-250 volts.

If voltages at main terminals are balanced but voltage at 6, 7 and 8 are unbalanced, check continuity of leads 6, 7 and 8. Where an isolating transformer is fitted (MX321 AVR) check transformer windings. If faulty the transformer unit must be replaced.

If voltages are unbalanced, refer to 7.5.1.2.

7.5.1.1 BALANCED MAIN TERMINAL VOLTAGES

If all voltages are balanced within 1% at the main terminals, it can be assumed that all exciter windings, main windings and main rotating diodes are in good order, and the fault is in the AVR or transformer control. Refer to subsection 7.5.2 for test procedure.

If voltages are balanced but low, there is a fault in the main excitation windings or rotating diode assembly. Proceed as follows to identify :-

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Rectifier Diodes

The diodes on the main rectifier assembly can be checked with a multimeter. The flexible leads connected to each diode should be disconnected at the terminal end, and the forward and reverse resistance checked. A healthy diode will indicate a very high resistance (infinity) in the reverse direction, and a low resistance in the forward direction. A faulty diode will give a full deflection reading in both directions with the test meter on the 10,000 ohms scale, or an infinity reading in both directions.

On an electronic digital meter a healthy diode will give a low reading in one direction, and a high reading in the other.

Replacement of Faulty Diodes

The rectifier assembly is split into two plates, the positive and negative, and the main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative biased diodes and the positive plate carrying positive biased diodes. Care must be taken to ensure that the correct polarity diodes are fitted to each respective plate. When fitting the diodes to the plates they must be tight enough to ensure a good mechanical and electrical contact, but should not be overtightened. The recommended torque tightening is 4.06 - 4.74Nm (36-42lb in).

Surge Suppressor

The surge suppressor is a metal-oxide varistor connected across the two rectifier plates to prevent high transient reverse voltages in the field winding from damaging the diodes. This device is not polarised and will show a virtually infinite reading in both directions with an ordinary resistance meter. If defective this will be visible by inspection, since it will normally fail to short circuit and show signs of disintegration. Replace if faulty.

Main Excitation Windings

If after establishing and correcting any fault on the rectifier assembly the output is still low when separately excited, then the main rotor, exciter stator and exciter rotor winding resistances should be checked (see Resistance Charts), as the fault must be in one of these windings. The exciter stator resistance is measured across leads X and XX. The exciter rotor is connected to six studs which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings.

Resistance values should be within +/-10% of the values given in the table below :-

FRAME	Main	Exciter Stator			Exciter
SIZE	Rotor	Type 1	Type 2*	Type 3**	Rotor
UC22C	0.59	21	28	138	0.142
UC22D	0.64	21	28	138	0.142
UC22E	0.69	20	30	155	0.156
UC22F	0.83	20	30	155	0.156
UC22G	0.94	20	30	155	0.156
UC27C	1.12	20	-	-	0.156
UC27D	1.26	20	-	-	0.156
UC27E	1.34	20	-	-	0.182
UC27F	1.52	20 .	-	-	0.182
UC27G	0.69	20	-	-	0.182
UC27H	0.82	20	-	-	0.182
UCD27J	2.08	20	-	-	0.182
UCD27K	2.08	20	-	-	0.182

^{*} Used with 1 phase transformer controlled 3 phase or 1 phase generators.

7.5.1.2 UNBALANCED MAIN TERMINAL VOLTAGES

If voltages are unbalanced, this indicates a fault on the main stator winding or main cables to the circuit breaker.

NOTE: Faults on the stator winding or cables may also cause noticeable load increase on the engine when excitation is applied. Disconnect the main cables and separate the winding leads U1-U2, U5-U6, V1-V2, V5-V6, W1-W2, W5-W6 to isolate each winding section. (U1-L1, U2-L4 on single phase generators).

Measure each section resistance - values should be balanced and within +/-10% of the value given below:-

AVR CONTROLLED GENERATORS						
FRAME	SECTION RESISTANCES					
SIZE	WINDING WINDING W		WINDING	WINDING		
SIZE	311	17	05	06		
UC22C	0.09	0.14	0.045	0.03		
UC22D	0.065	0.1	0.033	0.025		
UC22E	0.05	0.075	0.028	0.02		
UC22F	0.033	0.051	0.018	0.012		
UC22G	0.028	0.043	0.014	0.01		
UC27C	0.03	0.044	0.016	0.011		
UC27D	0.019	0.026	0.01	0.007		
UC27E	0.016	0.025	0.009	0.008		
UC27F	0.012	0.019	0.007	0.005		
UC27G	0.01	0.013	0.006	0.004		
UC27H	0.008	0.014	0.004	0.004		
UCD27J	0.006	0.009	-	•		
UCD27K_	0.006	0.009	-	-		

TRANSFORMER CONTROLLED GENERATOR					
FDAME	SECTION RESISTANCES, 3 PHASE WINDINGS				
FRAME SIZE	380V	400V	415V	416V	460V
SIZE	50Hz	50Hz	50Hz	60Hz	60Hz
UC22C	0.059	0.078	0.082	0.055	0.059
UC22D	0.054	0.056	0.057	0.049	0.054
UC22E	0.041	0.05	0.053	0.038	0.041
UC22F	0.031	0.032	0.033	0.025	0.031
UC22G	0.022	0.026	0.028	0.021	0.022

Measure insulation resistance between sections and each section to earth.

Unbalanced or incorrect winding resistances and/or low insulation resistances to earth indicate rewinding of the stator will be necessary. Refer to removal and replacement of component assemblies subsection 7.5.3.

7.5.2 EXCITATION CONTROL TEST 7.5.2.1 AVR FUNCTION TEST

'All types of AVR's can be tested with this procedure:

- 1. Remove exciter field leads X & XX (F1 & F2) from the AVR terminals X & XX (F1 & F2).
- Connect a 60W 240V household lamp to AVR terminals X & XX (F1 & F2).
- 3. Set the AVR VOLTS control potentiometer fully clockwise.
- Connect a 12V, 1.0A DC supply to the exciter field leads X & XX (F1 & F2) with X (F1) to the positive.
- 5. Start the generating set and run at rated speed.
- Check that the generator output voltage is within +/-10% of rated voltage.

^{**} Used with 3 phase transformer controlled 3 phase generators.

Voltages at AVR terminals 7-8 on SX460 AVR or P2-P3 on SX440 or SX421 AVR should be between 170 and 250 volts. If the generator output voltage is correct but the voltage on 7-8 (or P2- P3) is low, check auxiliary leads and connections to main terminals.

Voltages at P2, P3, P4 terminals on MX341 and MX321 hould be as given in 7.5.1.

The lamp connected across X-XX should glow. In the case of the SX460, SX440 and SX421 AVRs the lamp should glow continuously. In the case of the MX341 and MX321 AVRs the lamp should glow for approximately 8 secs. and then turn off. Failure to turn off indicates faulty protection circuit and the AVR should be replaced. Turning the "VOLTS" control potentiometer fully anti-clockwise should turn off the lamp with all AVR types.

Should the lamp fail to light the AVR is faulty and should be replaced.

Important! After this test turn VOLTS control potentiometer fully anti-clockwise.

7.5.2.2 TRANSFORMER CONTROL

The transformer rectifier unit can only be checked by continuity, resistance checks and insulation resistance measurement.

Two phase transformer

Separate primary leads T1-T2-T3-T4 and secondary leads 10-11. Examine windings for damage. Measure resistances across T1-T3 and T2-T4. These will be a low value but should be balanced. Check that there is resistance in the order of 8 ohms between leads 10 and 11. Check insulation resistance of each winding section to earth and to other winding sections.

Low insulation resistance, unbalanced primary resistance, open or short circuited winding sections, indicates the transformer unit should be replaced.

Three phase transformer

Separate primary leads T1-T2-T3 and secondary leads 6-7-8 and 10-11-12.

Examine windings for damage. Measure resistances across T1-T2, T2-T3, T3-T1. These will be low but should be balanced.

Check that resistances are balanced across 6-10, 7-11 and 8-12 and in the order of 18 ohms. Check insulation resistance of each winding section to earth and to other winding sections.

Low insulation resistance, unbalanced primary or secondary winding resistances, open or short circuited winding sections indicates the transformer unit should be replaced.

Rectifier units - Three phase and single phase

With the leads 10-11-12-X and XX removed from the rectifier unit (lead 12 is not fitted on single phase transformer rectifier units), check forward and reverse resistances between terminals 10-X, 11-X, 12-X, 10-XX, 11-XX and 12-XX with a multimeter.

A low forward resistance and high reverse resistance should be read between each pair of terminals. If this is not the case the unit is faulty and should be replaced.

7.5.3 REMOVAL AND REPLACEMENT OF **COMPONENT ASSEMBLIES**

METRIC THREADS ARE USED THROUGHOUT

Caution!

When lifting single bearing generators, care is needed to ensure the generator frame is kept in the horizontal plane. The rotor is free to move in the frame and can slide out if not correctly lifted. Incorrect lifting can cause serious personal injury.

7.5.3.1 REMOVAL OF PERMANENT MAGNET **GENERATOR (PMG)**

- Remove 4 screws holding the sheet metal cylindrical cover at the non-drive end and remove the cover.
- Disconnect the in line connector from the PMG stator (3 wires go to this connector). It may be necessary to cut off the nylon cable tie first.
- 3. Remove the 4 threaded pillars and clamps holding the PMG stator onto the end bracket.
- 4. Tap the stator out of the 4 spigots and withdraw. The highly magnetic rotor will attract the stator. Take care to avoid contact which may damage the windings.
- Remove the bolt in the centre from the rotor shaft and pull off the rotor. It may be necessary to gently tap the rotor away. Take care to tap gently and evenly - the rotor has ceramicmagnets which are easily broken by shock.

Important! The rotor assembly must not be dismantled.

Replacement is a reversal of the above procedure.

7.5.3.2 REMOVAL OF BEARINGS

Important! Position the main rotor so that a full pole face of the main rotor core is at the bottom of the stator bore.

NOTE: Removal of the bearings may be effected either after the rotor assembly has been removed OR more simply by removal of endbracket(s). Refer to 7.5.3.3. and 7.5.3.4.

The bearings are pre-packed with grease and sealed for life.

Q-Pulse Id TMS1367

The bearing(s) are a press fit and can be removed from the shaft with 3 leg or 2 leg manual or hydraulic bearing pullers.

SINGLE BEARING ONLY: Before trying to pull off the bearing remove the small circlip retaining it.

When fitting new bearings use a bearing heater to expand the bearing before fitting to the shaft. Tap the bearing into place ensuring that it contacts the shoulder on the shaft.

Refit the retaining circlip on single bearing generators.

7.5.3.3 REMOVAL OF ENDBRACKET AND EXCITER STATOR

- 1. Remove exciter leads X+, XX- at the AVR.
- Slacken 4 bolts (2 each side) situated on horizontal centre line holding the terminal box.
- Remove 2 bolts holding lifting lug, at the non-drive end, and remove lug.
- Remove sheet metal cylindrical cover (4 screws) over PMG (if fitted) or Remove shallow sheet metal cover (4 screws) at the nondrive end.
- Ease up the terminal box and support clear of the nondrive endbracket.
- Remove 6 bolts holding the non-drive endbracket to the stator bar assembly. The endbracket is now ready for removal.
- Replace the lifting lug onto the endbracket and sling the endbracket on a hoist to facilitate lifting.
- Tap the endbracket around its perimeter to release from the generator. The endbracket and exciter stator will come away as a single assembly.
- Remove the 4 screws holding the exciter stator to the endbracket and gently tap the exciter stator to release it. Replacement is a reversal of the above procedure.

7.5.3.4 REMOVAL OF THE ROTOR ASSEMBLY

Remove the permanent magnet generator. Refer to 7.5.3.1

Remove the four screws holding the sheet metal cover at the non drive end and remove cover.

Caution!

With the PMG rotor removed single bearing generator rotors are free to move in the frame. Ensure frame is kept in the horizontal plane when lifting.

TWO BEARING GENERATORS

- Remove 2 screws holding the sheet metal cover around the adaptor at the drive end and remove the cover.
- Remove the bolts holding the adaptor to the endbracket at the drive end.
- Tap off the adaptor. It may be preferred to sling the adaptor first depending on its size and weight.

Remove the screens and louvres (if fitted) at each side on the drive end.

Now ensure that the rotor is positioned with a full pole face at the bottom centre line. This is to avoid damage to the bearing exciter, or rotor winding, by limiting the possible rotor downward movement to the air gap length.

- Remove 6 bolts holding drive endbracket onto adaptor ring DE. The boltheads face towards the non-drive end. The top bolt passes through the centre of the lifting lug.
- Tap the drive endbracket away from the adaptor ring DE and withdraw the endbracket.
- 7. Ensure the rotor is supported at the drive end on a sling.
- Tap the rotor from the non-drive end to push the bearing clear of the endbracket and its position within an 'O' ring.
- Continue to push the rotor out of the stator bore, gradually working the sling along the rotor as it is withdrawn, to ensure that it is fully supported all the time.

SINGLE BEARING GENERATORS

- Remove the screws, screens and louvres (if fitted) at each side on drive end adaptor.
- UCI224, UCI274, UCM224, UCM274, UCD274 Only Remove 6 bolts holding the adaptor at the drive end. It may be preferred to sling the adaptor on a hoist. The bolt heads face towards the non-drive end. The top bolt passes through the centre of the lifting lug.
- 2a. **UCD224 Only** Remove 6 bolts holding the adaptor at the drive end. It may be preferred to sling the adaptor on a hoist.
- UCI224, UCI274, UCM224, UCM274, UCD274 Only Tap the adaptor away from stator bar adaptor ring.
- 3a. **UCD224 Only** Tap the adaptor away from stator bar assembly.

ALL SINGLE BEARING GENERATORS

- 4. Ensure the rotor is supported at drive end on a sling.
- 5. Tap the rotor from the non-drive end to push the bearing clear of the endbracket and its position within an 'O' ring.
- Continue to push the rotor out of the stator bore, gradually working the sling along the rotor as it is withdrawn, to ensure that it is fully supported at all times.

Replacement of rotor assemblies is a reversal of the procedures above.

Before commencing re-assembly, components should be checked for damage and bearing(s) examined for loss of grease.

Fitting of new bearing(s) is recommended during major overhaul.

Before replacement of a single bearing rotor assembly, check that the drive discs are not damaged, cracked or showing other signs of fatigue. Also check that the holes in the discs for drive fixing screws are not elongated.

Damaged or worn components must be replaced.

Caution!

When major components have been replaced, ensure that all covers and guards are securely fitted, before the generator is put into service.

7.6 RETURNING TO SERVICE

After rectification of any faults found, remove all test connections and reconnect all control system leads. Restart the set and adjust VOLTS control potentiometer on AVR controlled generators by slowly turning clockwise until rated voltage is obtained. Refit all terminal box covers/access covers and reconnect heater supply.

Caution!

Failure to refit all guards, access covers and terminal box covers can result in personal injury of death.

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SECTION 8 SPARES AND AFTER SALES SERVICE

8.1 RECOMMENDED SPARES

Service parts are conveniently packaged for easy identification. Genuine parts may be recognised by the Nupart name.

We recommend the following for Service and Maintenance. In critical applications a set of these service spares should be held with the generator.

AVR Controlled Generators

1.	Diode Set (6 diodes with surge suppresso	or)	RSK	2001
2.	AVR SX440		E000	24030
	AVR SX460		E000	24602
	AVR SX421		E000	24210
	AVR MX321		E000	23212
	AVR MX341		E000	23410
3.	Non drive end Bearing UC	22	051	01032
	UC	27	051	01049
4.	Drive end Bearing UC	22	051	01044
	UC	27	051	01050

Transformer Controlled Generators (UC22 Only)

1.	. Diode Set (6 diodes with surge suppressor)		RSK	2001
2.	Diode Assembly		E000	22006
3.	Non drive end Bearing	UC22	051	01032
4.	Drive end Bearing	UC22	051	01044

When ordering parts the machine serial number or machine identity number and type should be quoted, together with the part description. For location of these numbers see paragraph 1.3.

Orders and enquiries for parts should be addressed to:

STAMFORD & AvK Parts Department Barnack Road STAMFORD Lincolnshire PE9 2NB ENGLAND

Telephone: 44 (0) 1780 484000 Fax: 44 (0) 1780 766074

Or any of our subsidiary companies listed on the back cover.

8.2 AFTER SALES SERVICE

A full technical advice and on-site service facility is available from our Service Department at Stamford or through our Subsidiary Companies. A repair facility is also available at our Stamford Works.

TD UC MAN GB 10 06 03 GB 33 Copyright 2006

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Q-Pulse Id TM\$1367 Active 29/07/2015

PARTS LIST

TYPICAL SINGLE BEARING GENERATOR

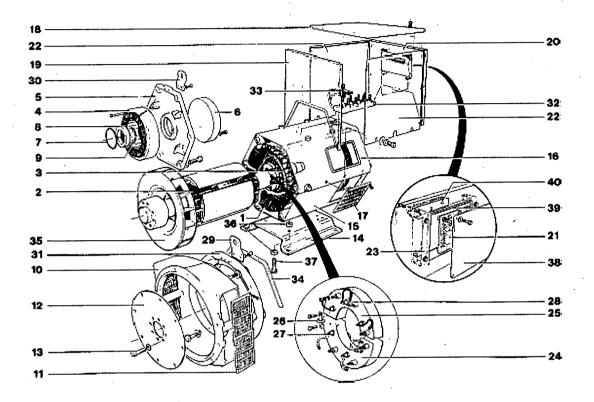
Plate Ref.	Description	
1	Stator	
2	Rotor	
3	Exciter Rotor	
4	Exciter Stator	
5	N.D.E. Bracket	
6	Cover N.D.E.	
7	Bearing 'O' Ring N.D.E.	
8	Bearing N.D.E.	
9	Bearing Circlip N.D.E.	
10	D.E. Bracket/Engine Adaptor	
11	D.E. Screen	
12	Coupling Disc	
13	Couplimg Bolt	
14	Foot	
15	Frame Cover Bottom	
16	Frame Cover Top	
17	Air Inlet Cover	
18	Terminal Box Lid	
19	Endpanel D.E.	
20	Endpanel N.D.E.	
21	AVR	
22	Side Panel	
23	AVR Mounting Bracket	
24	Main Rectifier Assembly - Forward	
25	Main Rectifier Assembly - Reverse	
26	Varistor	
27	Diode - Forward Polarity	
28	Diode - Reverse Polarity	
29	Lifting Lug - D.E.	
30	Lifting Lug - N.D.E.	
31	Frame to Endbracket Adaptor Ring	
32	Main Terminal Panel	
33	Terminal Link	
34	Edging Strip	
35	Fan	
36	Foot Mounting Spacer	
37	Cap Screw	
38	AVR Access Cover	
39	AVR Anti-Vibration Mounting Assembly	
40	Auxiliary Terminal Assembly	

N.D.E. Non Driven End
D.E. Driven End
P.M.G. Permanent Magnet Generator
A.V.R. Automatic Voltage Regulator

Active 29/07/2015

Fig. 11.

TYPICAL SINGLE BEARING GENERATOR



PARTS LIST

TYPICAL TWO BEARING GENERATOR

Plate Ref.	late Ref. Description	
1	Stator	
2	Rotor	
3	Exciter Rotor	
4	Exciter Stator	
5	N.D.E. Bracket	
6	Cover N.D.E.	
7	Bearing 'O' Ring N.D.E.	
8	Bearing N.D.E.	
9	Bearing Wave Washer.D.E.	
10	D.E. Bracket	
11	D.E. Screen	
12	Bearing D.E.	
13	Bearing D.E.	
	F4	
14	Foot	
15	Frame Cover Bottom	
16	Frame Cover Top	
17 ^	Air Inlet Cover	
18	Terminal Box Lid	
19	Endpanel D.E.	
20	Endpanel N.D.E.	
21	AVR	
22	Side Panel	
23	AVR Mounting Bracket	
24 Main Rectifier Assembly - Forward		
25	Main Rectifier Assembly - Reverse	
26	Varistor	
27	Diode - Forward Polarity	
28	Diode - Reverse Polarity	
29	Lifting Lug - D.E.	
30	Lifting Lug - N.D.E.	
31	Frame to Endbracket Adaptor Ring	
32	Main Terminal Panel	
33	Terminal Link	
34	Edging Strip	
35	Fan	
36	Foot Mounting Spacer	
. 37	Cap Screw	
38	AVR Access Cover	
39	AVR Anti-Vibration Mounting Assembly	
40	Auxiliary Terminal Assembly	
41		
42 PMG Exciter Rotor		
43 PMG Exciter Notor		
44	PMG Bolt	
45	PMG Boit PMG Pillar	
46	PMG Clamp	
47	PMG Dowel	

N.D.E. Non Driven End D.E. Driven End

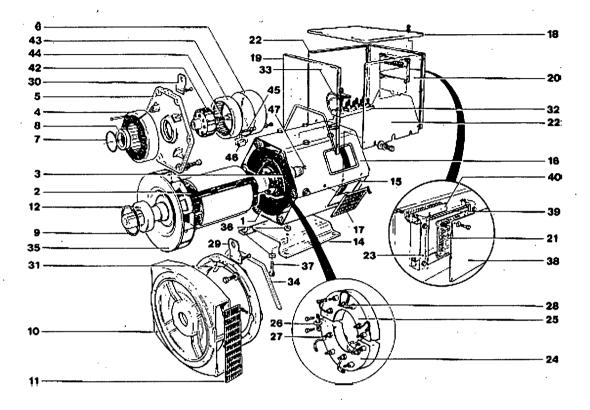
P.M.G.

Permanent Magnet Generator A.V.R. Automatic Voltage Regulator

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Fig. 12.

TYPICAL TWO BEARING GENERATOR



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PARTS LIST

TYPICAL TWO BEARING (SERIES 5) GENERATOR

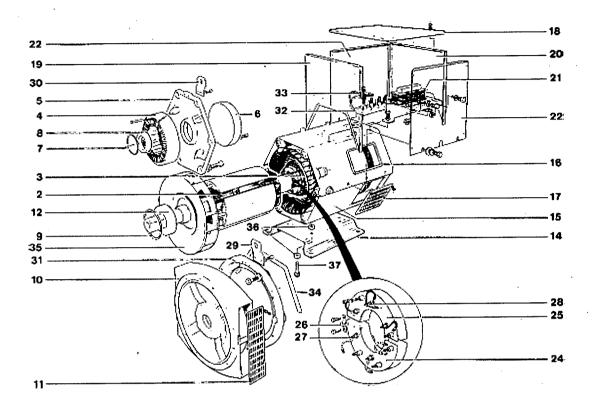
Plate Ref.	te Ref. Description		
.1	Stator		
2	Rotor		
3	Exciter Rotor		
4	Exciter Stator		
5	N.D.E. Bracket		
6	Cover N.D.E.		
7	Bearing 'O' Ring N.D.E.		
8	Bearing N.D.E.		
9	Bearing Wave Washer N.D.E.		
10	D.E. Bracket		
11	D.E. Screen		
12	Bearing D.E.		
13			
14	Foot		
15	Frame Cover Bottom		
16	Frame Cover Top		
17	Air Inlet Cover		
18	Terminal Box Lid		
19 Endpanel D.E.			
20	Endpanel N.D.E.		
21	Series 5 Control Gear		
. 22	Side Panel		
23			
24	Main Rectifier Assembly - Forward		
25	Main Rectifier Assembly - Reverse		
26	Varistor		
27	Diode - Forward Polarity		
28	Diode - Reverse Polarity		
29	Lifting Lug - D.E.		
30	Lifting Lug - N.D.E.		
31	Frame to Endbracket Adaptor Ring		
32	Main Terminal Panel		
33	Terminal Link		
34	Edging Strip		
35	Fan		
36	Foot Mounting Spacer		
37	Cap Screw		

N.D.E. Non Driven End D.E. Driven End

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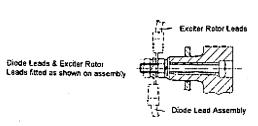
Fig. 13.

TYPICAL TWO BEARING (SERIES 5) GENERATOR



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Fig. 14.
ROTATING RECTIFIER ASSEMBLY



Scrap Section A-A

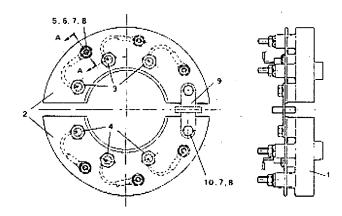


Plate Ref.	Description	aty
. 1	Hub	1 '
2	Fin	2
3	Diode (fwd)	3
4	Diode (rev)	3
5	Hx Sciew	6
6	Hx Nut	1.6
7	Pt. Washer	8
۵	SC. LWasher	٥
9	Varistor	1
10	Hx Screw	2

NOTES: Filing of Diodes.

- Underside of diodes to be smeared with Midland Silicone Heat Sink' compound type MS2623. This compound must not be applied to the diode threads.
- 2. Diodes to be lightened to a lorque of 2.03 2.37 Nm.
- 3. For Nupart recililer service kil see page 28.

Q-Pulse Id TMS1367

A.C. GENERATOR WARRANTY

WARRANTY PERIOD

A.C. Generators

In respect of a.c. generators the Warranty Period is eighteen months from the date when the goods have been notified as ready for despatch by N.I. or twelve months from the date of first commissioning (whichever is the shorter period).

DEFECTS AFTER DELIVERY

We will make good by repair or, at our option, by the supply of a replacement, any fault which under proper use appears in the goods within the period specified on Clause 12, and is found on examination by us to be solely due to defective material and workmanship; provided that the defective part is promptly returned, carriage paid, with all identification numbers and marks intact, or our works or, if appropriate to the Dealer who supplied the goods.

Any part repaired or replaced, under warranty, will be returned by N.I. free of harge (via sea freight if outside the UK).

We shall not be liable for any expenses which may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement supplied by us. We shall be under no liability for defects in any goods which have not been properly installed in accordance with N.I. recommended installation practices as detailed in the publications 'N.I. Installation, Service and Maintenance Manual' and 'N.I. Application Guidelines', or which have been improperly stored or which have been repaired, adjusted or altered by any person except ourselves or our authorised agents, or in any second-hand goods, proprietary articles or goods not of our own manufacture although supplied by us, such articles and goods being covered by the warranty (if any) given by the separate manufacturers.

Any claim under this clause must contain fully particulars of the alleged defect, the description of the goods, the date of purchase, and the name and address of the Vendor, the Serial Number (as shown on the manufacturers identification plate) or for Spares the order reference under which the goods were supplied.

Our judgement in all cases of claims shall be final and conclusive and the claimant shall accept our decision on all questions as to defects and the exchange of a part or parts.

Our liability shall be fully discharged by either repair or replacement as above, and in any event shall not exceed the current list price of the defective goods.

Our liability under this clause shall be in lieu of any warranty or condition implied by law as to the quality or fitness for any particular purpose of the goods, and save as expressly provided in this clause we shall not be under any liability, whether in contract, tort or otherwise, in respect of defects in goods delivered or for any injury, damages or loss resulting from such defects or from any work undone in connection therewith.

*		-	
MACHINE SERIAL NU	JMBER		

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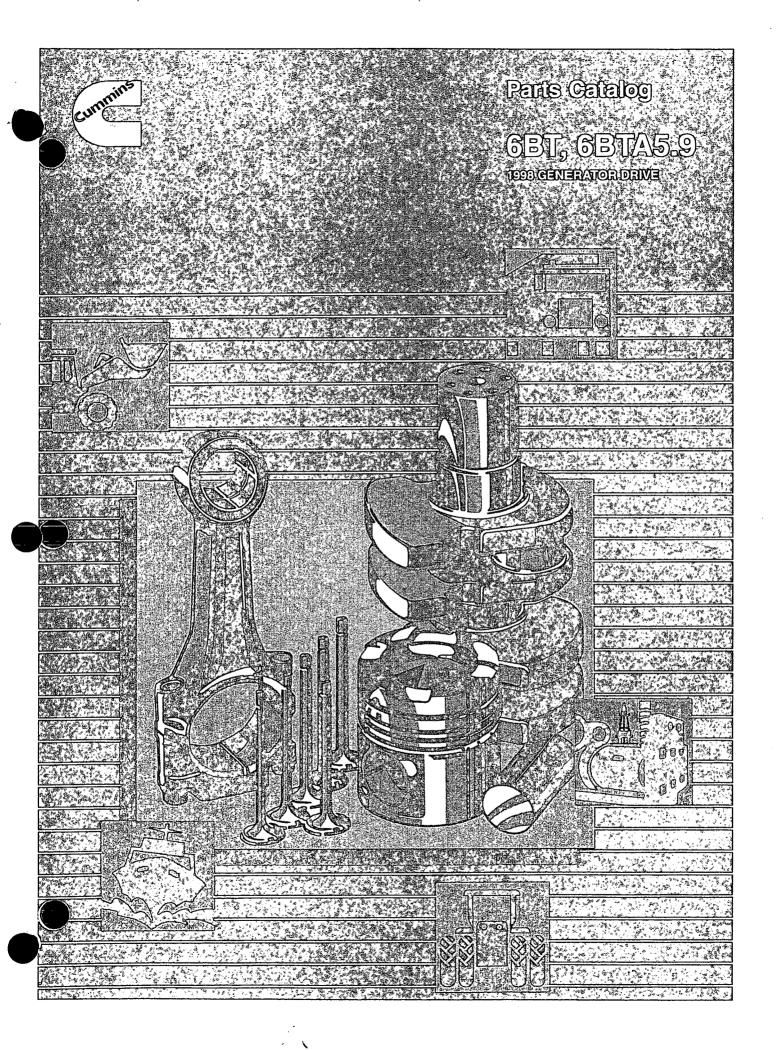
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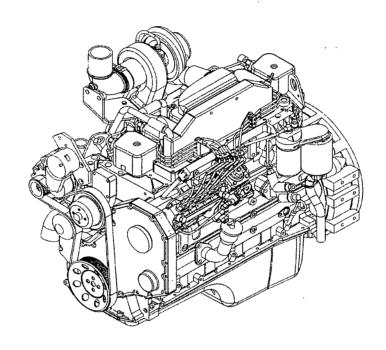


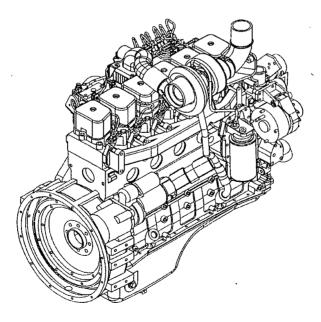


Parts Catalog

6BT, 6BTA5.9

1998 Generator Drive







Cummins Engine Co., Inc.

New Parts Warranty Midrange

COVERAGE

PRODUCTS WARRANTED

This warranty applies to New Parts marketed by Cummins for its A, B, and C Series engines. It applies anywhere in the world where service is available through a Cummins distributor or A, B, and C Series dealer.*

COVERAGE

This warranty covers any failures of parts on or after December 1, 1986, which result, under normal use and service, from defects in workmanship or material (Warrantable Failures). The coverage extends six months from the date of first installation.

This warranty continues to all subsequent Owners until the end of the period of coverage.

CUMMINS RESPONSIBILITIES

Cummins will pay for all parts and labor needed to repair the damage to the engine resulting from the Warrantable Failure. All labor costs will be paid in accordance with Cummins published Standard Repair Time quidelines.

Cummins will pay for the lubricating oil, antifreeze, filter elements, and other maintenance items that are not reusable due to the Warrantable Failure.

Cummins will pay reasonable labor costs for engine removal and reinstallation when necessary to make the warranty repair.

OWNER RESPONSIBILITIES

At the time when the parts are installed, Owner is responsible for the preparation of a written record containing the following: (1) the date of installation of the parts; (2) the engine serial number; (3) the engine miles, hours or kilometers of operation; (4) the parts installed, and (5) the location of the parts in the engine. The purpose of this record is to protect Owner's interests and support any claim for a Warrantable Failure.

Owner is responsible for the operation and maintenance of the engine as specified in Cummins Operation and Maintenance Manuals.

Before expiration of the warranty, Owner must give notice to a Cummins distributor or A, B, and C Series dealer* of a failure considered to be warrantable and deliver the engine to such facility for repair.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during warranty repairs except where such items are not reusable due to a Warrantable Failure.

Owner is responsible for communication expenses, meals, lodging and similar costs incurred by Owner as a result of a Warrantable Failure. Owner is responsible for non-engine repairs and for "downtime" expenses, cargo damage and all business costs and losses resulting from a Warrantable Failure. CUMMINS IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

(In the United States, some states do not allow the exclusion or limitation of incidental or consequential damages relating to Consumer Products, so the above limitation or exclusion may not apply to you.)

LIMITATIONS

Cummins is not responsible for failures resulting from Owner or Operator abuse or neglect, such as: operation without adequate coolant or lubricants; overfueling; overspeeding; lack of maintenance of lubricating, cooling or air intake systems; improper storage, starting, warm-up, run-in or shutdown practices. Cummins is also not responsible for failures caused by incorrect fuel, or by water, dirt or other contaminants in the fuel.

Except for fuel pumps, Cummins does not warrant parts supplied by Cummins which bear the name of another company. These parts are warranted by their manufacturers and not by Cummins. This category of parts includes, but is not limited to: hydraulic pumps, alternators, starters, fans, air conditioning compressors, clutches, filters, transmissions, torque converters, marine gears, air cleaners and non-Cummins air compressors, engine compression brakes, and steering pumps.

Parts used in warranty repairs may be new Cummins, Cummins approved rebuilt parts, or repaired parts. Cummins is not responsible for failures resulting from the use of parts not approved by Cummins.

Before a claim for excessive oil consumption will be considered, Owner must submit adequate documentation to show that consumption exceeds Cummins published standards.

This warranty does not apply to parts furnished by Cummins at no charge to the Owner.

THIS WARRANTY IS THE SOLE WARRANTY MADE BY CUMMINS IN REGARD TO THESE PARTS. CUMMINS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.



Page ii

Product Identification Information

Data plates should be referred for parts identification.

1. ENGINE DATA PLATE

Curnent	Cummins Engine Company, Inc. Columbus, Indiana	Engine Cert. I.D.	C.I.D./L. Pouce Cube/L	Family Famille	CPL	Model Modele	FEL	EPA	CARB
C.	47202-3005 Made in U.S.A. 3920701	Certificat d'Identite				Injector P/N Injecteur P/N	NDX		
	WARNING: Injury may result and warranty is voided if their rate rpm or altitudes exceed published maximum values for this model and application. AMERITISSEMENT: Danger do bessures et d'annulation de le garantie et defoit de combustible trimin ou atilitude dépassant les voieurs maximum announce'es pour ce modele et son utilisation.		н.			Engine No. Moteur No.	РМ		
AVERT			d Froid	Int. Adm.	Exh. Ech.	Ref. No.			
						Fuel rate at adv. HP			mm ³
pour ce me			age			De'bit combust, a puiss, indic	quee		stroke
Date of Mk	1.	idle Speed (rp	om) E	.c.s.		Advertised HP	at		rpm
Date of Fat		Vitesse Rolen	ti			Puiss. Indiquee (ch)	8		.,

2. FUEL PUMP DATA PLATE



BOS	SCH
16/RSV425 1100A0C CDC-NO 390 6541	2190-8R
Made in USA	927

RATED SPEED	
CONV. DATE	
CDC NO.	
SPEC. NO.	

This catalog was compiled by Rita Wheeler in Parts Communications.

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Customer Service Information

This standard Parts Catalog contains parts information for the following Cummins Engine Model(s):

6BT

D402049DX02

CPL 2372

6BTA

D403050DX02

CPL 2373

Certain basic engine components have been matched to give optimum performance to your engine. The part numbers listed in this catalog for these components are for a standard engine configuration. When ordering any of the Control Parts List (CPL) components listed below, please order by part description and engine serial number. Reference to the CPL number stamped on the engine data (name) plate will also help identify the proper service parts for your engine.

Control Parts List (CPL) Components

Injector Camshaft Cylinder Head Pump, Injector

Page 111, 117 Page 109, 115 Page 118-121

Exhaust Manifold Engine Piston Turbocharger

Page 141 Page 107, 113 Page 125-127

Page 67-69

USER INFORMATION

- . Parts numbers appearing in () are for identification purposes only and should not be used when ordering service replacement parts.
- . The reference numbers appearing on the art pages is for publication use only.
- . Assembly content is shown by part number indentation.
- . Options are engineered production part groupings, specifically used for compiling engine orders.
- . Option numbers are for reference only and are not sold for service.
- . Use assembly and not option content to determine service parts replacement.

ALWAYS SPECIFY ENGINE MODEL AND SERIAL NUMBER WHEN ORDERING PARTS FROM THIS CATALOG

Engine Model	Engine Serial No	
MFG Make	Model	Chassis No.
Fuel Pump Assembly No.	Injector No.	
Belt, Fan	Belt, Water Pump	Belt, Gen.
Element, Fuel Filter	Full Flow Lub. Filter	
Air Cleaner	By-Pass Lub. Filter	
Special Equipment		
-		

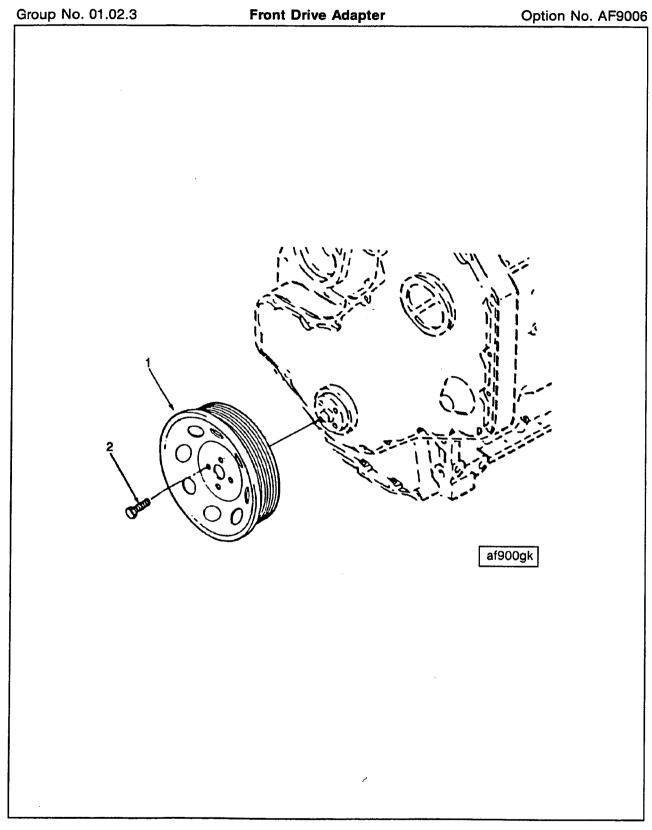
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Water Pump	155
Option Number Index	. A-1

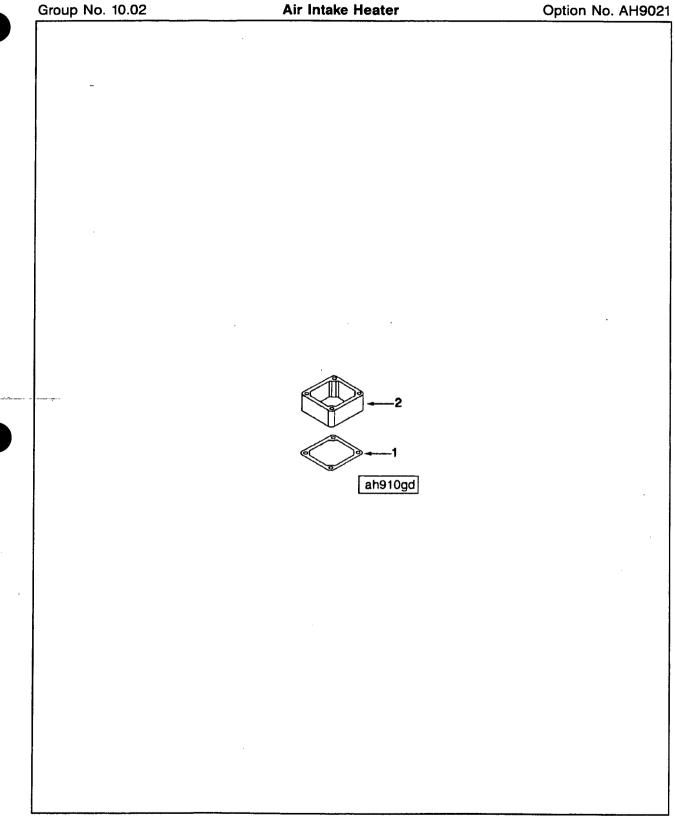
Page 1



Page 2

	up No. 01.02.3	Front Drive Adapter				Option No. AF90
Ref No.	Part Number	Part Name	Req	Remarks		
		FRONT DRIVE ADAPTER				
		OPTION AF9006		Front Drive Adapter		
				Engine Family: B Series Adaptable To PTO: No Pulley Type: 8 Groove Torque Limit (LBS.FT.): 210 Location From FFOB (MM): 93.32 Pulley Effective Diameter (MM): 173.76 Attachment Provision: Mounted Structure Code: 02 EBM Restricted Cylinders: 4		
1	3914494	Pulley, Crankshaft	1			
2	3903857	Screw, Hex Flange Head Cap	4	M12 x 1.25 x 36		

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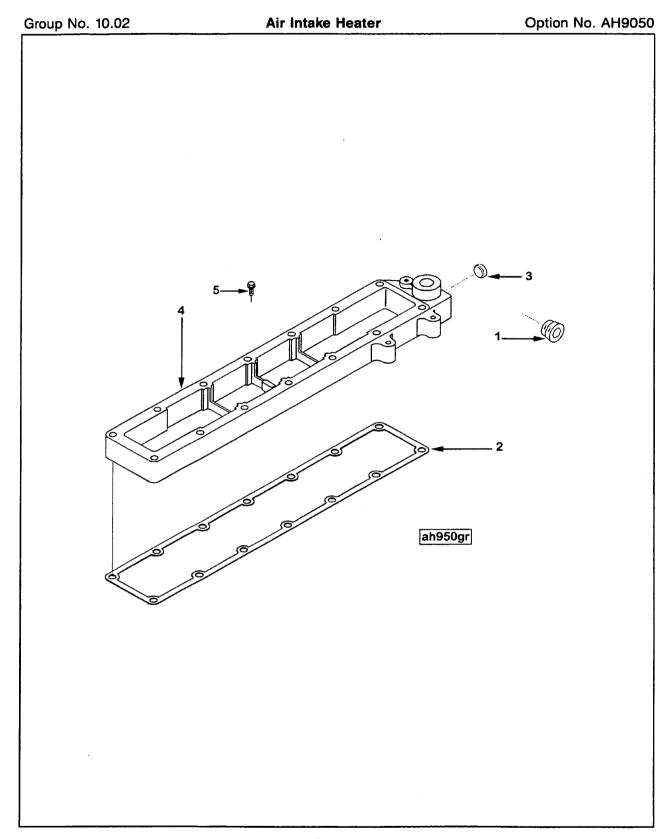
Group No. 10.02

Air Intake Heater

Option No. AH9021

	up No. 10.02	10.02 Air Intake Heater Option No. A		Option No. AH902
Ref No.	Part Number	Part Name	Req	Remarks
		AIR INTAKE HEATER		
		OPTION AH9021		Grid Air Heater
1	3931604	Gasket, Connection	1	Engine Family: B Series Component Provided: Spacer Heater/Spacer Thickness (MM): 41.1 Structure Language: 02 EBM Engine Aspiration: Charge Air Cooled Naturally Aspirated Turbocharged
2	3922484	Connection, Spacer	1	
	Ì			

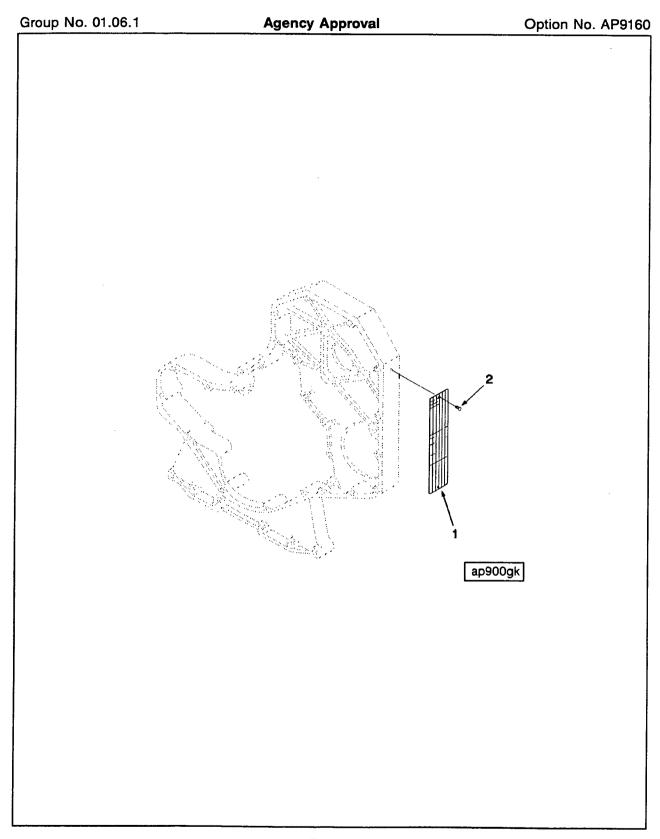
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Grou	p No. 10.02	Air Intake Heater		Option No. AH9050	
Ref No.	Part Number	Part Name	Req	Remarks	
140.	:	AIR INTAKE HEATER OPTION AH9050		Grid Air Heater Engine Family: B Series Component Provided: Spacer Controls Provided: No	
1 2 3 4 5	3008468 3931347 3900956 (3927991) 3913638	Plug, Pipe Gasket, Int Manifold Cover Plug, Expansion Connection, Spacer Screw, Hex Flange Head Cap	1 1 2 1	Unique Characteristics: 1/2 In. CI Connection At Rear Of Spacer Structure Language: 02 EBM Engine Aspiration: Jacket Water Aftercooled Terminal Orientation: 6 Cylinder - Rear 3/4 NPT M6 x 1.00 x 16	

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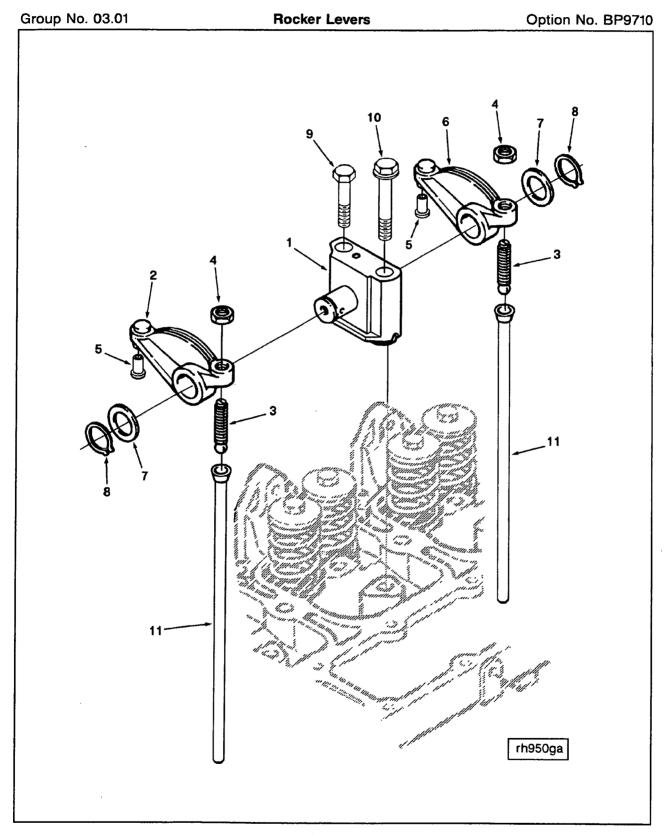


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Group No. 01.06.1

Agency Approval

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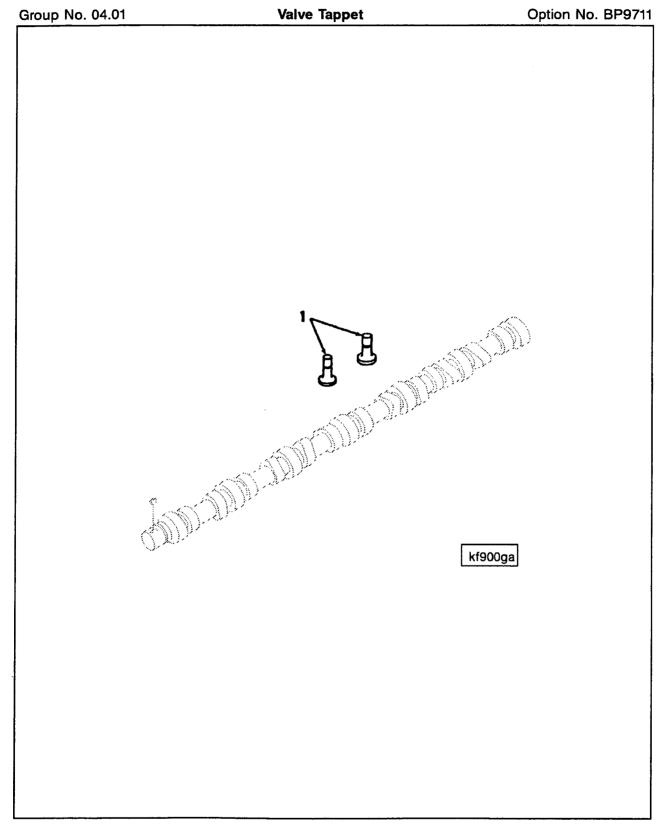
Page 10

Group No. 03.01

Rocker Levers

aroup No. 03.01	10. U3.U1 HOCKER Levers		Option No. BP97	
Ref No. Part Number	ber Part Name	Req	Remarks	
Ref D. N. Lee				

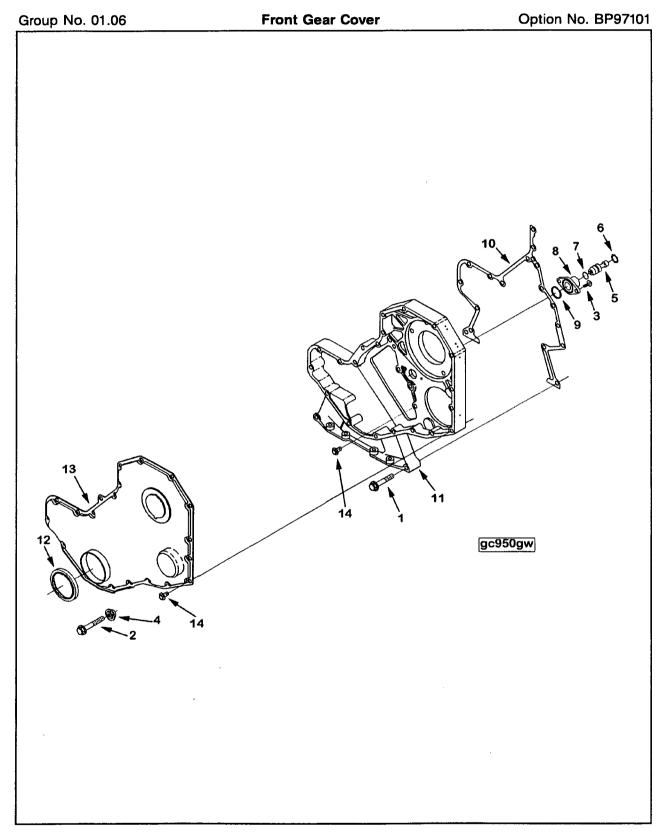
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Group No. 04.01		Valve Tappet		Option No. BP97	
ef o.	Part Number	Part Name	Req	Remarks	
		VALVE TAPPET			
		OPTION BP9711		Camfollower Cover	
				Engine Family: B Series Cylinders: 6 Structure Code: 02 EBM	
	0001000	Toward Walls		Structure Code: 02 EBM	
1	3931623	Tappet, Valve	12		
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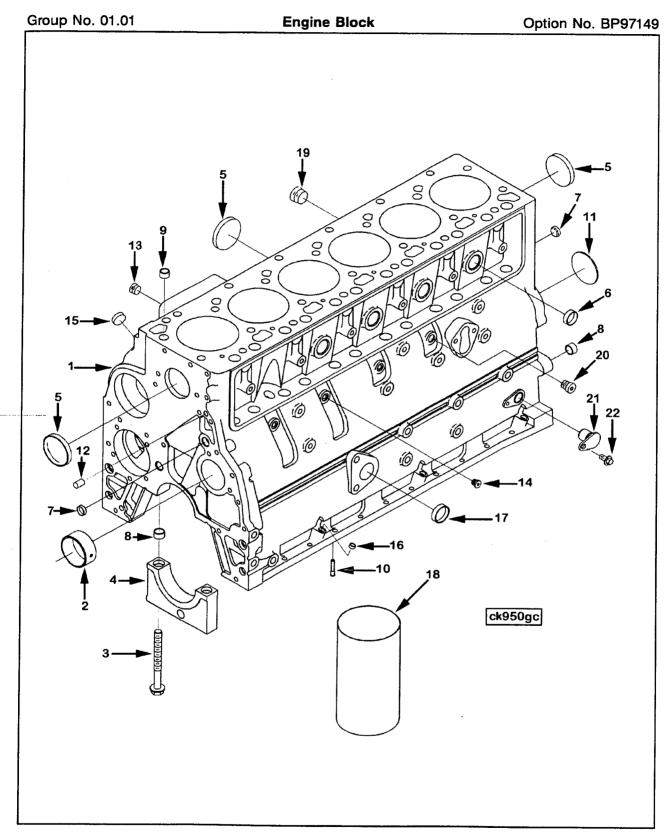
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Front Gear Cover

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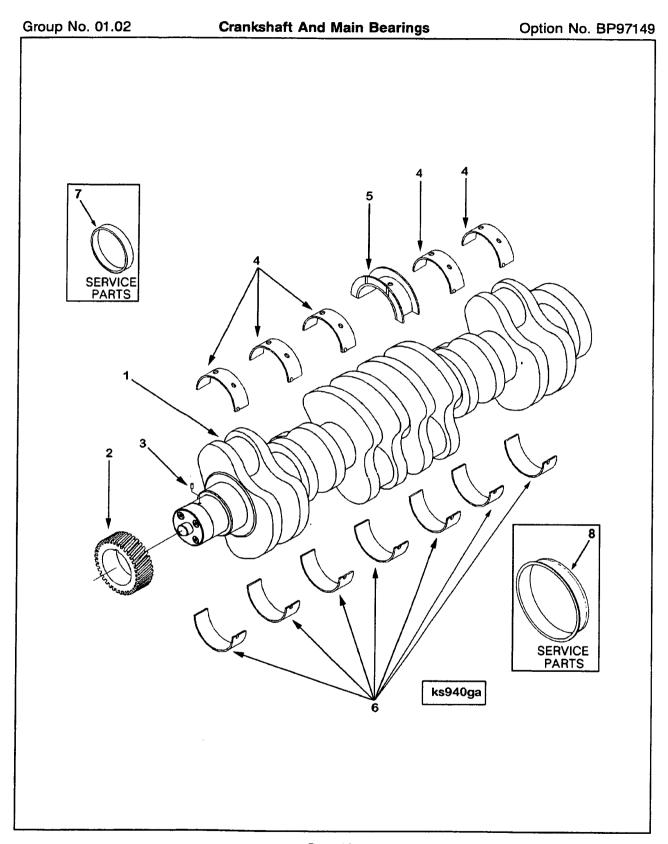
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Group No. 01.01

Engine Block

Group No. 01.01		Engine Block		Option No. BP971	
Ref No.	Part Number	Part Name	Req	Remarks	
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 8 16 17 19 20 21 22	3802997 (3942162) 3940059 3927948 (3900967) (3900965) (3914035) 3900956 3900068 3933220 3902343 3930139 3900687 3900257 3008468 3678923 3920706 3900955 3900955 3900955 3900958 3008469 3678921 3932296 3900629	Block, Cylinder Block, Cylinder Block, Cylinder Block, Cylinder Bushing Screw, Hexagon Head Cap Cap, Main Bearing Plug, Expansion Plug, Expansion Plug, Expansion Plug, Expansion Dowel, Ring Kit, Block Hardware Dowel, Ring Nozzle, Piston Cooling Plug, Expansion Dowel, Pin Plug, Pipe Plug, Threaded Plug, Expansion Dowel, Ring Plug, Expansion Dowel, Ring Plug, Expansion Dowel, Ring Plug, Threaded Plug, Expansion Plug, Expansion Plug, Expansion Plug, Expansion Plug, Threaded Plug, Threaded Plug, O Ring Screw, Hex Flange Head Cap	1 1 16 7 5 4 3 14 1 2 6 1 2 1 3 1 2 3 1 1 1 1 1 1	Cylinder Block Engine: B Series Cylinders: 6 Aspiration: Turbocharged Turbo Exh. Outlet Location: HMFO HMRO Turbo Drain Orientation: 12:00 Fuel Type: Diesel Premium Block: Yes Tapped Fittings: STORM Structural Block: No Expansion plug 3007635 may be used in Brazil applications in place of 3914035. For use with Encore block in place of BP9786. CNS may use painted or unpainted blocks. M12 x 1.50 x 119 1/2 NPTF M10 x 1.0 3/4 NPTF M14 x 1.5 M8 x 1.25 x 16	
2 2 4 18	3904369 3903242 (3900967) 3904166	Bushing Bushing Cap, Main Bearing Sleeve, Salvage	A/R A/R 7 A/R	Oversize bushing for No. 1 bore Oversize bushing for No. 2-5 bore	

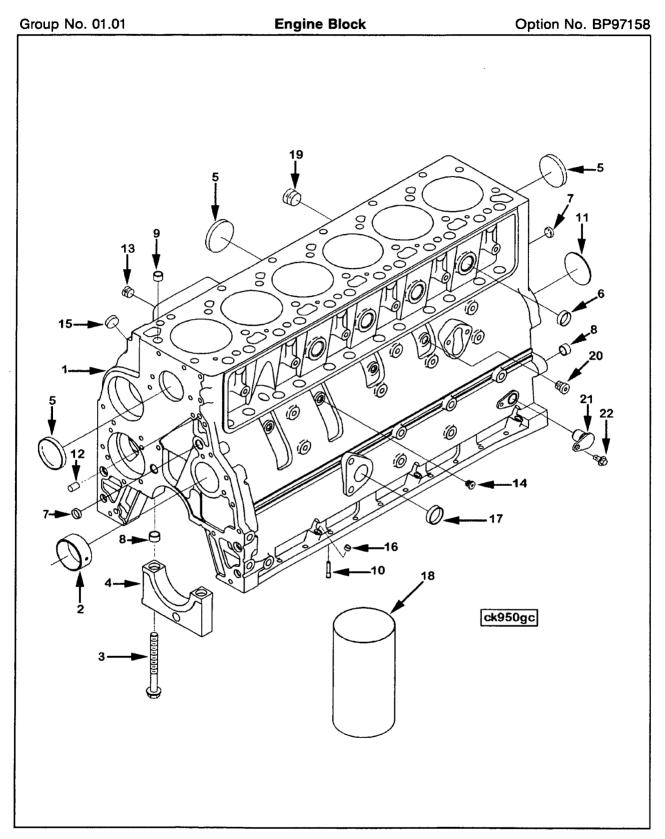
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Page 18

Group No. 01.02 Crankshaft And Main Bearings Option No. BP97149 Ref Part Number **Part Name** Req Remarks No. **CRANKSHAFT OPTION BP97149** 3908032 Crankshaft, Assembly (3929037)Crankshaft, Engine 1 Gear, Crankshaft 3929027 2 1 3 3904483 Dowel, Pin 1 **MAIN BEARING SETS** 3802070 Set, Main Brg (std) Standard Bearing, Main (3929016)6 Bearing, Crankshaft Thrust (3926723)5 7 6 (3929021) Bearing, Main 3802071 Set, Main Brg (.010) 0.25mm Oversize (3929017)Bearing, Main 6 Bearing, Crankshaft Thrust Bearing, Main (3283065) 5 7 (3929022)6 3802072 Set, Main Brg (.020) 0.50mm Oversize (3929018)Bearing, Main 6 (3283066)Bearing, Crankshaft Thrust 5 Bearing, Main 7 (3929023)6 3802073 Set, Main Brg (.030) 0.75mm Oversize (3929019)Bearing, Main 6 (3283067)Bearing, Crankshaft Thrust 5 Bearing, Main 7 (3929024)6 3802074 Set, Main Brg (.040) 1.00mm Oversize (3929020) Bearing, Main 6 (3283068)Bearing, Crankshaft Thrust 5 (3929025)Bearing, Main 7 6 Bearing, Crankshaft Thrust 3800330 .5mm Oversize Bore/.5mm Oversize Thrust 1 Bearing, Crankshaft Thrust (3283063) 5 1 6 (3929023) Bearing, Main 1 Bearing, Crankshaft Thrust Bearing, Crankshaft Thrust 3800331 1.0mm Oversize Bore/1.0mm Oversize Thrust (3283064) 5 Bearing, Main (3929025) 6 1 **SERVICE PARTS** 3802820 Kit, Seal 1 Front 3926126 Kit, Seal Rear 8

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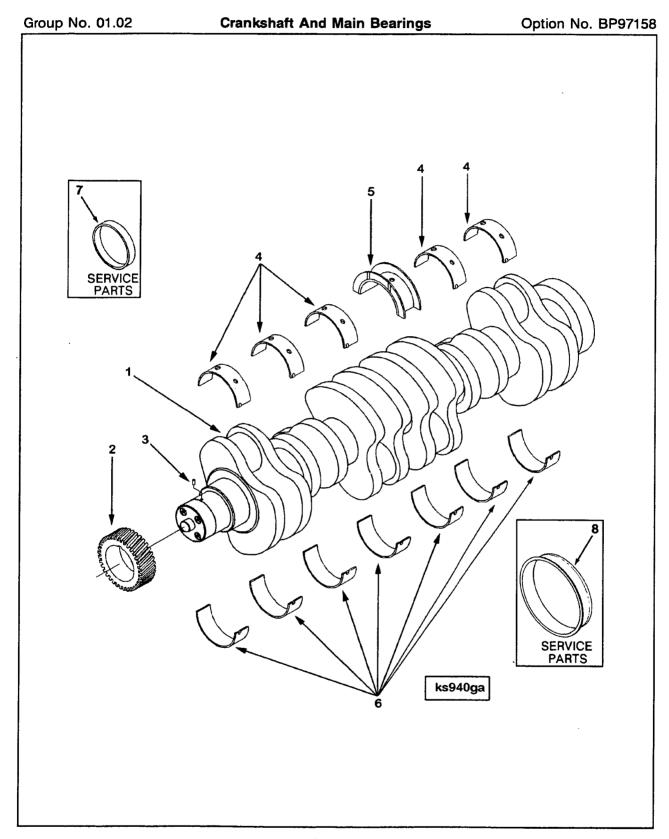
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Group No. 01.01

Engine Block

aroup No. 01.01		Engine Block		Option No. BP97	
Ref No. Part N	lumber	Part Name	Req	Remarks	
3802997 1 (394216 2 39400 3 39279 4 (39009 5 (39009 6 (39140 7 39009 3 393322 9 39023 10 39301 11 39006 12 39002 13 30084 14 36789 15 39207 8 39000 16 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 17 39009 18 300844 20 36789 21 39322 22 39006	52) 59 48 167) 165) 335) 56 68 0 43 39 87 57 68 82 30 66 68 55 55 58 59 21	Block, Cylinder Block, Cylinder Block, Cylinder Block, Cylinder Bushing Screw, Hexagon Head Cap Cap, Main Bearing Plug, Expansion Plug, Expansion Plug, Expansion Dowel, Ring Kit, Block Hardware Dowel, Ring Nozzle, Piston Cooling Plug, Expansion Dowel, Pin Plug, Pipe Plug, Threaded Plug, Expansion Dowel, Ring Plug, Expansion Dowel, Ring Plug, Expansion Dowel, Pipe Plug, Threaded Plug, Expansion Plug, Expansion Plug, Expansion Plug, Expansion Plug, Expansion Plug, Expansion Plug, Expansion Plug, Fipe Plug, Threaded Plug, O Ring Screw, Hex Flange Head Cap	1 1 1 1 6 7 5 4 3 4 1 2 6 1 2 1 3 1 2 3 1 1 1 1 1 1	Cylinder Block Engine: B Series Cylinders: 6 Aspiration: Jacket Water Aftercooled Fuel Type: Diesel Premium Block: Yes Tapped Fittings: STORM Structural Block: No Restricted Fuel Pump Mfg/ Model: Bosch A Bosch P3000 Bosch P7100 Expansion plug 3007635 may be used in place of 3910435. For use with Encore block in place of BP9863. CNS may use painted or unpainted blocks. M12 x 1.50 x 119 1/2 NPTF M10 x 1.0 3/4 NPTF M14 x 1.5 M8 x 1.25 x 16	
2 3904369 2 3903242 4 (3900967 18 3904166		SERVICE PARTS Bushing Bushing Cap, Main Bearing Sleeve, Salvage	A/R A/R 7 A/R	Oversize bushing for No. 1 bore Oversize bushing for No. 2-5 bore	

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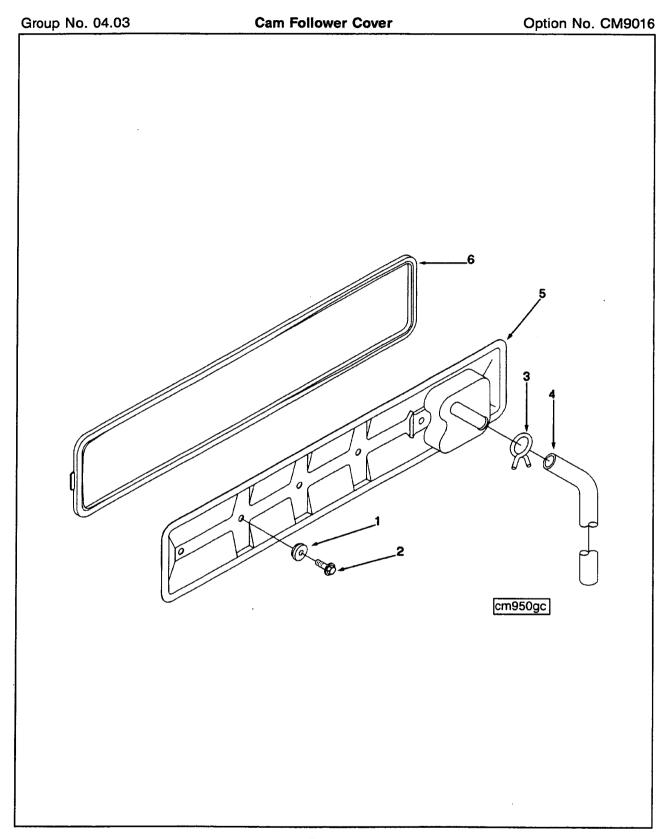
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Group No. 01.02

Crankshaft And Main Bearings

Group No. 01.02		Crankshaft And Main Bearings		s Option No. BP97158	
Ref No.	Part Number	Part Name	Req	Remarks	
		CRANKSHAFT OPTION BP97158			
1 2 3	3908032 (3929037) 3929027 3904483	Crankshaft, Assembly Crankshaft, Engine Gear, Crankshaft Dowel, Pin	1 1 1		
4 5 6	3802070 (3929016) (3926723) (3929021)	MAIN BEARING SETS Set, Main Brg (std) Bearing, Main Bearing, Crankshaft Thrust Bearing, Main	1 6 1 7	Standard	
4 5 6	3802071 (3929017) (3283065) (3929022)	Set, Main Brg (.010) Bearing, Main Bearing, Crankshaft Thrust Bearing, Main	1 6 1 7	0.25mm Oversize	
4 5 6	3802072 (3929018) (3283066) (3929023)	Set, Main Brg (.020) Bearing, Main Bearing, Crankshaft Thrust Bearing, Main	1 6 1 7	0.50mm Oversize	
4 5 6	3802073 (3929019) (3283067) (3929024)	Set, Main Brg (.030) Bearing, Main Bearing, Crankshaft Thrust Bearing, Main	1 6 1 7	0.75mm Oversize	
4 5 6	3802074 (3929020) (3283068) (3929025)	Set, Main Brg (.040) Bearing, Main Bearing, Crankshaft Thrust Bearing, Main	1 6 1 7	1.00mm Oversize	
5 6	3800330 (3283063) (3929023)	Bearing, Crankshaft Thrust Bearing, Crankshaft Thrust Bearing, Main	1 1 1	.5mm Oversize Bore/.5mm Oversize Thrust	
5 6	3800331 (3283064) (3929025)	Bearing, Crankshaft Thrust Bearing, Crankshaft Thrust Bearing, Main	1 1	1.0mm Oversize Bore/1.0mm Oversize Thrust	
7 8	3802820 3926126	SERVICE PARTS Kit, Seal Kit, Seal	1	Front Rear	
		·			

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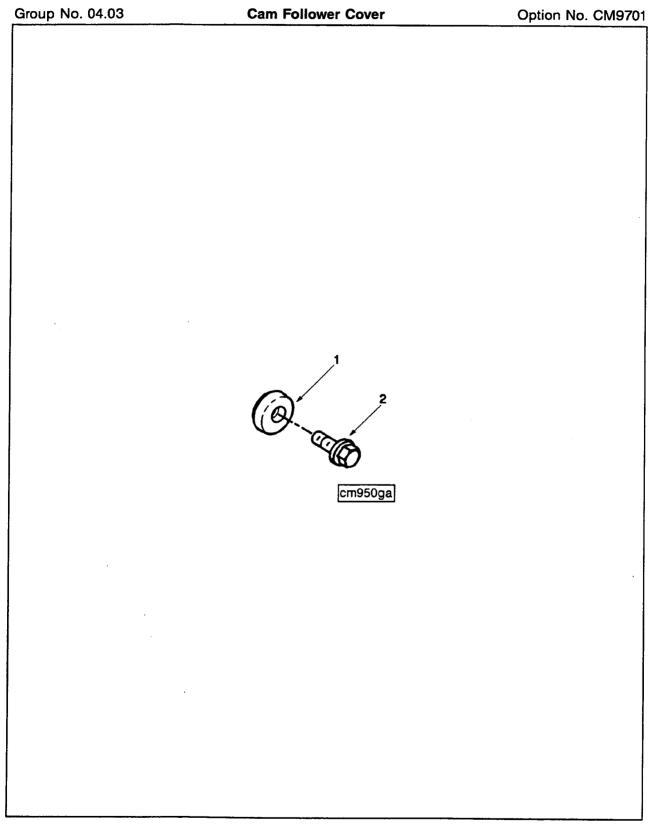
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Cam Follower Cover

Option No. CM9016

Gro	up No. 04.03	Cam Follower Co	ver	Option No. CM9016
Ref No.	Part Number	Part Name	Req	Remarks
Ref		i	T	
	3928832	Gasket, Push Rod Cover	1	

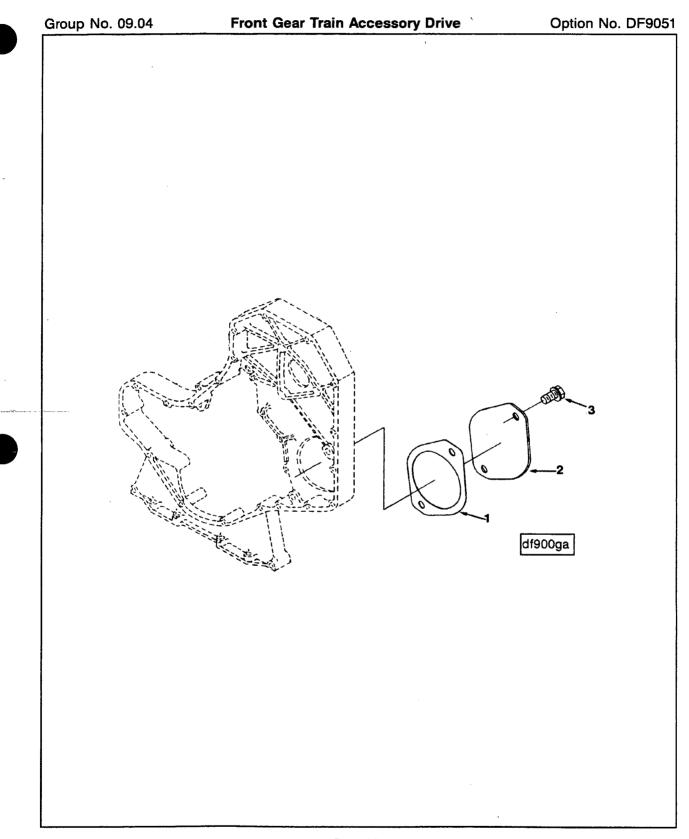
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Gro	up No. 04.03	Cam Follower Cov	er	Option No. CM9701
Ref No.	Part Number	Part Name	Req	Remarks
		CAM FOLLOWER COVER OPTION CM9701		Cam Follower Cover Mounting Structure Code: 02 EBM Fuel Type: Diesel For Inline Fuel Pumps
1 2	3928759 3900629	Seal, Grommet Screw, Hex Flange Head Cap	2 2	M8 x 1.25 x 16
			:	

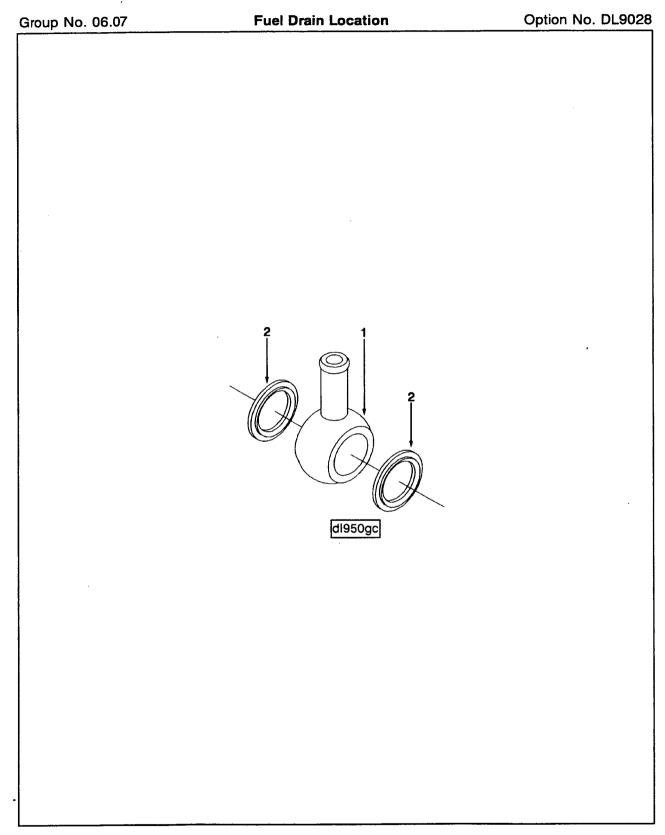
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Front Gear Train Accessory Drive Group No. 09.04 Option No. DF9051 Ref No. **Part Number Part Name** Req Remarks FRONT GEAR TRAIN ACCESSORY **OPTION DF9051** Front Gear Train Accessory Drive Cover Plate Provided: Yes Engine Family: **B** Series To be selected when there is no air compressor, raw water pump or gear driven vacuum pump selected. 3929751 Gasket, Acc Drive Cover 3914868 Plate, Cover 2 Screw, Hex Flange Head Cap 3901249 3 2 M12 x 1.75 x 25

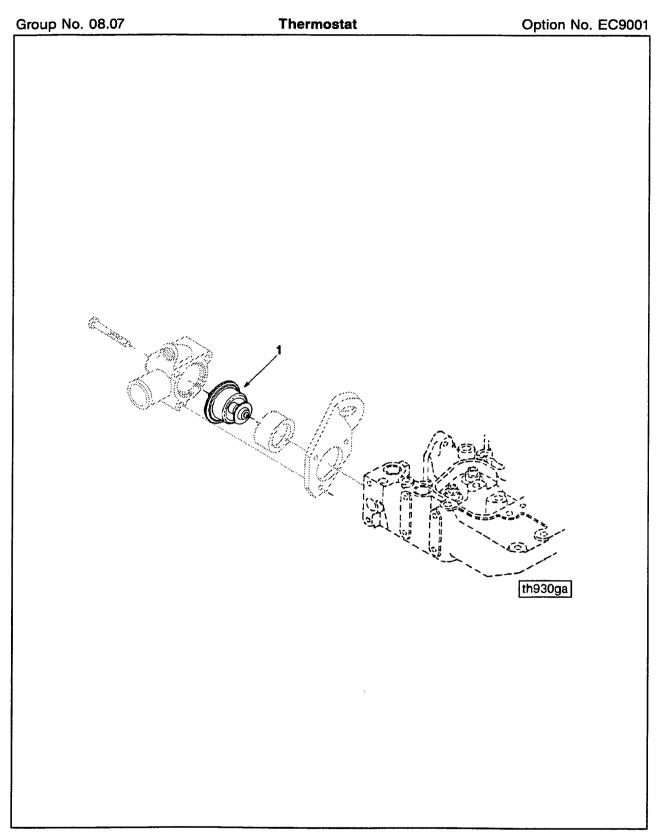
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Group No. 06.07 **Fuel Drain Location** Option No. DL9028 Ref Req Part Number **Part Name** Remarks No. **FUEL DRAIN LOCATION OPTION DL9028 Drain Location** Drain Tube OD (MM): 7.90 Connection Type: Filter Head Customer Connect Location: Fuel Pump -Outboard Engine Family: B Series Restricted Fuel Pump Mfg/Model: Bosch A Bosch MW Nippondenso EP-9 Zexel Hyrid A Attaches to outboard side of pump. BZL may use 3355095 in place of 3911447. 3911447 Connector, Banjo 2 3918192 Washer, Sealing 2 M6 x 1.00 x 12

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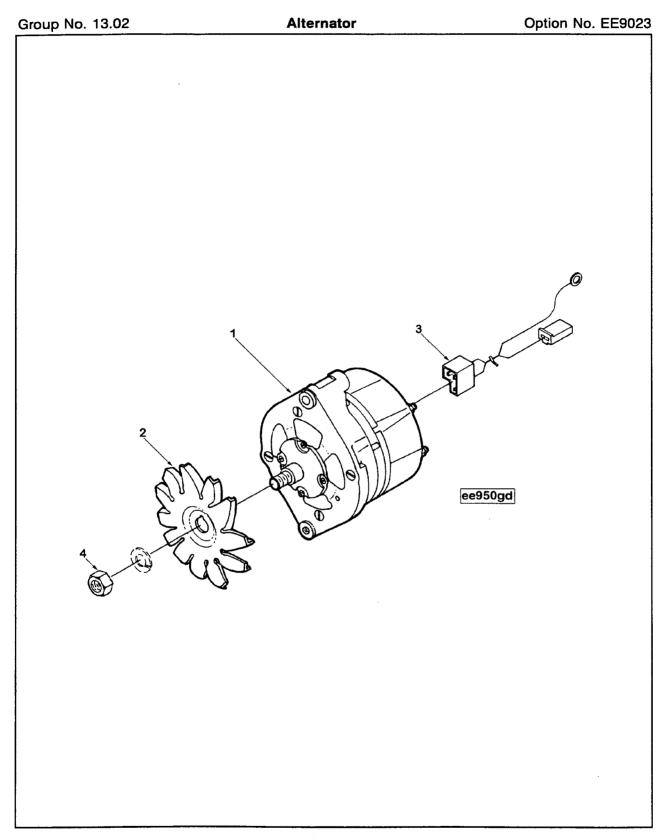
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Thermostat

Option No. EC9001

	up No. 08.07	Thermostat		Option No. EC9001
Ref No.	Part Number	Part Name	Req	Remarks
		THERMOSTAT OPTION EC9001		Thermostat
4	3802968 3283589 3920336 3923331	Kit, Thermostat Thermostat Thermostat Template Gasket, Thm Housing Cover	1 1 1 1 1	Thermostat Opening Temp: 83 Deg C Number of Thermostats: 1 Vented Thermostat: Yes Vented Type: Jiggle Pin Soft-Seat Style Thermostat Includes Gasket

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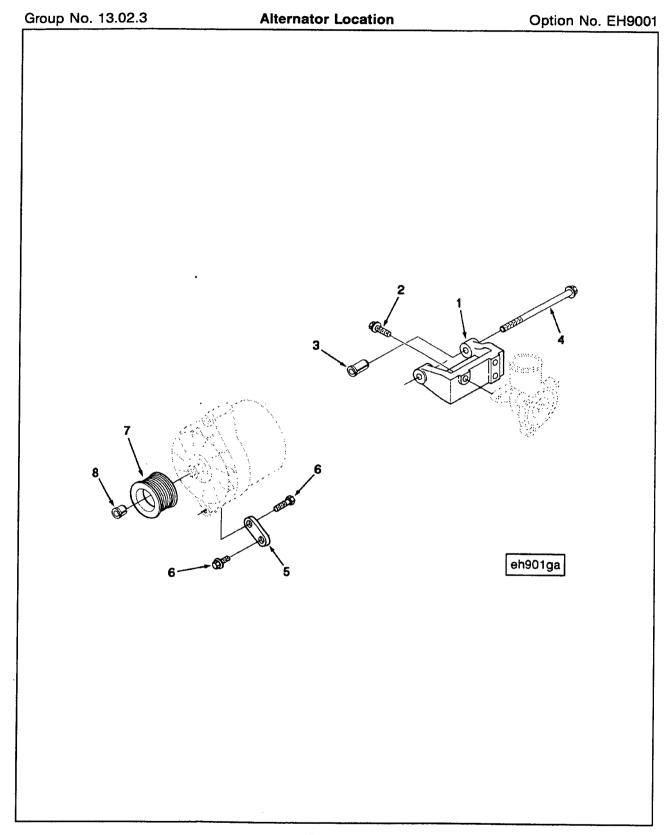
Group No. 13.02

Alternator

Option No. EE9023

	up No. 13.02	Alternator		Option No. LEGOZO
Ref No.	Part Number	Part Name	Req	Remarks
1 2 3 4	3920679 3904981 3920831 3282074	Part Name ALTERNATOR OPTION EE9023 Alternator Fan, Alternator Harness, Wiring Nut, Hexagon Flange	1 1 1 1	Alternator Alternator Manufacturer/Model: Bosch K-1 Voltage: 12 Amperage: 63 Functions W/Horizontal Oil Filter: Yes Alternator Manufacturer/Model: Bosch K-1 1 Voltage: 12 Amperage: 63 Functions W/Horizontal Oil Filter: Yes C Series

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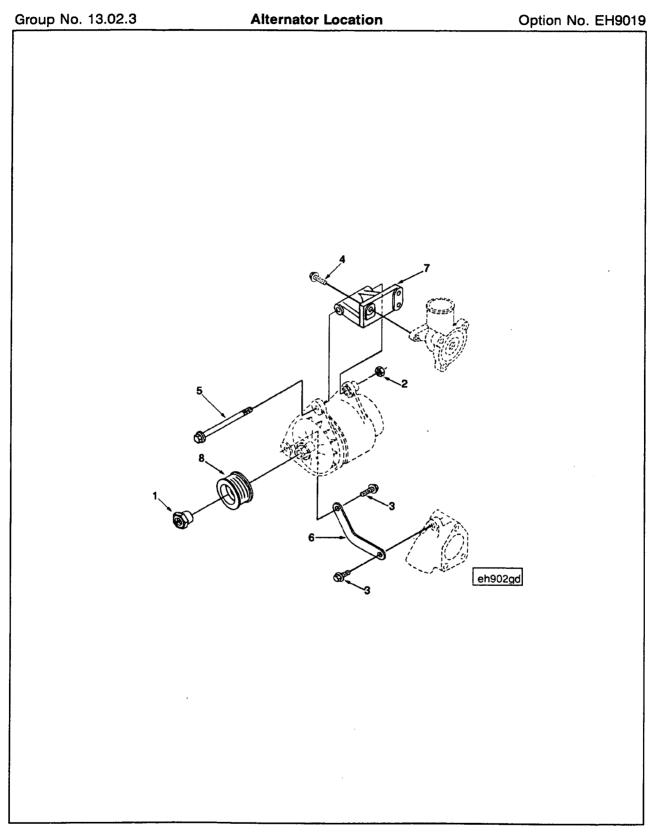
Group No. 13.02.3

Alternator Location

Option No. EH9001

Part Number Part Name Req Remarks
Alternator Location Pulley Retainer Provided: Yes Alternator Pulley Provided: Yes Alternator Pulley Provided: Yes Alternator Pulley Provided: Yes Drive Hardware Supplier: Cummins Alternator Drive Speed: 2.9 Alternator Mount Type: 2" Spool Structure Code: 02 EBM Damper Pulley Effective Diameter (MM): 173.76 Engine Family: B Series Alternator Manufacturer/Model: Bosch K-1 Required Water Pump Pulley Type: Hardened Standard 1 3923387 Support, Alternator 2 3900631 Screw, Hex Flange Head Cap 3 3910715 Spacer, Mounting 1 1 3908226 Screw, Hex Flange Head Cap 5 3903089 Brace, Alternator Screw, Hex Flange Head Cap 5 3903089 Brace, Alternator Screw, Hex Flange Head Cap 5 3903089 Grew, Hex Flange Head Cap 5 3903089 Grew, Hex Flange Head Cap 5 3900630 Alternator Location Pulley Retainer Provided: Yes Alternator Pulley Provided: Yes Alternator Dampier Structure Code: 02 EBM Damper Pulley Effective Diameter (MM): 173.76 Engine Family: B Series Alternator Manufacturer/Model: Bosch K-1 Required Water Pump Pulley Type: Hardened Standard 1 M8 x 1.25 x 25 M10 x 1.50 x 95 M10 x 1.25 x 20
8 3908563 Retainer, Pulley 1

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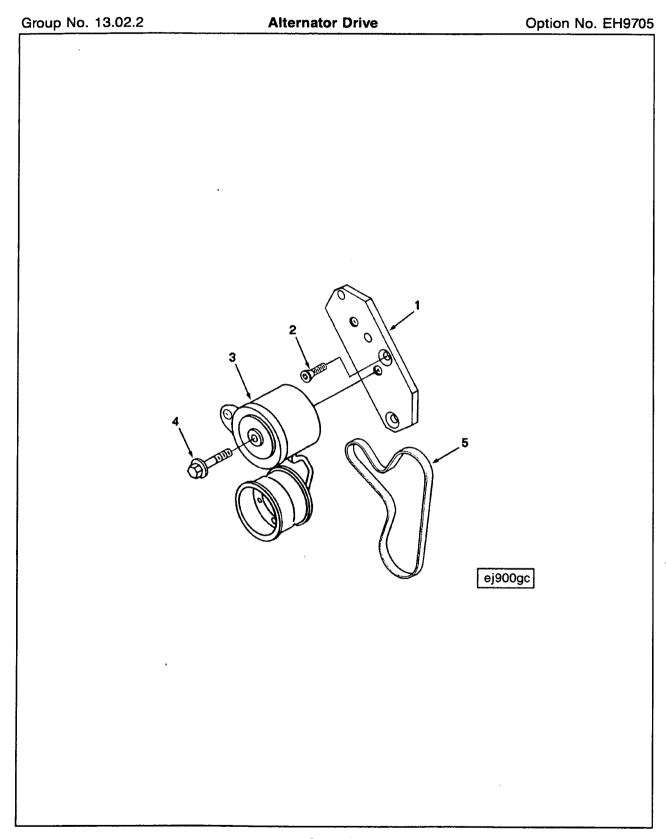
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Group No. 13.02.3

Alternator Location

Option No. EH9019

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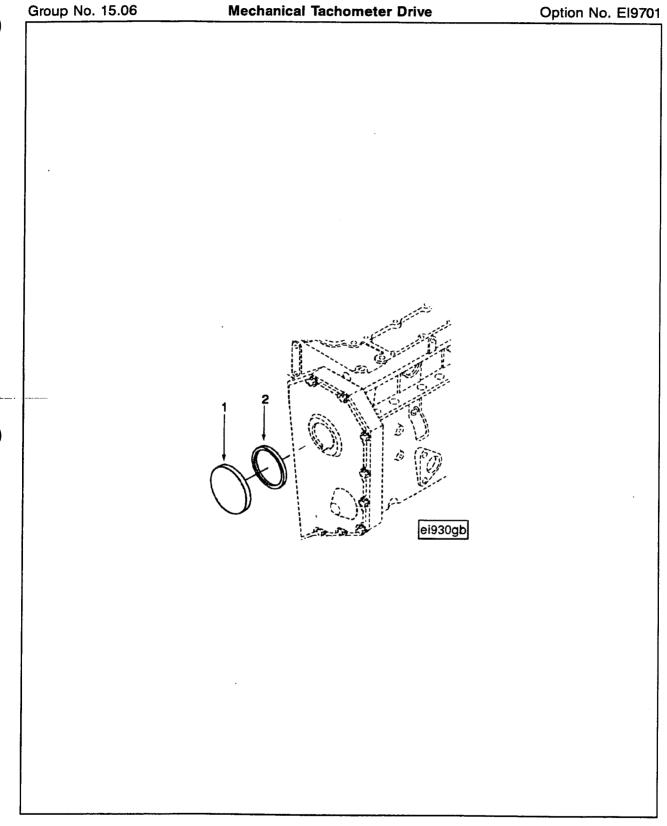
Group No. 13.02.2

Alternator Drive

Option No. EH9705

Group No. 13.02.	Alternator Driv	/e	Option No. EH9705
Ref Part Numbe	Part Name	Req	Remarks
3919736 2 3925186 3 3922900 4 3904446 5 3911560		T	

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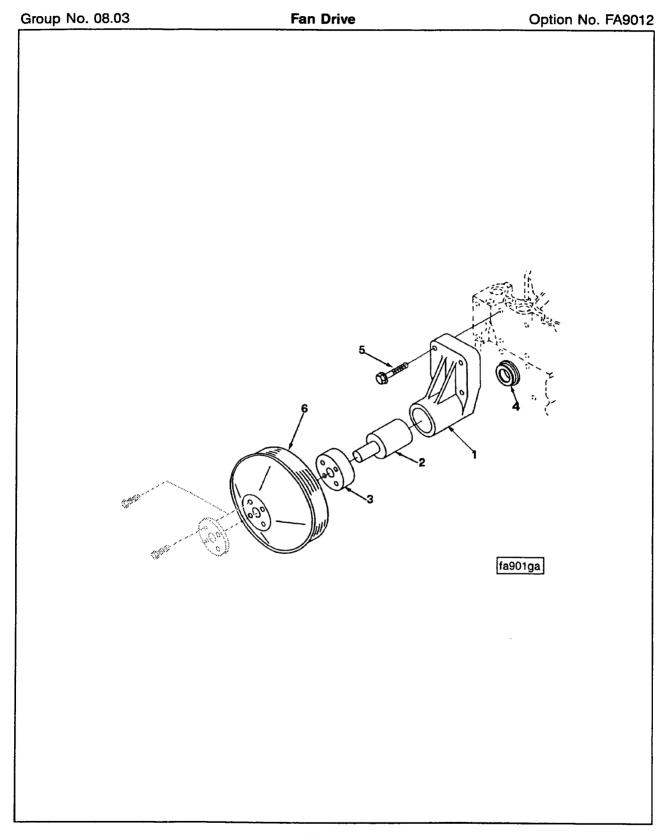
Group No. 15.06

Mechanical Tachometer Drive

Option No. El9701

Ref	Part Number	Part Name	Req	
No.		MECHANICAL TACHOMETER DRIV OPTION E19701		Mechanical Tach Drive Cover
				Mechanical Tach Drive Provision: No Structure Code: 02 EBM Oil Fill Location: Fuel Pump Side Exhaust Side Valve Cover None Engine Family: C Series B Series
1 2	3903463 3903475	Cover, Access Hole Seal, Rectangular Ring	1	
	:			
	:			

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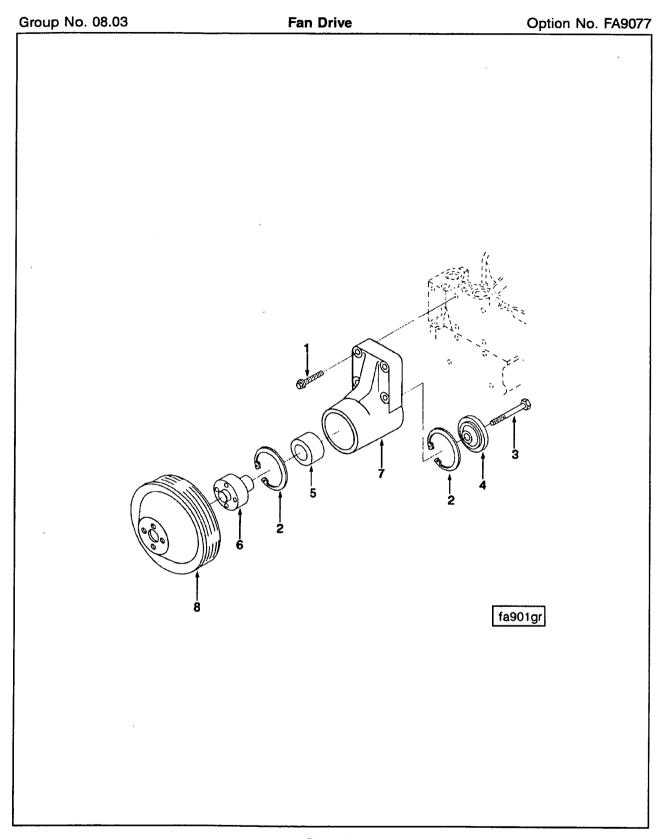


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Fan Drive

Group No. 08.03	Fan Drive)	Option No. FA901
Ref Part Number	Part Name	Req	Remarks
3909888 (3902348) (3908164) 3 (3901364) 3 3909887 5 3928873 6 3914458	Fan Drive Part Name FAN DRIVE OPTION FA9012 Support, Fan Support, Fan Shaft, Fan Drive Hub, Fan Retainer, Shaft Screw, Hex Flange Head Cap Pulley, Fan		Fan Drive Component Supplier: Cummins Fan Drive Ratio: 1.35:1 Mounting Bolt Circle (MM): 50 Engine Fan Center (MM): 292.0 (11.5 In) Horizontal Offset: 0.0 Fan Hub Pulley Material: Spun Steel Required Damper Pulley Diameter (MM): 173.76 Structure Code: 02 EBM Engine Family: B Series M8 x 1.25 x 40
	·		

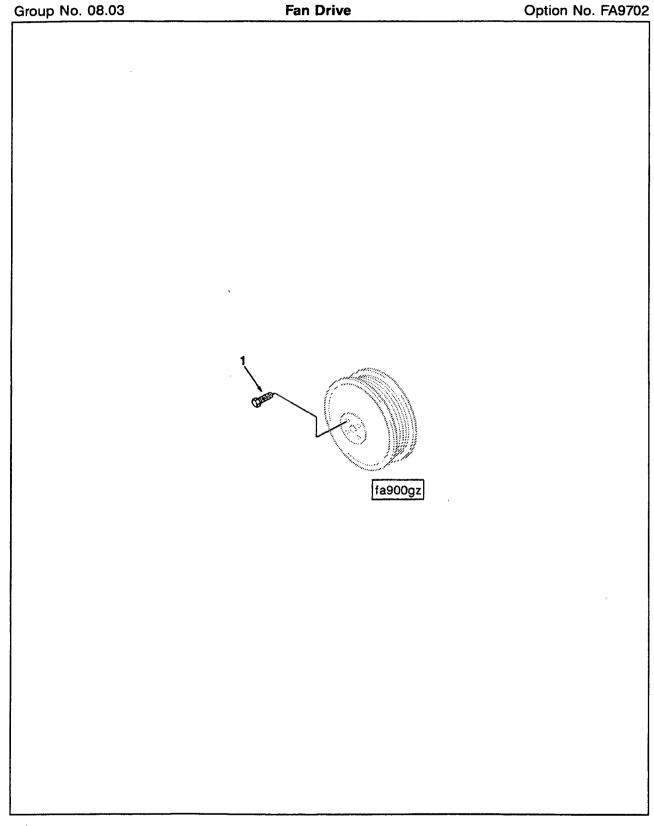
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Fan Drive

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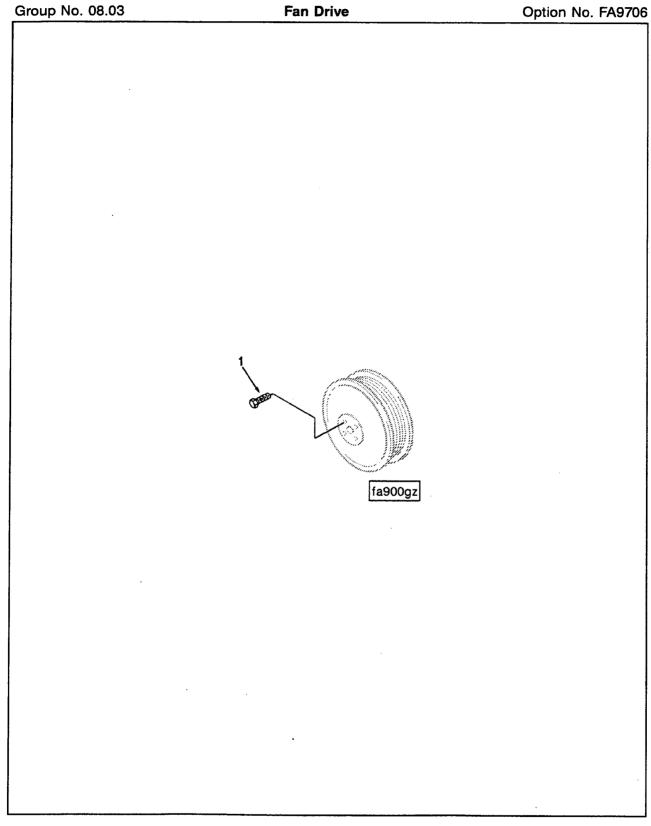


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Fan Drive

	up No. 08.03	Fan Drive		Option No. FA9/02
Ref No.	Part Number	Part Name	Req	Remarks
		FAN DRIVE OPTION FA9702		Fan Drive Mounting
1	3900630	Screw, Hex Flange Head Cap	4	Required Bolt Circle (MM): 50 Installation Responsibility: Customer Fastener Length (MM): 20 Spacer Type: Clamping Plate Engine Family: B Series M8 x 1.25 x 20
		·		

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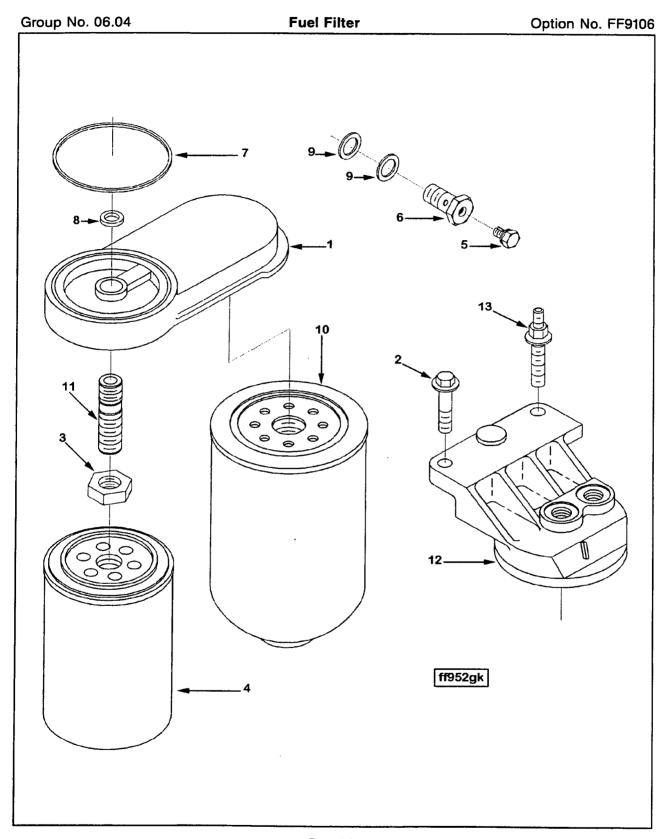


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Fan Drive

	up No. 08.03	Fan Drive		Option No. FA9706
Ref No.	Part Number	Part Name	Req	Remarks
		FAN DRIVE		For Delia Manualia
1	3903990	OPTION FA9706 Screw, Hex Flange Head Cap	4	Fan Drive Mounting Required Bolt Circle (MM): 60 Installation Responsibility: Customer Fastener Length (MM): 20 Spacer Type: Clamping Plate Fan Hub Material: Spun Steel Engine Family: B Series C Series M10 x 1.50 x 20
				·
		•		

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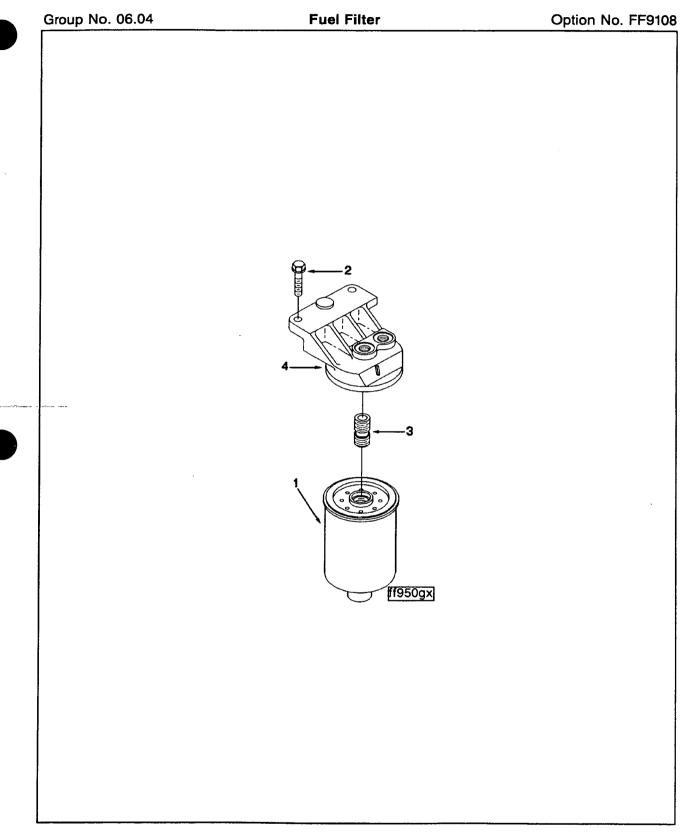


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Fuel Filter

Ref No. Part Number Part Name Req Remarks
FUEL FILTER OPTION FF9106 Fuel Filter Element Type: Dual Water Separator Provision: Yes Mtg. Angle from Crank C/L: 20 Deg F Of Crank C/L Element Style: Spin On Installation Responsibility: Cummins Filter Location: #5 Top Of Head Absolute Filtration (Microns): 28 Compatible With Lift Pump: Yes 3897331 3897337 3897337 Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter Head, Fuel Filter 1

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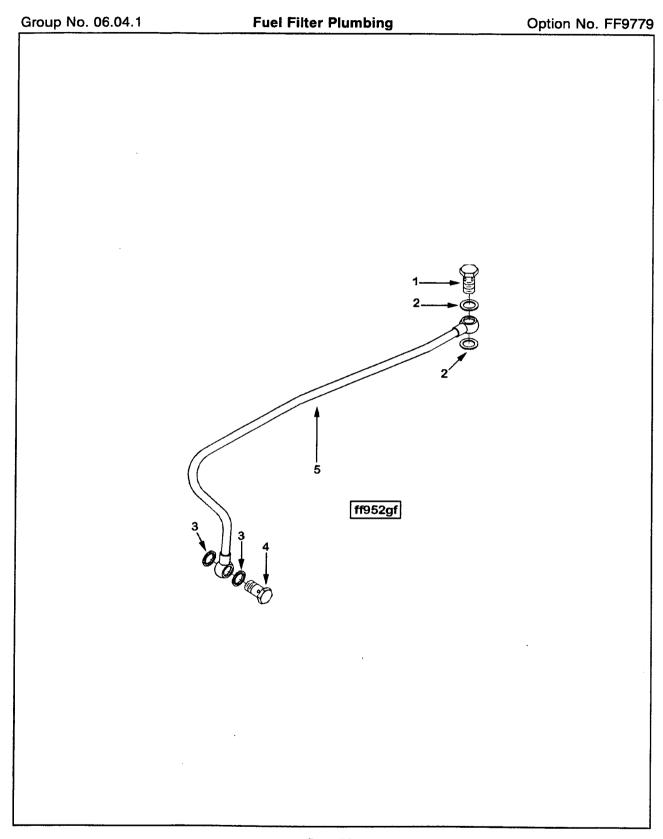


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Fuel Filter

		i dei l'illei		Option No. FF9108
Ref No.	Part Number	Part Name	Req	Remarks
Ref	9931063 3900632 3925954 3930969	Part Name FUEL FILTER OPTION FF9108 Filter, Fuel Screw, Hex Flange Head Cap Adapter, Filter Head Head, Fuel Filter	1 2 1 1	Remarks Fuel Filter Element Type: Single Water Separator Provision: No Element Style: Spin On Installation Responsibility: Cummins Filter Location: Air Heater Flange Absolute Filtration (Microns): 28 Compatible With Lift Pump: Yes Air Heater Connection Provided: No Restricted Fuel Pump Style: Inline Engine Family: B Series Engine Cylinders: 6 M8 X 1.25 X 35

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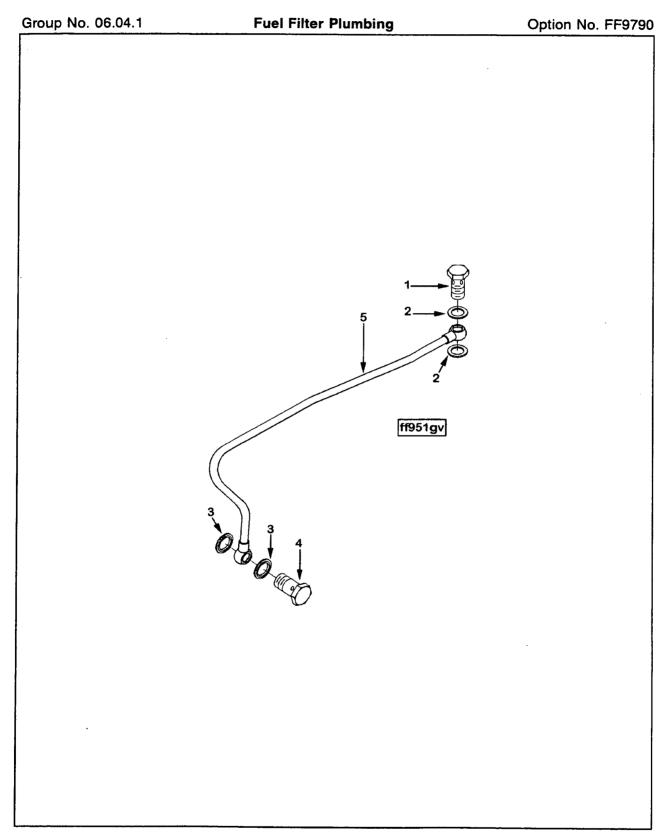
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Group No. 06.04.1

Fuel Filter Plumbing

Part Number Part Name Req Remarks
Fuel Filter Plumbing Family: B Series Pump Mfg/Model: Bosch A Governor Type: RSV Heater/Spacer/Glow Plug Provision: Heater/ Spacer Tube Material: Steel Boost Control Provision: With Mounting Location: Air Heater Flange Structure Code: 02 EBM Cylinders: 6 Fuel supply line for Bosch A pump from filte head mounted off grid heater/spacer for JW 6BTA. DEP may use 3283280 washer, sealing in place of 3918191 washer, sealing. 1 3905860 3 3918192 Washer, Sealing 3 3918192 Washer, Sealing 4 3924725 Screw, Banjo Connector 1 M14 x 1.50 x 26

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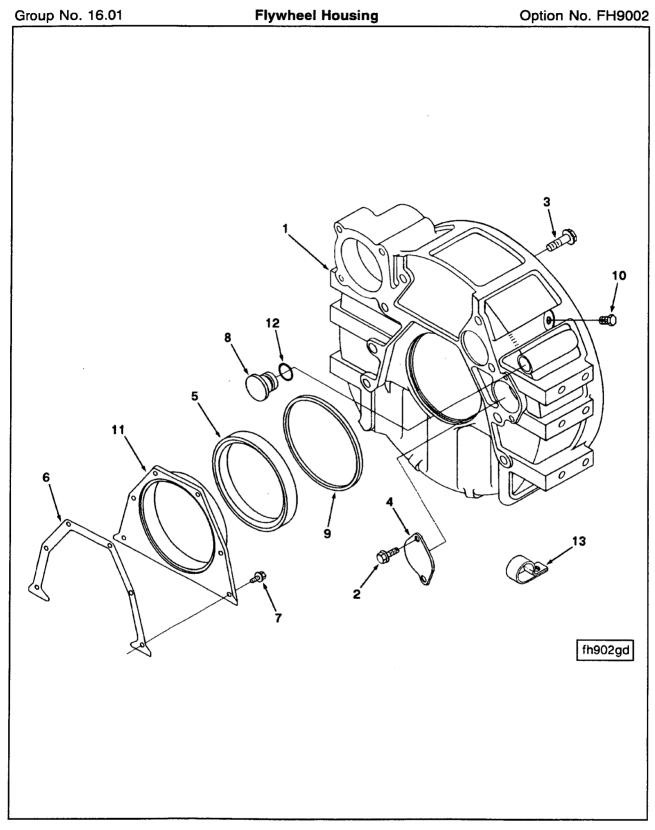
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Group No. 06.04.1

Fuel Filter Plumbing

Group No. 06.04.1 Fuel Filter Plumbing		g Option No. FF		
Ref No. Pa	rt Number	Part Name	Req	Remarks
Ref p	8860 1191 1192 1725	T	Ť	Remarks Fuel Filter Plumbing Family: B Series Pump Mfg/Model: Bosch A Governor Type: RSV Heater/Spacer/Glow-Plug Provision: Glow Plug Intake Cover Flange Thickness (MM): 11 Tube Material: Steel Boost Control Provision: With Mounting Location: #5 Top Of Head Structure Code: 02 EBM Cylinders: 6 DEP may use 3283280 Washer, Sealing in place of 3918191 Washer, Sealing. M12 x 1.50 x 24 M14 x 1.50 x 26

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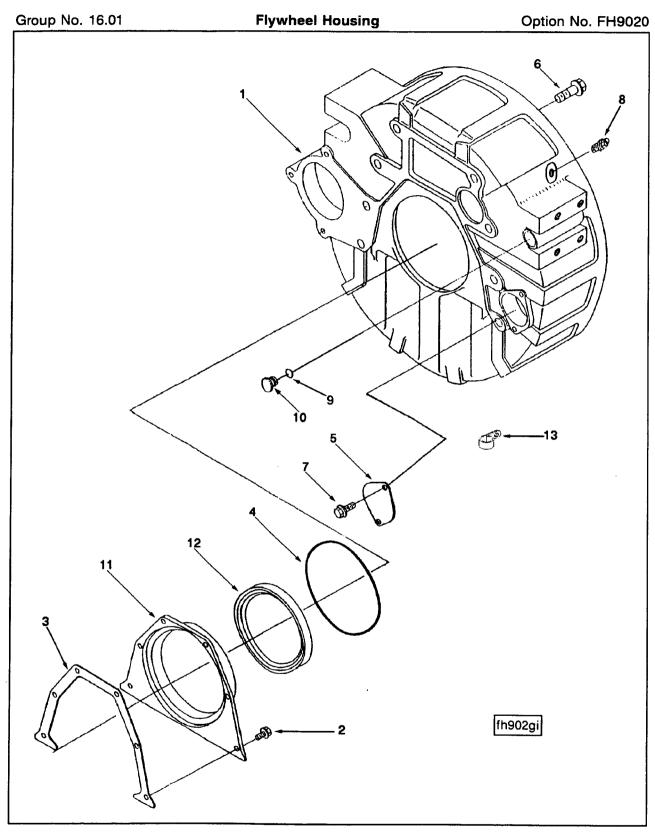
Group No. 16.01

Flywheel Housing

Option No. FH9002

Group No. 16.01	Flywheel Housii	ıg	Option No. FH9002
Ref No. Part Number	Part Name	Req	Remarks
1 3931627 2 3912072 3 3920447 4 3925234 3934486 5 (3933262) 6 3928493 7 3913638 8 3910248 9 3912473 10 3904181 11 3921043 12 3910260 13 3928989	Housing, Flywheel Screw, Self Tapping Metal Screw, Hex Flange Head Cap Plate, Cover Rr Crankseal Serv Kit Seal, Oil Gasket, Rear Cover Screw, Hex Flange Head Cap Plug, O Ring Seal, Rectangular Ring Plug, Threaded Cover, Rear Seal, O Ring Clip	12811111111111	Flywheel Housing Wet/Dry Clutch: Dry Housing Material: Aluminum SAE Size or Type: SAE 3 Starter Mount SAE: SAE #1 - 3 Bolt 90 Degree St Quadrant: 1st Starter Pad Offset From RFOB (MM): 0.00 Starter Mounting Hole Diameter (MM): 88.9 Mount Type: Pad Engine Mounting Hole Dimension: M12 x 1.75-6H # Mount Holes: 12 Engine Mount Top Hole +/- CR C/L (MM): 82.5 Tach Sensor Location: 4th Tach Size: 3/4 - 16 UNF Tach Count: 1 Trans MT Holes Count/Thread: 12 - M10 x 1.5 x 25 Starter Bore Angle (Deg): 47 Starter Center Distance: 216.407 Engine Family: B Series Not to be used with low mount rear out turbo locations. M8 x 1.25 x 15 M12 x 1.75 x 40 Includes Installation Tools M6 x 1.00 x 16 3/4 - 16 UNF

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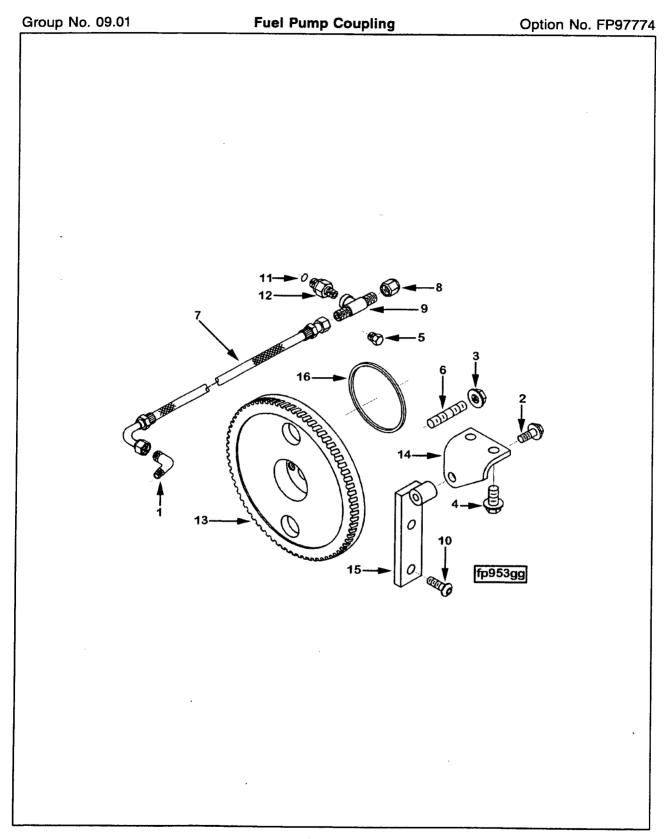


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Option No. FH9020

3roup No. 16.01	Flywheel Hou	sing	Option No. FH9020
Ref No. Part Number	Part Name	Req	Remarks
	FLYWHEEL HOUSING		
	OPTION FH9020		Flywheel Housing
1 3931716 2 3913638 3 3928493 3 3912473 5 3925234 6 3920447 7 3912072 8 3904181 9 3910260 10 3910248 11 3921043 3934486 12 (3933262) 13 3928989	Housing, Flywheel Screw, Hex Flange Head Cap Gasket, Rear Cover Seal, Rectangular Ring Plate, Cover Screw, Hex Flange Head Cap Screw, Self Tapping Metal Plug, Threaded Seal, O Ring Plug, O Ring Plug, O Ring Cover, Rear Rr Crankseal Serv Kit Seal, Oil Clip	1 6 1 1 1 8 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Wet/Dry Clutch: Dry Housing Material: Aluminum SAE Size or Type: SAE 2 Starter Mount SAE: SAE #1-3 Bolt 90 Degrees Starter Quadrant: 2nd Starter Pad Offset From RFOB (MM): 0.00 Starter Mounting Hole Diameter (MM): 88.9 Mount Type: Pad Engine Mounting Hole Dimension: M12 x 1.75-6H # Mount Holes: 8 Engine Mount Top Hole +/- CR C/L (MM): 150.68 Tach Sensor Location: 4th Tach Size: 3/4 - 16 UNF Tach Count: 1 Trans MT Holes Count/Thread: 12 - M10 x 1.50 6H Starter Pad +/- CR C/L Y AXIS (MM): 7 Starter Pad +/- CR C/L X AXIS (MM): 234.08 Starter Bore Angle (Deg): 92 Starter Center Distance: 234.185 Engine Family: B Series M6 x 1.00 x 16 M8 x 1.25 x 15 3/4 - 16 UNF Includes Installation Tools (For Use W/Dry Clutches)
	SERVICE PARTS		
3926126	Rear Crank Seal Serv. Kit		Includes Installation Tools W/wear Sleeve (For Use W/Dry Clutches)
(3925530) (3925532)	Seal, Oil Wear Sleeve		

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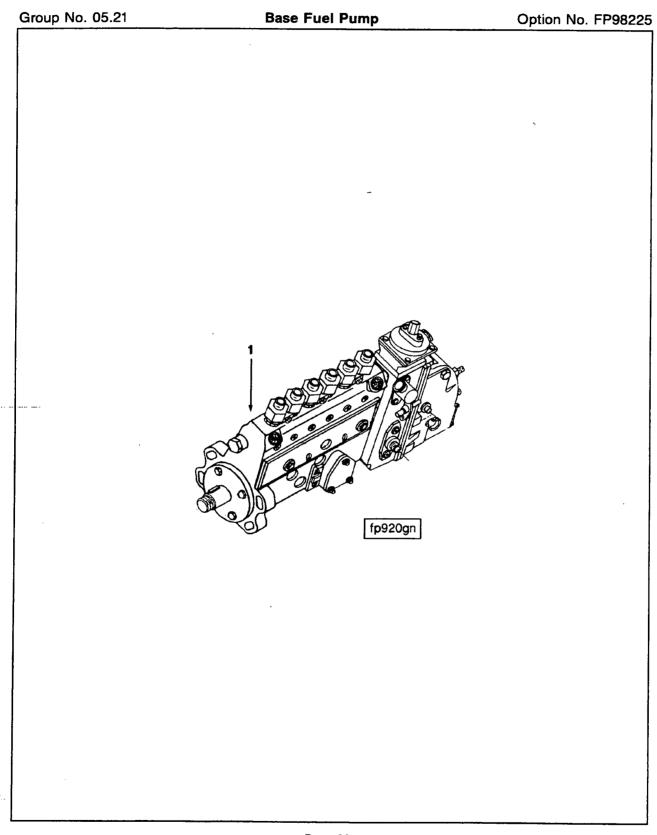


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Option No. FP97774

aroup No. 09.01	Fuel Pump Cou	pling	Option No. FP97774
Ref No. Part Number	Part Name	Req	Remarks
1 68139 2 3900630 3 3902662 4 3903990 5 3906619 6 3907978 7 3918536 8 3921556 9 3924346 10 3928231 (3932321) 11 3678925 12 (3932320) 13 3934188 14 3934506 15 3934507 16 (3934575)	FUEL PUMP COUPLING OPTION FP97774 Elbow, Male Adapter Screw, Hex Flange Head Cap Nut, Hexagon Flange Screw, Hex Flange Head Cap Plug, Pipe Stud Hose, Flexible Cap, Tube Tee, Female Branch Screw, Round Head Cap Connector, Male Seal, O Ring Connector, Male Gear, Fuel Pump Brace, Fuel Pump Brace, Fuel Pump Seal, Rectangular Ring	1 1 4 2 1 4 1 1 1 2 1 1 1 1 1 1 1 1	Engine Family: B Series Governor Type: RSV Air Compressor Support @ 185mm from FFOB: No Fuel Pump Supports Provided: Yes Boost Control Provision: Yes Engine Cylinders: 6 Fuel Pump Mfg/Model: Bosch A Aspiration: Turbocharged Jacket Water Aftercooled DEP may substitute 3282371 for 3907978. M8 x 1.25 x 20 M10 x 1.50 M10 x 1.50 (Both Ends) x 50 7/16-20 Thd M8 x 1.25 x 25

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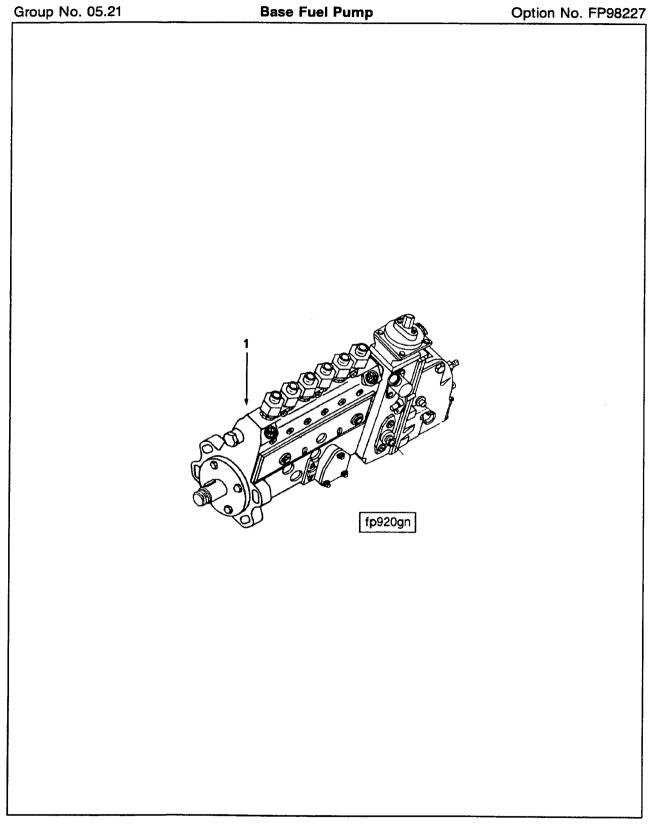
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Base Fuel Pump

Option No. FP98225

Base Fuel Pu	mp	Option No. FP9822
Part Name	Req	<u> </u>
		Remarks Fuel Pump Engine Family: B Series Engine Cylinders: 6 Advertised HP: 140 @ 1800 Governed HP: 140 @ 1800 Fuel Pump Type: Inline Pump Manufacturer/Model: Bosch A High Idle: 1890 Governor Type: RSV High Pressure Tube ID (mm): 1.8 Shutoff Lever Design: Direct link External Oiling Provision: Yes Compatible Fuel Rating - FR: 90354 CPL: 2372 Certified by: EPA MOH,CARB Certification Year: 1997 Certification Status: Pending Peak Power: 140 Governor Break RPM: 1800 Governor Regulation (%): 5 Pump Shut-down Lever Design: Inboard-direct.
	BASE FUEL PUMP OPTION FP98225	BASE FUEL PUMP OPTION FP98225

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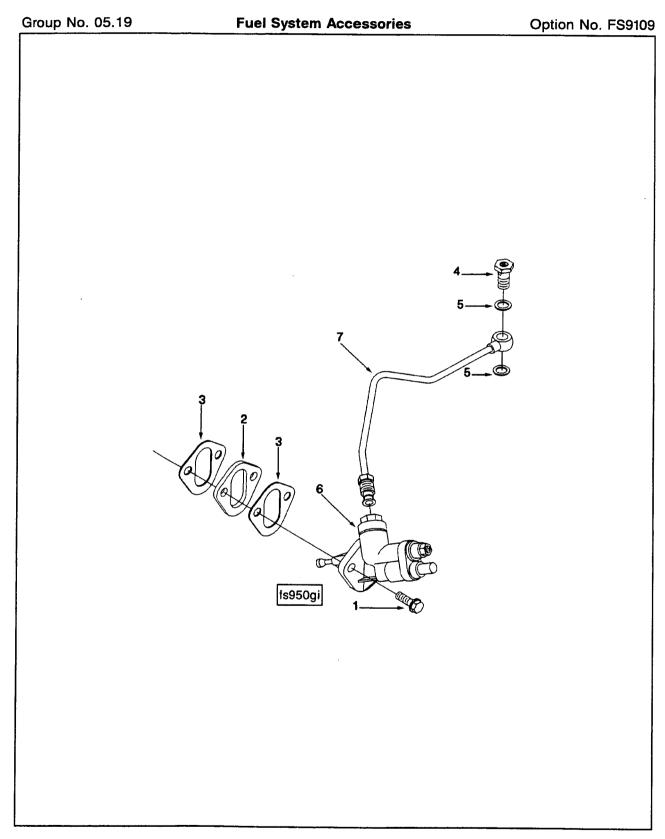
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Base Fuel Pump

Option No. FP98227

Gro	up No. 05.21	Base Fuel Pump		Option No. FP98227
Ref No.	Part Number	Part Name	Req	Remarks
		BASE FUEL PUMP OPTION FP98227		Fuel Pump Engine Family: B Series
				Engine Cylinders: 6 Advertised HP: 177 @ 1800 Governed HP: 177 @ 1800 Fuel Pump Type: Inline Pump Manufacturer/Model: Bosch A High Idle: 1890 Governor Type: RSV High Pressure Tube ID (mm): 1.8 Shutoff Lever Design: Direct Link External Oiling Provision: Yes Compatible Fuel Rating - FR: 90356 CPL: 2373 Certified by: EPA MOH,CARB Certification Year: 1997 Certification Status: Pending Peak Power: 177 Governor Break RPM: 1800 Governor Regulation (%): 5
1	(3933101) (3933757)	Pump, Fuel Injection Specification, Engine Perf	1	Pump Shut-down Lever Design: Inboard-Direct
				·
				·

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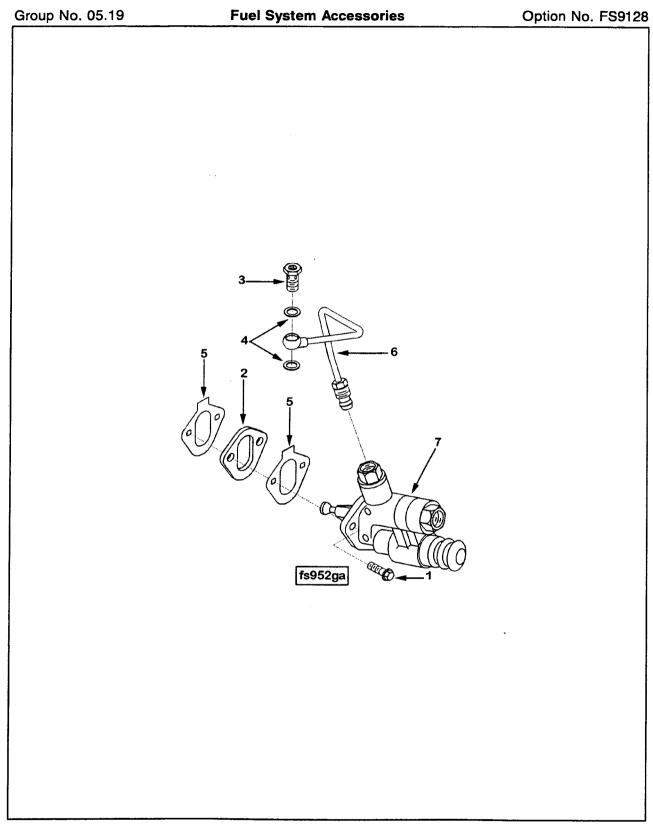


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Fuel System Accessories

Option No. FS9109

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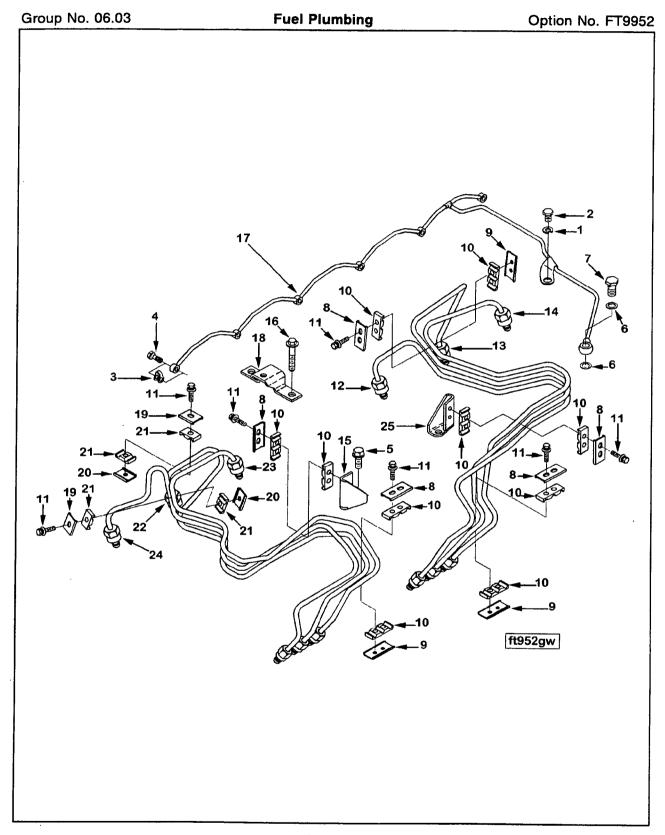
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Fuel System Accessories

Option No. FS9128

iroup No. 05.19	Fuel System Access	ories	Option No. FS912
Ref lo. Part Number	Part Name	Req	Remarks
1 3900631 2 3914284 3 3916361 4 3918191 5 3931348 6 3928423 7 3933252	Screw, Hex Flange Head Cap Spacer, Mounting Screw, Banjo Connector Washer, Sealing Gasket, Cover Plate Tube, Fuel Supply Pump, Fuel Transfer	2 1 1 2 2 1 1	Lift Pump Structure Code: 02 EBM Pump Style: Piston Pump Operation: Mechanical Pump Supplier: Cummins Pump Measured Flow RPM: 1250 Fuel Inlet Size: 1/2-14 NPTF Filter Location: #5 Top Of Head Unique Characteristics: 96 Industrial Product Restricted Fuel Pump: Bosch A Cylinders: 6 Engine Family: B Series MB X 1.25 X 25 M12 x 1.50 x 24

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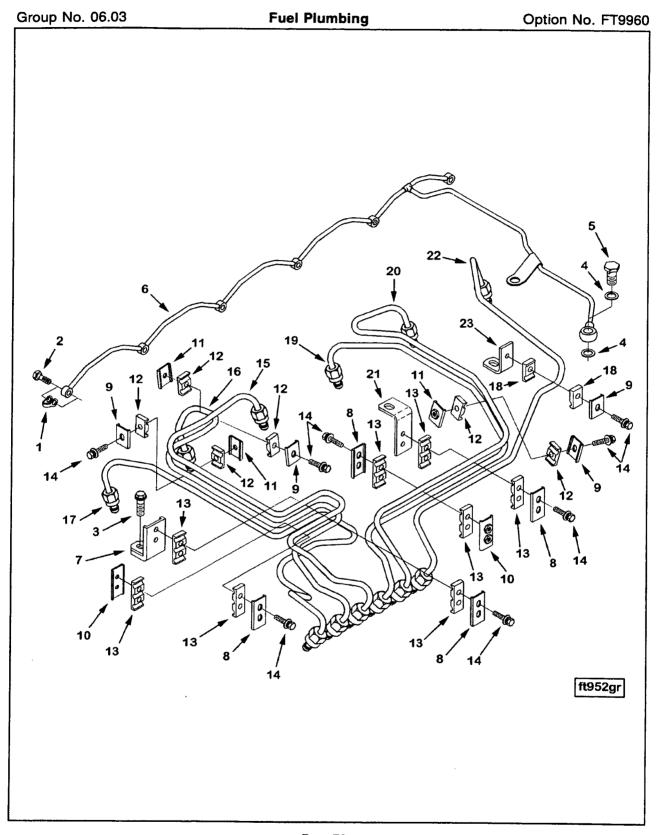


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Fuel Plumbing

Group No. 06.03	Fuel Plumbi	ng	Option No. FT995	2
Ref No. Part Number	Part Name	Req	Remarks	7
Ref Bort Number	FUEL PLUMBING OPTION FT9952 Washer, Lock Screw, Hexagon Head Cap Seal, Banjo Connector Screw, Banjo Connector Screw, Hex Flange Head Cap Washer, Sealing Valve, Check Brace, Tube Brace, Tube Isolator, Vibration Screw, Captive Washer Cap Tube, Injector Fuel Supply Tube, Injector Fuel Supply Tube, Injector Fuel Supply Tube, Injector Fuel Supply Frace, Tube Brace, Tube	Req 1 1 1 6 6 6 1 2 1 1 1 1 1 1 1 2 2 4 1 1 1 1 1 1 1 1		2
14 3928479 15 3930772 16 3930837 17 3930847 18 3931038 19 3904711 20 3917717 21 3917746 22 3928475 23 3928476	Tube, Injector Fuel Supply Brace, Tube Screw, Hex Flange Head Cap Manifold, Fuel Brace, Tube Brace, Tube Brace, Tube Isolator, Vibration Tube, Injector Fuel Supply Tube, Injector Fuel Supply	1 4 1 1 2 2 4 1	No. 6 Cylinder No. 2 Cylinder No. 3 Cylinder	

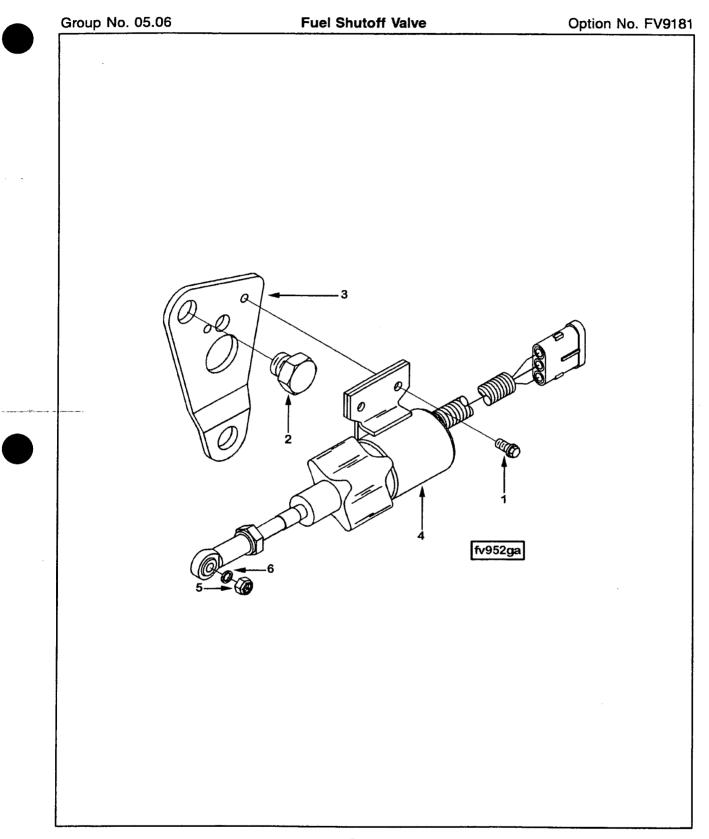
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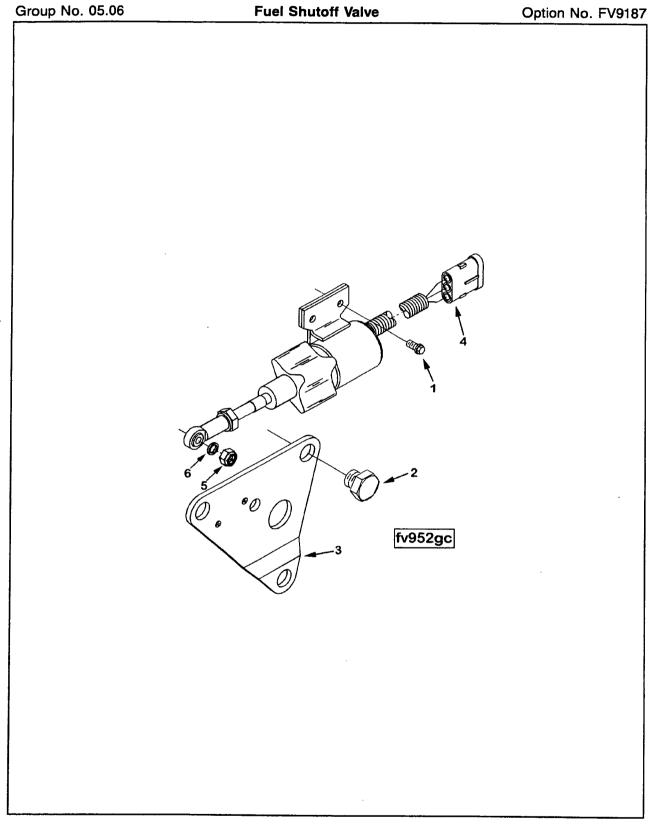
Fuel Plumbing Option No. FT9960 Group No. 06.03 Ref **Part Number** Part Name Req Remarks No. **FUEL PLUMBING OPTION FT9960** Fuel Plumbing Engine Family: B Series **Engine Cylinders: 6** High Pressure Tube ID.: 1.8 Fuel Pump Governor: RSV Adaptable To Air Heater: Yes Intake Cover Flange Thickness: 11 mm Intake Cover Opening Location : Rear Restricted Aspiration: Turbocharged Fuel Pump Manufacturer/Model: Bosch A 3903380 Seal, Banjo Connector 6.2MM M6 x 1.00 x 14.3 3905307 Screw, Banjo Connector 6 2 3918109 Screw, Hex Flange Head Cap M8 x 1.25 x 25 1 3 2 4 3918188 Washer, Sealing **8MM** 5 3924726 Valve, Check 1 M8 x 1.25 x 17.5 3933295 Manifold, Fuel 6 Brace, Tube Brace, Tube 3282942 1 7 4 3904519 8 4 Brace, Tube 3904711 2 10 3917716 Brace, Tube 3917717 Brace, Tube 3 11 3917746 Isolator, Vibration 5 12 Isolator, Vibration 8 3917747 13 Screw, Captive Washer Cap Tube, Injector Fuel Supply M5 x 0.8 x 24.5 12 3920854 14 No. 3 Cylinder 15 3929463 1 3929464 Tube, Injector Fuel Supply 1 No. 2 Cylinder 16 3932007 Tube, Injector Fuel Supply 1 No. 1 Cylinder 17 2 3919359 Isolator, Vibration 18 3929465 Tube, Injector Fuel Supply No. 4 Cylinder 19 Tube, Injector Fuel Supply No. 5 Cylinder 3929466 1 20 Brace, Tube 3932417 1 No. 6 Cylinder 22 3932495 Tube, Injector Fuel Supply 1 3940840 Brace, Tube 23

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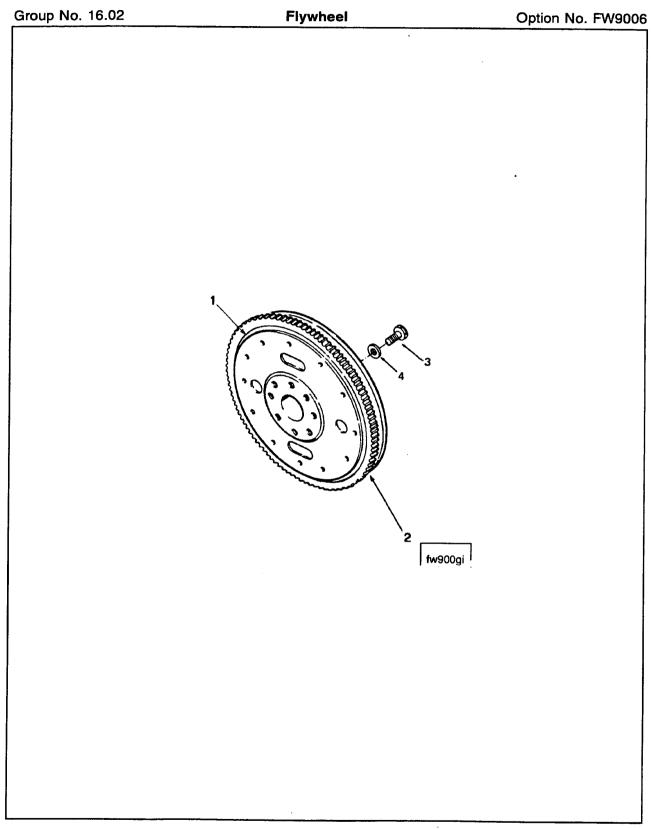
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Fuel Shutoff Valve

Option No. FV9187

oup No. 05.06	Fuel Shutoff Va	alve	Option No. FV918
Part Number	Part Name	Req	Remarks
Port Number	Fuel Shutoff Valve Fuel Shutoff Valve OPTION FV9187 Screw, Hex Flange Head Cap Screw, Hexagon Head Cap Bracket, Solenoid Solenoid, Fuel Pump Nut, Lock Washer, Plain		

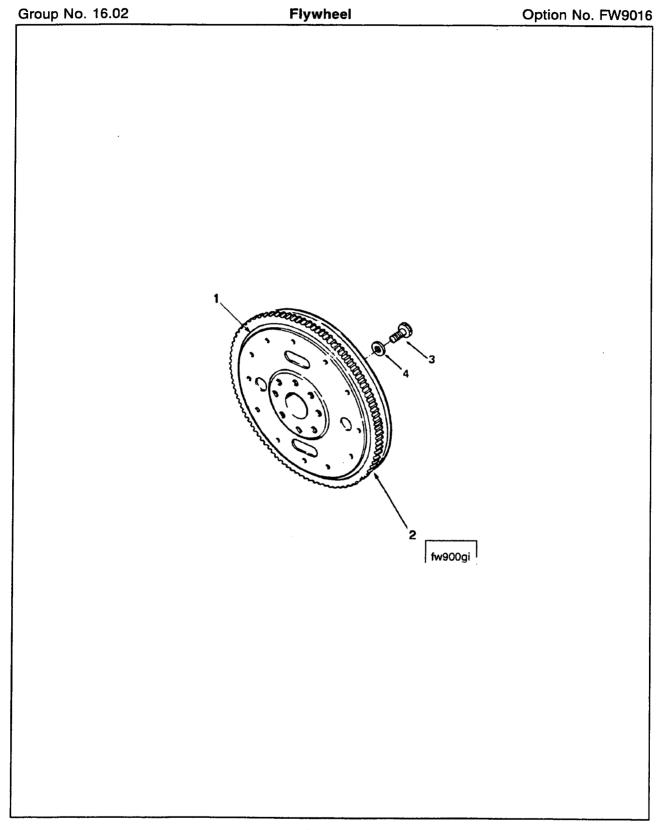
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roup No. 16.02	Flywhee		Option No. FW90
o. Part Number	Part Name	Req	Remarks
	Flywheel Flywheel Flywheel Gear, Flywheel Ring Screw, Hexagon Head Cap Washer, Plain	Req	Flywheel Type: Flywheel Housing SAE Size or Type: SAE 3 Intended Drive Hardware: 11 1/2 " OC Clutc Material Specification: 41,044 Ring Gear Pitch: 10/12 Ring Gear Pitch Diameter: 403.86 MM (15.9 In) Ring Gear Tooth Count: 159 Crank Flange To Ring Gear Leading Edge (MM): 17.01 Maximum RPM: 3970 RPM Pilot Bearing Bore Dia (MM): 71.97 Clutch Mounting Bolt Circle (MM): 333.38 Clutch Mounting Hole Count: 8 Clutch Mounting Hole Nomenclature: 3/8-16 UNC-2B Moment of Inertia (KG/M2): 0.78 Structure Code: 02 EBM Required Starter Center Distance (MM): 216.40 Applicable Engine Families: B Series M12 x 1.25 x 32 1.65 thick

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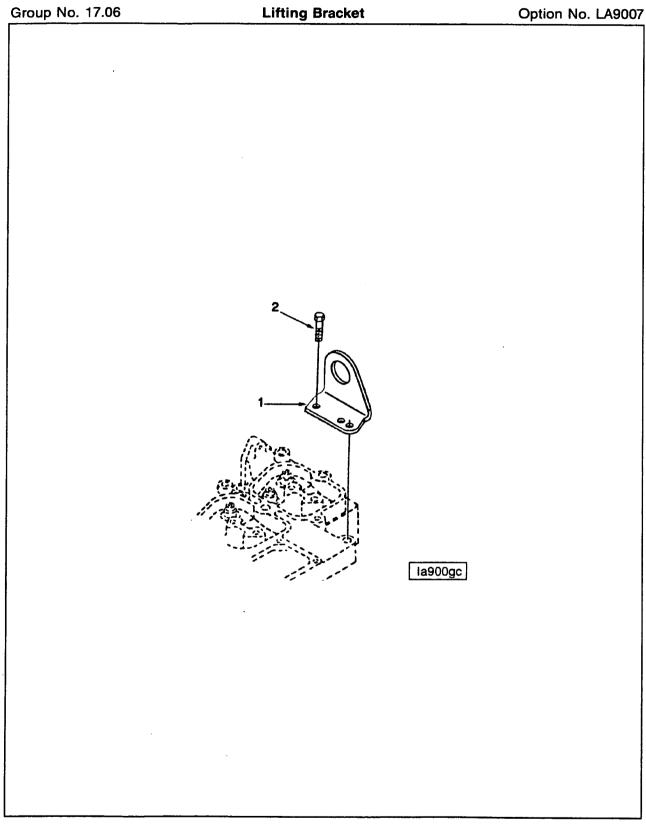


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Group No. 16.02	Flywheel	Option No. FW9016
Dof		

Part Number
Flywheel Type: Flyw

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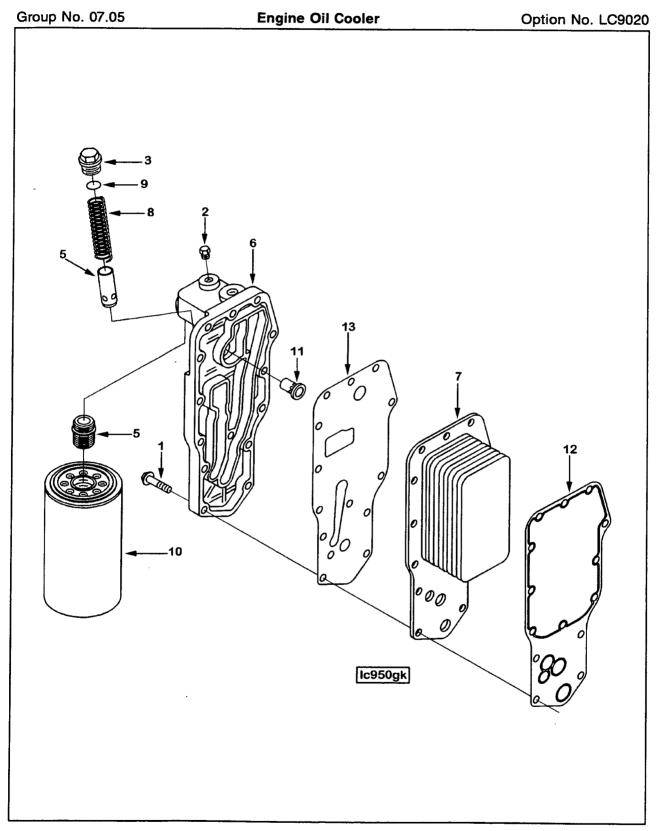
Group No. 17.06

Lifting Bracket

Option No. LA9007

		Lifting Bracket		Option No. LA9007
Ref No.	Part Number	Part Name	Req	Remarks
Ref	3908118	Part Name LIFTING BRACKET OPTION LA9007 Bracket, Lifting Screw, Hexagon Head Cap		Remarks Lifting Bracket Structure Code: 02 EBM Engine Family: B Series Capscrew Length: 30MM Allows For Intake Trunking: No Max Lifting Load (Lbs.): 2000 Bracket Pre-Painted: No Bracket(s) Provided: Front And Rear Neuss will use 25mm mounting capscrews. M12 x 1.75 x 30

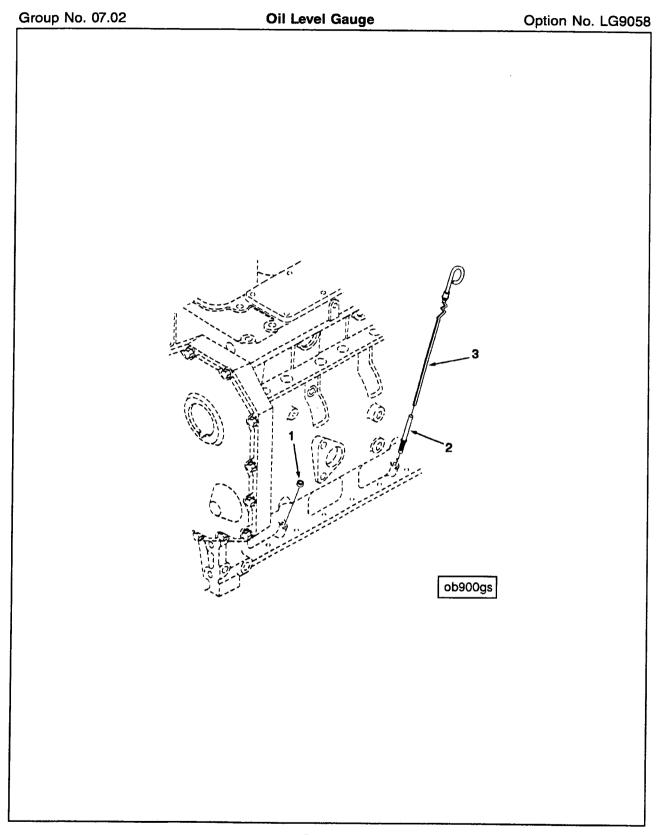
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up No. 07.05	Engine Oil Co	oler	Option No. LC9	020
Part Number	Part Name	Req	Remarks	
<u> </u>	T			020

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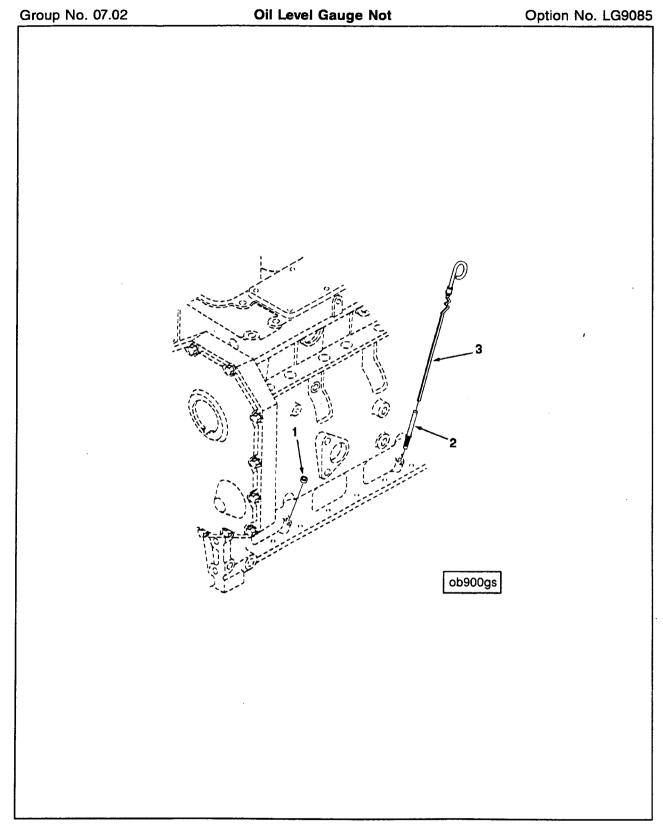
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Oil Level Gauge

Option No. LG9058

Ref No.				Option No. LG9058
110.	Part Number	Part Name	Req	Remarks
1 3 2 3	3900955 3279104 3905786	Part Name OIL LEVEL GAUGE OPTION LG9058 Plug, Expansion Tube, Oil Gauge Dipstick	3 1 1	T

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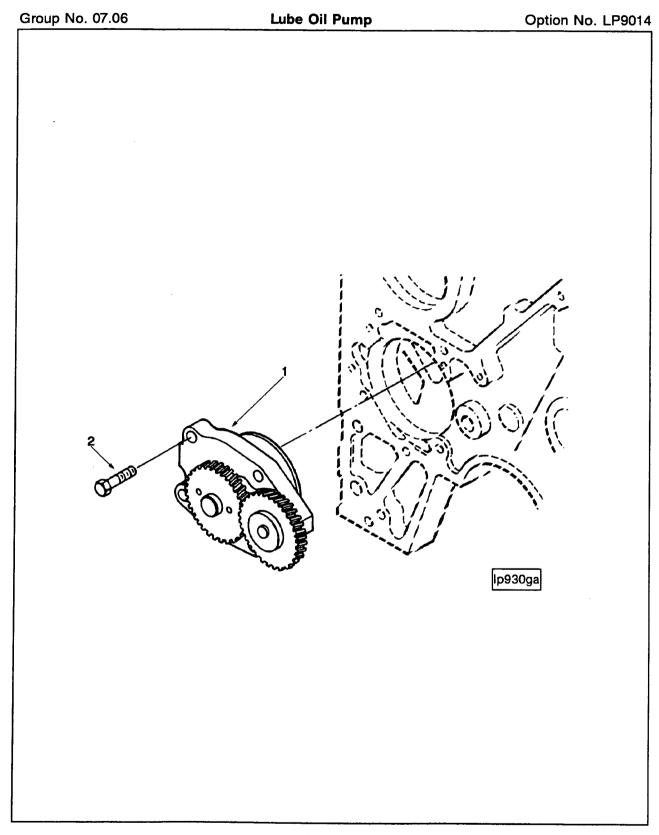
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Oil Level Gauge Not

Option No. LG9085

Part Number Part Name Req Remarks	GIU	up No. 07.02	Oil Level Gauge N	OL .	Option No. LG9085
DPTION LG9085 Lube Oil Gauge Structure Language: 02 EBM Family: B Series Cylinders: 6 Supplier: Cummins Oil Pan High Limit (qt): 15 Oil Pan Low Limit: 13 Oil Pan Sump: Front Entry Location from FFOB (mm): 168.0 Power Angle (deg): 0 Pull Direction: 45 deg Functions with Air Compressor: Yes Tube Effective Length (mm): 155 Gauge End Horizontal from Crank C/L: To Be Determined Gauge End Vertical from Crank C/L: To Be Determined Gauge End Horizontal from FFOB: To Be Determined Gauge End Horizontal from FFOB: To Be Determined Functions with Balancer: Yes	Ref No.	Part Number	Part Name	Req	Remarks
	2	3900955 3905128	Plug, Expansion Tube, Oil Gauge	1	Structure Language: 02 EBM Family: B Series Cylinders: 6 Supplier: Cummins Oil Pan High Limit (qt): 15 Oil Pan Low Limit: 13 Oil Pan Sump: Front Entry Location from FFOB (mm): 168.0 Power Angle (deg): 0 Engine Tilt (deg): 0 Pull Direction: 45 deg Functions with Air Compressor: Yes Tube Termination Side: Fuel Pump Side Tube Effective Length (mm): 155 Gauge End Horizontal from Crank C/L: To Be Determined Gauge End Vertical from Crank C/L: To Be Determined Gauge End Horizontal from FFOB: To Be Determined

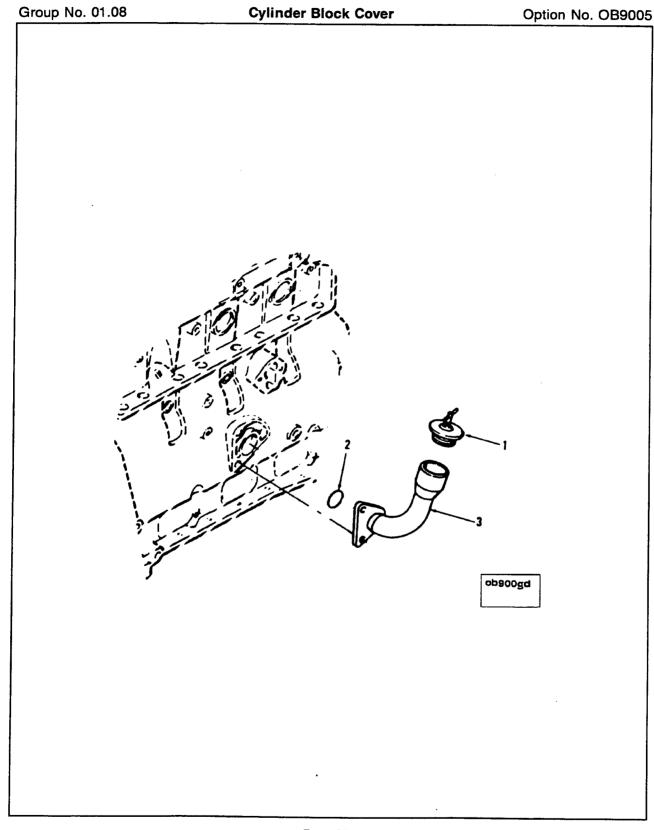
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Group No. 07.06 Lube Oil Pump Option No. LP9014 Ref No. Req **Part Number Part Name** Remarks LUBE OIL PUMP **OPTION LP9014** Lubricating Oil Pump Pump Flow Rate (GPM @ RPM): 20.5 @ 4200 Unique Characteristics: To Be Determined Engine Cylinders: 6 Engine Family: **B** Series C Series Nitrotec will be removed from lube pump. Pump, Lubricating Oil 3941742 1 2 3900677 Screw, Hexagon Head Cap 4 M8 x 1.25 x 30

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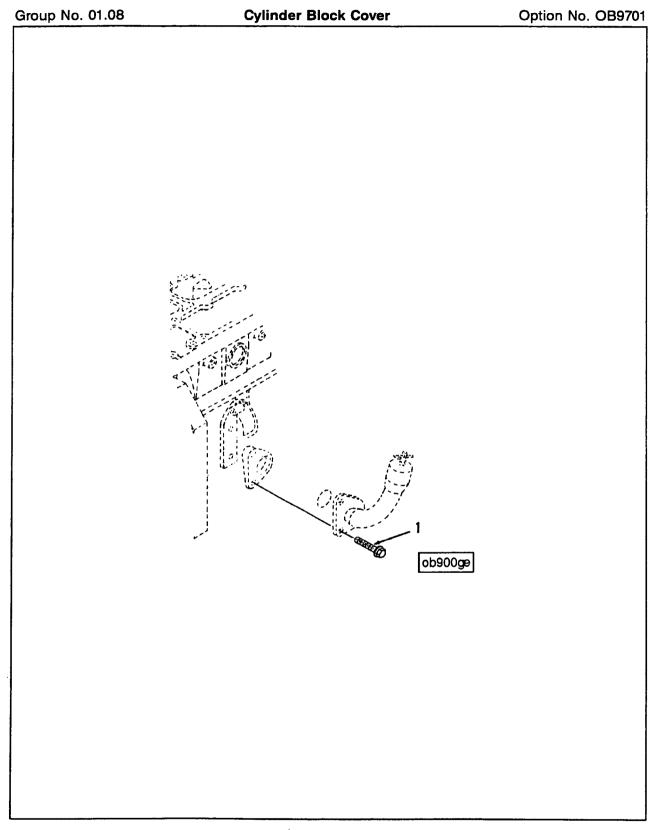
Group No. 01.08

Cylinder Block Cover

Option No. OB9005

Ref No. Part Number CYLINDER BLOCK COVER OPTION 0B9005 Cylinder Block Cover Engine Family: B Series Fill Tube Supplier: Cummins Oil Fill Location: Fuel Pump Side Fill Position From EFOB (MM): 278 Position Horiz Fron Crank C/L (MM): 259 Position Horiz With Air CPH (MM): 293.5 Fill Cap Supplier: Cummins Fill Cap Supp
Cylinder Block Cover Engine Family: B Series Fill Tube Supplier: Cummins Oil Fill Location: Fuel Pump Side Fill Position From FFOB (MM): 278 Position Vert From Crank C/L (MM): 174 Position Horiz Fron Crank C/L (MM): 255 Positon Horiz With Air CPR (MM): 293.5 Fill Cap Supplier: Cummins Functional W/Dual Power Ratings: Yes Side Mounting Fasteners Required: Yes Structure Code: 02 EBM Restricted Breather Type: Open Fuel Type: Diesel Restricted Lift Pump Type: Lever Air Compressor Restriction: To Be Deten P/N 3906704, O'Ring Seal, is interchang with P/N 3906696.

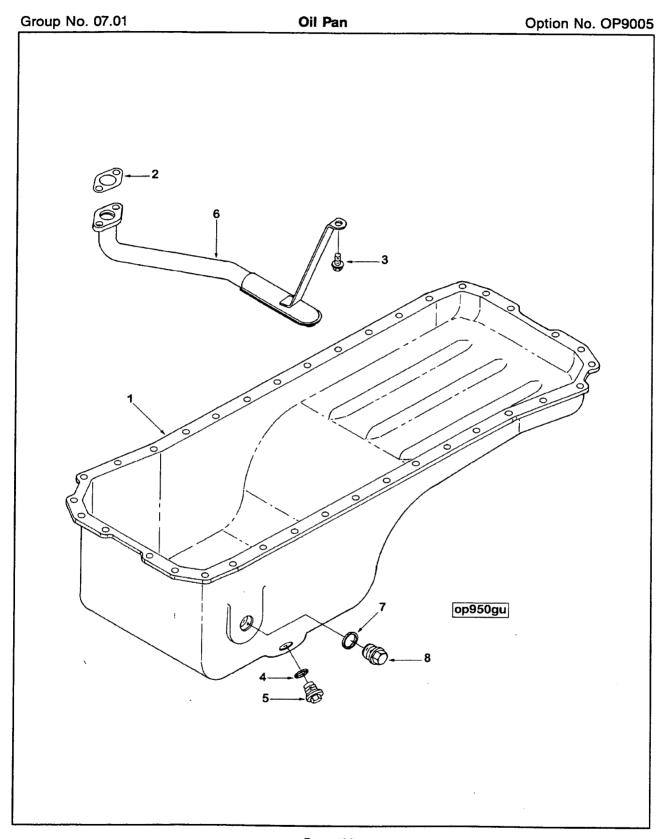
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Cylinder Block Cover Group No. 01.08 Option No. OB9701 Ref Part Name Req Part Number Remarks No. CYLINDER BLOCK COVER **OPTION OB9701** Cylinder Block Cover Adapter Structure Language: 02 EBM Oil Fill Location: Fuel Pump Side Air Compressor Support Provided: No CPR Rear Support Location: No Screw, Hex Flange Head Cap 2 3901249 M12 x 1.75 x 25

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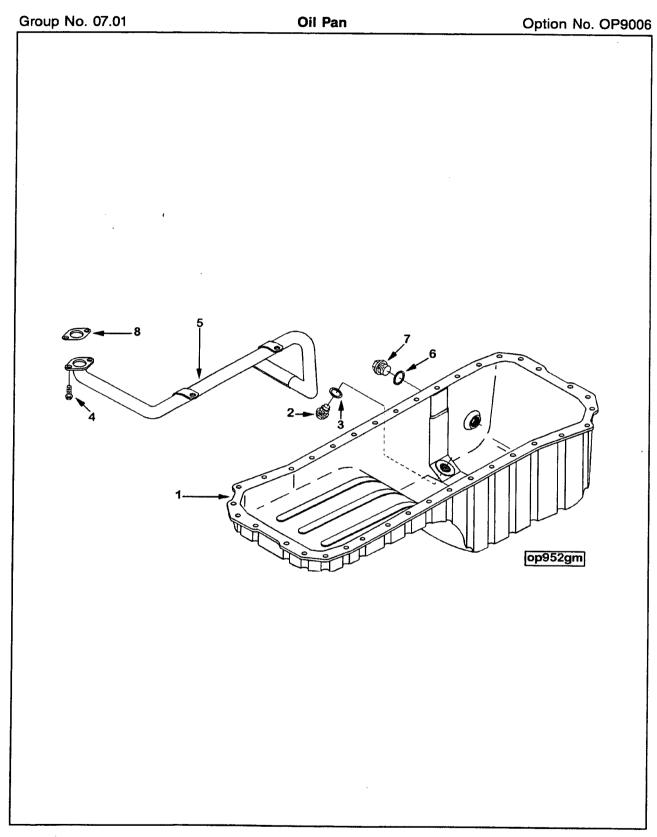
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Group No. 07.01

Oil Pan

3roup No. 07.01	Oil Pan		Option No. OP900
Ref No. Part Number	Part Name	Req	Remarks
Ref Port Number		Req	

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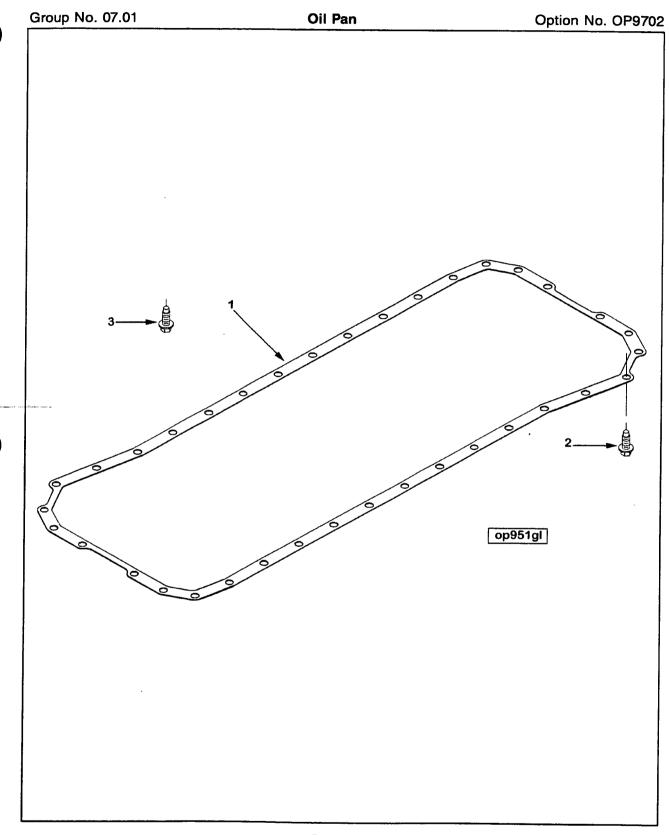
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Group No. 07.01

Oil Pan

Grou	ıp No. 07.01	Oil Pan		Option No. OP9006	<u> </u>
Ref No.	Part Number	Part Name	Req	Remarks	7
12345678	3915703 3924147 3920773 3900630 3921992 3902425 3924148 3931349	OIL PAN OPTION OP9006 Pan, Oil Plug, Threaded Washer, Sealing Screw, Hex Flange Head Cap Connection, Oil Suction Washer, Sealing Plug, Threaded Gasket, Flange	1 1 1 2 1 1 1 1	Oil Pan Family: B Series Cylinders: 6 Sump Style: Standard Sump Location: Rear Oil Pan Material: Stamped Steel Drain Location: Exhaust Manifold Side Pan High Capacity (Qt): 15 (14.191 I) Pan Low Capacity (Qt): 13 (12.299 I) Front Up Angularity (Deg): 40 Front Down Angularity (Deg): 40 Side To Side Angularity (Deg): 40 Structure Code: 02 EBM Oil Pan Type: Non-Isolated Internally Cast Suction Tube: No Required Oil Filter Medium: Cellulose Suction Tube Flange Thickness (mm): 5.16 Heater Boss Size & Location: 22mm Exhaust DEP may substitute 3281626 capscrew in place of 3920400. DEP may use 3282266 plug in place of 3924148 plug. M8 x 1.25 x 20	

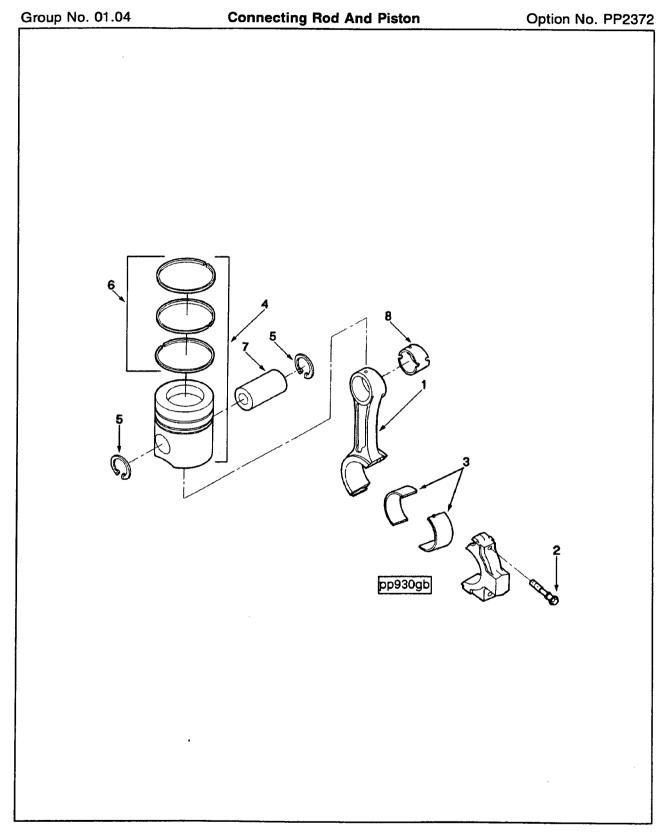
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Group No. 07.01 Oil Pan Option No. OP9702 Ref No. Part Number **Part Name** Req Remarks OIL PAN **OPTION OP9702** Oil Pan Mounting Engine Family: B Series Cylinders: 6 Bedplate Capability: Without Required Oil Pan Material: Stamped Steel Structure Code: 02 EBM Gasket, Oil Pan Screw, Hex Flange Head Cap 3931346 36 3920400 M8 x 1.25 x 21 3900630 Screw, Hex Flange Head Cap

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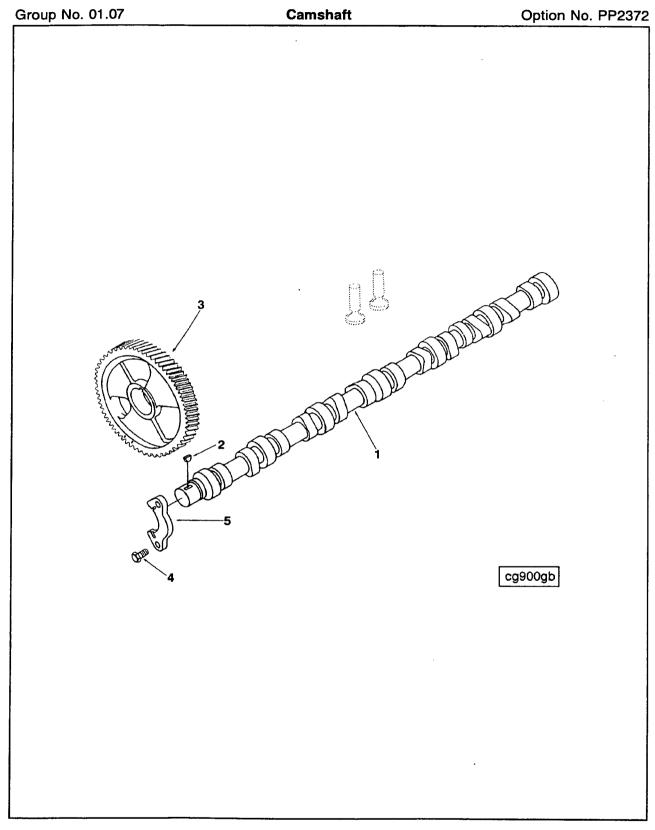
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Group No. 01.04

Connecting Rod And Piston

Grou	up No. 01.04	Connecting Rod And Piston		o. 01.04 Connecting Rod And Piston Option No. PP		ion No. PP2372	
Ref No.	Part Number	Part Name	Req	Remarks			
		CONNECTING ROD AND PISTON					
ı		OPTION PP2372		CPL2122			
1	3942581	Rod, Engine Connecting	6	. —			
١'	(3942580)	Rod, Engine Connecting	1				
2	3900919	Screw, Connecting Rod Cap	2	MJ11 x 1.25 x 59			
8	3941476	Bushing	1				
3	3901170 3802747	Bearing, Connecting Rod Kit, Engine Piston	12	Standard Standard			
4	(3928673)	Piston, Engine	1	Standard			
5	3901706	Ring, Retaining	2				
6	3802746	Set, Piston Ring	1	Standard			
7	3901793	Pin, Piston	6				
3	3901171	Bearing, Connecting Rod	A/R	0.25mm Oversize			
3	3901172	Bearing, Connecting Rod	A/R	0.50mm Oversize			
3	3901173	Bearing, Connecting Rod	A/R	0.75mm Oversize			
3	3901174	Bearing, Connecting Rod	A/R	1.00mm Oversize			
4	3802764	Kit, Engine Piston	6	0.50mm Oversize			
Ì	(3928674)	Piston, Engine	1	0.50mm Oversize			
5	3901706	Ring, Retaining	2				
6	3802422	Set, Piston Ring	1	0.50mm Oversize			
4	3802765	Kit, Engine Piston	6	1.00mm Oversize			
	(3928675)	Piston, Engine	1 1	1.00mm Oversize			
5	3901706 3802423	Ring, Retaining Set, Piston Ring	2	1.00mm Oversize			
6	3002423	Set, Fision Hing	'	1.00mm Oversize			
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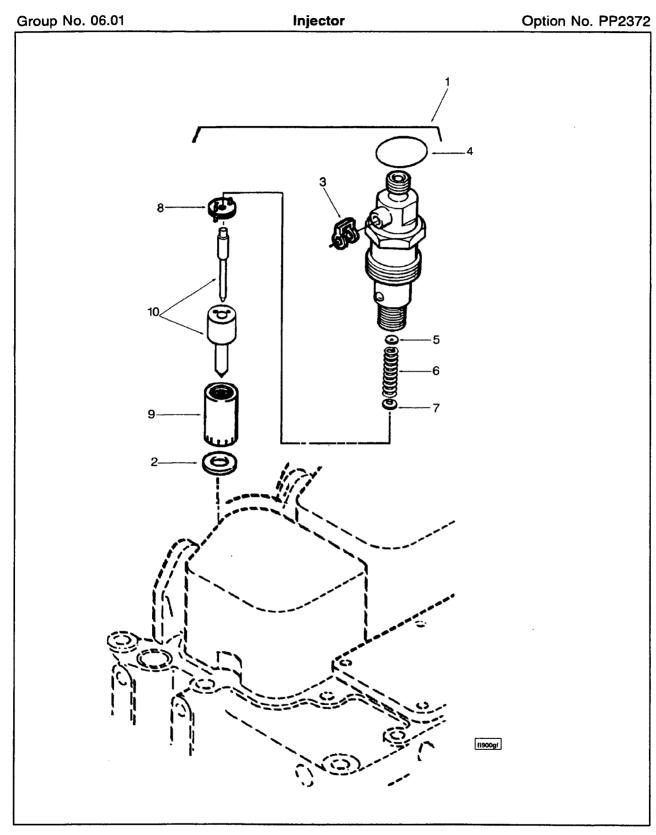
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Camshaft Group No. 01.07 Option No. PP2372 Ref No. **Part Number** Part Name Req Remarks **CAMSHAFT OPTION PP2372** 3929886 Camshaft 1 2 Key, Plain Woodruff Gear, Camshaft 3902332 3929030 4 3900227 Screw, Hexagon Head Cap 2 M8 x 1.25 x 22 3927155 Support, Camshaft Thrust

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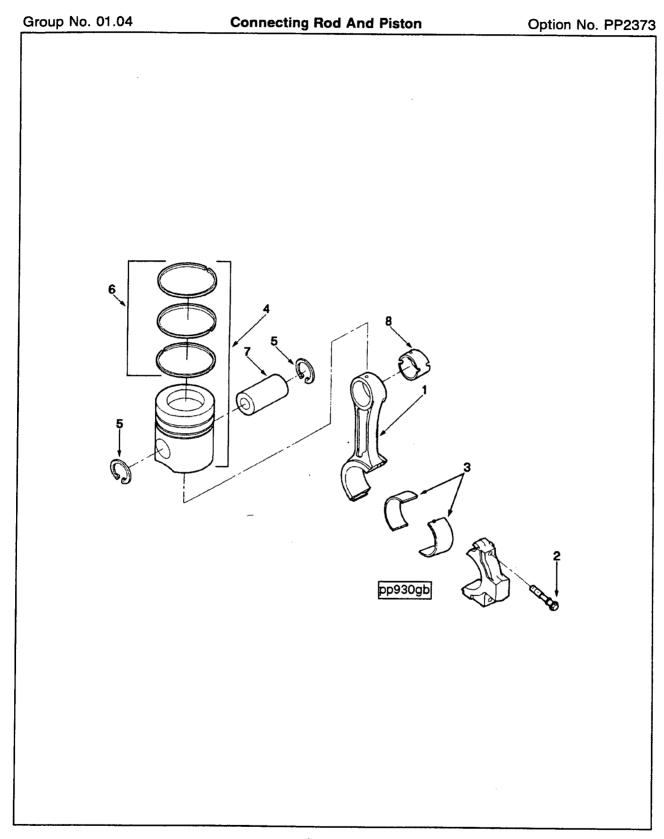
Group No. 06.01

Injector

Option No. PP2372

Gro	p No. 06.01 Injector		o. 06.01 Injector Option No. PP23	
Ref No.	Part Number	Part Name	Req	Remarks
		INJECTOR		
		OPTION PP2372		
1	3802677	Kit, Injector	6	
	(3929490)	Injector	1	
2	3906659	Seal, Injector	1	
3	3903380 3909356	Seal, Banjo Connector Seal, Rectangular Ring		
5	3905156	Shim	A/R	1.00 mm Thick
5	3905157	Shim	A/R	1.04 mm Thick
5	3905158	Shim	A/R	1.08 mm Thick
5	3905159	Shim Shim	A/R A/R	1.10 mm Thick 1.14 mm Thick
5 5	3905160 3905161	Shim	A/R	1.18 mm Thick
5	3905162	Shim	A/R	1.20 mm Thick
5	3905163	Shim	A/R	1.24 mm Thick
5	3905164	Shim	A/R	1.28 mm Thick
5 5	3905165 3905166	Shim Shim	A/R A/R	1.30 mm Thick 1.34 mm Thick
5	3905167	Shim	A/R	1.38 mm Thick
5	3905168	Shim	A/R	1.40 mm Thick
5	3905169	Shim	A/R	1.44 mm Thick
5	3905170	Shim Shim	A/R A/R	1.48 mm Thick 1.50 mm Thick
5 5	3905171 3905172	Shim	A/R	1.54 mm Thick
5	3905173	Shim	A/R	1.58 mm Thick
5	3905174	Shim	A/R	1.60 mm Thick
5	3905175	Shim	A/R	1.64 mm Thick
5	3905176 3905177	Shim Shim	A/R A/R	1.68 mm Thick 1.70 mm Thick
5 5	3905178	Shim	AVR	1.74 mm Thick
5	3905180	Shim	A/R	1.78 mm Thick
5	3905181	Shim	A/R	1.80 mm Thick
5	3905182	Shim Shim	A/R A/R	1.84 mm Thick 1.88 mm Thick
5 5	3905183 3905184	Shim	A/R	1.90 mm Thick
5	3905185	Shim	A/R	1.94 mm Thick
5	3905186	Shim	A/R	1.98 mm Thick
6	3905152	Spring, Compression	6	
7	3917945	Spindle	6	
8	3917946 3905155	Disc, Intermediate Retainer, Injector Nozzle	6	
10	3929492	Nozzle, Injector	6	
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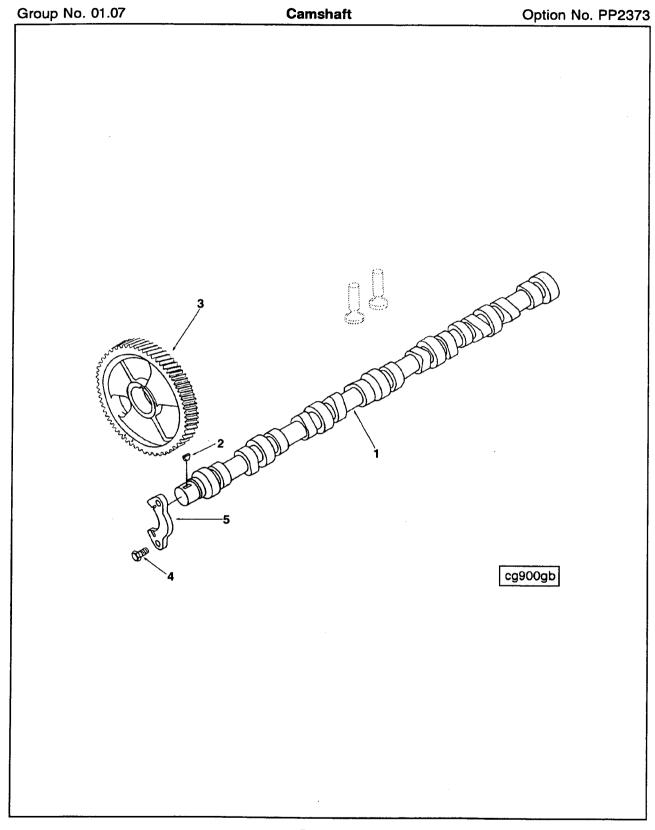
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Group No. 01.04

Connecting Rod And Piston

Part Number	Froup No. 01.04			Connecting Rod And Piston		d Piston Option No. PP2	
1 3942581 Rod, Engine Connecting Rod, Engine Connecting 1 2 3900919 Screw, Connecting Rod Cap 2 MJ11 x 1.25 x 59 Bushing 1 1 Standard S	lef lo. Part Number	Part Name	Req	Remarks			
1 3942581		CONNECTING ROD AND PISTON					
(3942580) Rod, Engine Connecting 1 3900919 Screw, Connecting Rod Cap 2 Bushing 1 1 3901170 Bearing, Connecting Rod 12 Standard 12 Standard 13802747 Kit, Engine Piston 6 Standard 14 Standard 15 Standard 16 Standard 17 Standard 18		OPTION PP2373		CPL2122			
(3942580) Rod, Engine Connecting 1 3900919 Screw, Connecting Rod Cap 2 MJ11 x 1.25 x 59 Screw, Connecting Rod Cap 1 Standard Standar	1 3942581	Rod, Engine Connecting	6				
8 3941476 Bushing 1 3 3901170 Bearing, Connecting Rod 12 4 3802747 Kit, Engine Piston 6 5 3901706 Ring, Retaining 2 6 3802746 Set, Piston Ring 1 7 3901793 Pin, Piston 6 3 3901171 Bearing, Connecting Rod A/R 0.25mm Oversize 3 3901172 Bearing, Connecting Rod A/R 0.50mm Oversize 3 3901173 Bearing, Connecting Rod A/R 0.75mm Oversize 3 3901174 Bearing, Connecting Rod A/R 0.75mm Oversize 4 3802764 Kit, Engine Piston 6 0.50mm Oversize 5 3901706 Ring, Retaining 2 6 3802422 Set, Piston Ring 1 0.50mm Oversize 4 3802765 Kit, Engine Piston 6 1.00mm Oversize 4 3802765 Kit, Engine Piston 6 1.00mm Oversize 5 3901706 Ring, Retaining 2 1.00mm Oversize	(3942580)	Rod, Engine Connecting					
3 3901170 Bearing, Connecting Rod 12 Standard 3802747 Kit, Engine Piston 6 5 Standard 5	- I			MJ11 x 1.25 x 59			
4 3802747 (3928673) Kit, Engine Piston Piston, Engine 6 Standard 5 3901706 3802746 Ring, Retaining 2 7 3901793 Set, Piston Ring 1 3 3901171 Bearing, Connecting Rod Bearing, Connecting Rod A/R A/R 0.25mm Oversize 3 3901172 Bearing, Connecting Rod Bearing, Connecting Rod A/R A/R 0.75mm Oversize 3 3901174 Bearing, Connecting Rod Bearing, Connecting Rod A/R A/R 0.50mm Oversize 4 3802764 (3928674) Kit, Engine Piston Piston, Engine 1 0.50mm Oversize 5 3901706 Ring, Retaining 2 4 3802765 (3928675) Kit, Engine Piston Piston, Engine 6 1.00mm Oversize 5 3901706 Ring, Retaining 1 1.00mm Oversize	- 1			Standard			
(3928673) Piston, Engine 1 2 3901706 Set, Piston Ring 1 1 5 5 3901793 Pin, Piston 6 6 6 6 6 6 6 6 6		Kit, Engine Piston					
6 3802746 Set, Piston Ring Pin, Piston 1 Standard 3 3901793 Bearing, Connecting Rod Bearing		Piston, Engine					
7 3901793 Pin, Piston 6 3 3901171 Bearing, Connecting Rod A/R 0.25mm Oversize 3901172 Bearing, Connecting Rod A/R 0.50mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.75mm Oversize 0.50mm Over	_	Ring, Retaining		Standard			
3 3901172 Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod A/R 1.00mm Oversize A/R 0.50mm Oversize 0.75mm Oversize 1.00mm Oversize 4 3802764 (3928674) Piston, Engine Ring, Retaining Set, Piston Ring Set, Piston Ring Set, Piston Ring Set, Piston, Engine Piston Piston, Engine Piston, Engine Piston, Engine Piston, Engine Ring, Retaining Set, Piston, Engine Ring, Retaining Set, Piston, Engine Ring, Retaining Set, Piston, Engine Ring, Retaining Set, Piston Ring Retaining Set, Piston Ring Retaining Set, Piston Ring Retaining Set, Piston Ring Retaining Set, Piston Ring Retaining Set, Piston Ring Retaining Set, Piston Ring Rod A/R 0.50mm Oversize N/R 0.75mm Oversize Set, Piston Ring N/R 0.50mm Oversize Set, Piston Ring N/R 0.50mm Oversize Set, Piston Ring Set, Pi				Statituaru			
3 3901172 Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod Bearing, Connecting Rod A/R 1.00mm Oversize 1.00mm Oversize 4 3802764 (3928674) Piston, Engine Ring, Retaining Set, Piston Ring 6 0.50mm Oversize 0.50mm Oversize 5 3802422 Set, Piston Ring 1 0.50mm Oversize 4 3802765 (3928675) Piston, Engine Piston, Engine Piston, Engine Piston, Engine Ring, Retaining 6 1.00mm Oversize 1.00mm Oversize 5 3901706 Ring, Retaining 2 1.00mm Oversize 1.00mm Oversize	3 3901171	Bearing, Connecting Rod	A/R	0.25mm Oversize			
3 3901173 Bearing, Connecting Rod Bearing, Connecting Rod A/R A/R 0.75mm Oversize 1.00mm Oversize 1	- a	Bearing, Connecting Rod		0.50mm Oversize			
4 3802764 Kit, Engine Piston 6 0.50mm Oversize 0.50mm Oversize 0.50mm Oversize 0.50mm Oversize 5 3901706 Ring, Retaining 2 2 Set, Piston Ring 1 0.50mm Oversize 0.50mm Oversize 1 0.50mm Oversiz	3 3901173	Bearing, Connecting Rod					
(3928674) Piston, Engine 1 0.50mm Oversize	3 3901174	Bearing, Connecting Rod	A/R	1.00mm Oversize			
(3928674) Piston, Engine 1 0.50mm Oversize	4 3802764	Kit. Engine Piston	6	0.50mm Oversize			
5 3901706 Ring, Retaining 2 1 0.50mm Oversize 4 3802765 Kit, Engine Piston 6 1.00mm Oversize 9 1 1.00mm Oversize 1 1.00m		Piston, Engine					
4 3802765 Kit, Engine Piston 6 1.00mm Oversize (3928675) Piston, Engine 1 1.00mm Oversize 5 3901706 Ring, Retaining 2	5 3901706	Ring, Retaining	2				
(3928675) Piston, Engine 1 1.00mm Oversize 5 3901706 Ring, Retaining 2	6 3802422	Set, Piston Ring	1	0.50mm Oversize			
5 3901706 Ring, Retaining 2							
				1.00mm Oversize			
	~			1.00mm Oversize			

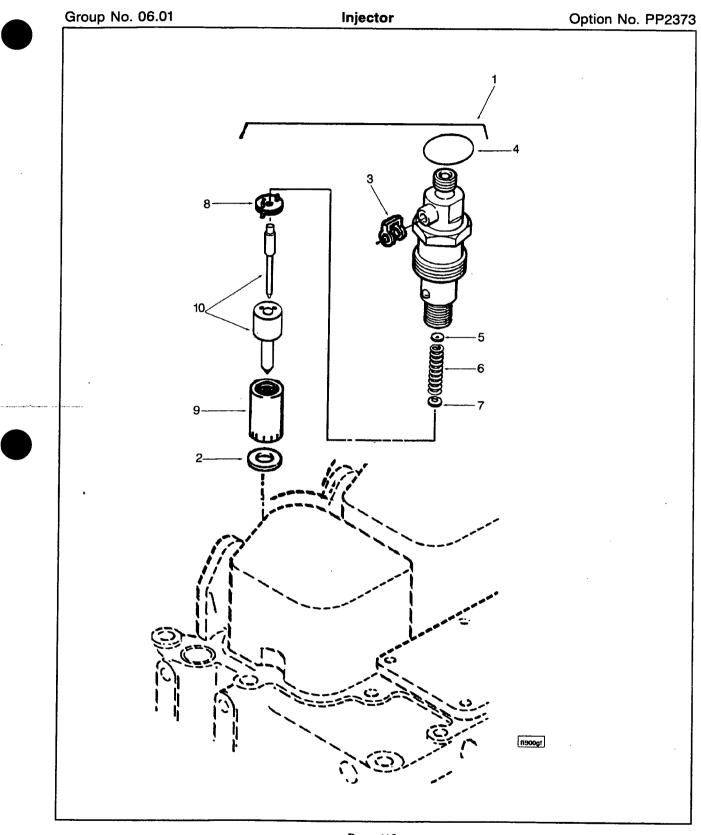
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Camshaft Group No. 01.07 Option No. PP2373 Part Number **Part Name** Req Remarks CAMSHAFT **OPTION PP2373** Camshaft Key, Plain Woodruff Gear, Camshaft Screw, Hexagon Head Cap Support, Camshaft Thrust 3929886 1 1 1 2 3902332 2 3 3929030 3900227 M8 x 1.25 x 22 3927155 5

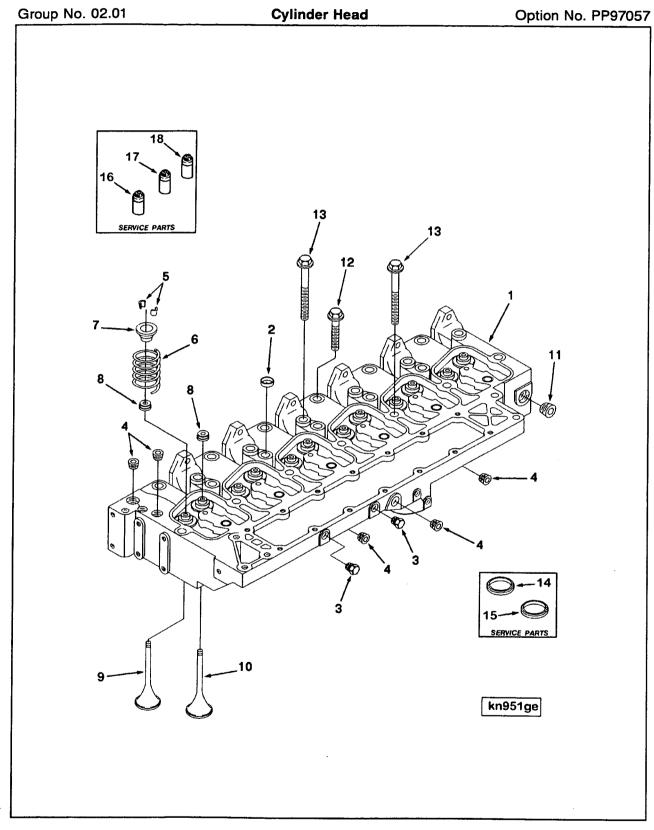
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Group No. 06.01 Injector Option No. PP2373 Ref Part Number Part Name Req Remarks No. **INJECTOR OPTION PP2373** 3802677 Kit, Injector 6 (3929490) Injector 1 3906659 Seal, Injector 2 1 3 3903380 Seal, Banjo Connector 1 3909356 Seal, Rectangular Ring 4 Shim 3905156 A/R 5 1.00 mm Thick 3905157 Shim 1.04 mm Thick A/R 5 3905158 Shim A/R 1.08 mm Thick 5 3905159 5 Shim A/R 1.10 mm Thick 5 3905160 Shim A/R 1.14 mm Thick 3905161 Shim 5 A/R 1.18 mm Thick 3905162 Shim A/R 1.20 mm Thick 5 3905163 5 Shim A/R 1.24 mm Thick Shim 3905164 5 A/R 1.28 mm Thick 5 3905165 Shim A/R 1.30 mm Thick 5 3905166 Shim A/R 1.34 mm Thick 5 5 3905167 Shim A/R 1.38 mm Thick 3905168 Shim A/R 1.40 mm Thick 3905169 Shim 5 A/R 1.44 mm Thick 5 3905170 Shim **A/R** 1.48 mm Thick 5 3905171 Shim A/R 1.50 mm Thick 5 3905172 Shim 1.54 mm Thick **A/R** 1.58 mm Thick 5 3905173 Shim A/R 3905174 Shim 5 A/R 1.60 mm Thick 5 3905175 Shim A/R 1.64 mm Thick 3905176 5 Shim **A/R** 1.68 mm Thick 5 3905177 Shim A/R 1.70 mm Thick 5 3905178 Shim A/R 1.74 mm Thick 5 3905180 Shim A/R 1.78 mm Thick 3905181 Shim 1.80 mm Thick 5 A/R 5 3905182 Shim A/R 1.84 mm Thick 5 3905183 Shim **A/R** 1.88 mm Thick 5 3905184 Shim A/R 1.90 mm Thick 5 3905185 Shim A/R 1.94 mm Thick 3905186 Shim A/R 1.98 mm Thick 3905152 Spring, Compression 6 6 7 3917945 Spindle 8 3917946 Disc, Intermediate 6 3905155 Retainer, Injector Nozzle 9 6 3929492 Nozzle, Injector 10 6

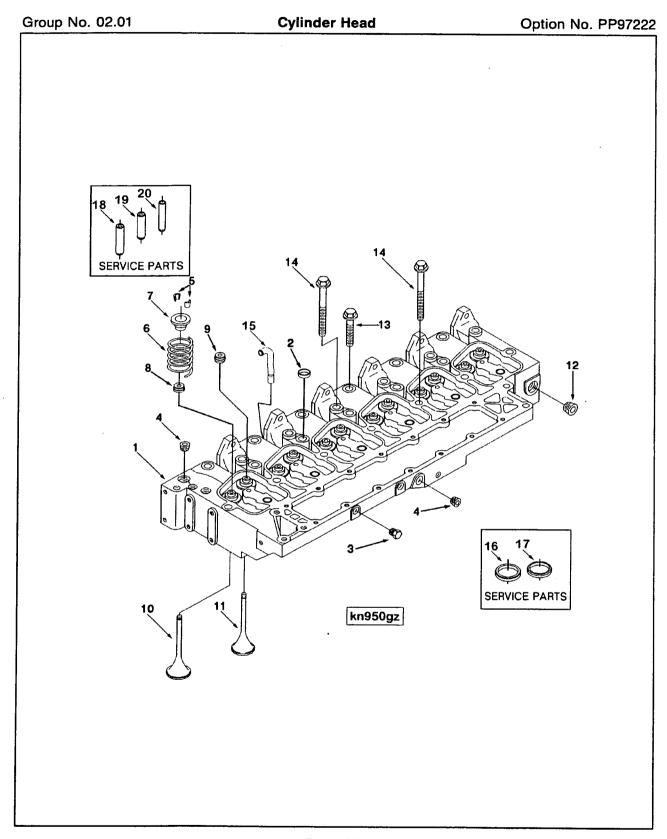
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Cylinder Head Group No. 02.01 Option No. PP97057 Ref Part Number **Part Name** Rea Remarks CYLINDER HEAD **OPTION PP97057** CYLINDER HEAD Engine Family: B Series Cylinder: 6 Swirl: Low Exh Spring PSI: 36 Cylinder Head Valve Material: Standard Exhaust Manifold Type: Dry Aspiration: Charge Air Cooled Turbocharged Head, Cylinder Head, Cylinder 3934769 (3934746) 1 2 (3812092) Plug, Expansion Plug, Pipe Plug, Pipe 3906619 1/8 NPT 2 5 6 3008468 1/2 NPT 4 Valve, Intake 3802355 Collet, Valve 3900250 12 9 (3920867)Valve, Intake 6 3802356 Valve, Exhaust 6 5 10 Collet, Valve 12 3900250 Valve, Exhaust (3920868)6 3926700 Spring, Valve 12 6 3900299 Retainer, Valve Spring 12 8 3901097 Seal, Vaive Stem 6 3921640 Seal, Valve Stem 6 8 3008469 3/4 NPT Plug. Pipe 1 11 Screw, Hex Flange Head Cap 3920779 6 M12 x 1.75 x 70 12 3920780 Screw, Hex Flange Head Cap 13 14 M12 x 1.75 x 120 **SERVICE PARTS** 3904105 Insert, Valve Exhaust 14 3906854 Insert, Valve Intake 15 3904408 Guide, Valve Stem 16 Thick wall 60.50mm Long intake 3904409 Guide, Valve Stem Thick wall 51.75mm Long exhaust 17 18 3906206 Guide, Valve Stem Thin wall can be used on both intake and exhaust

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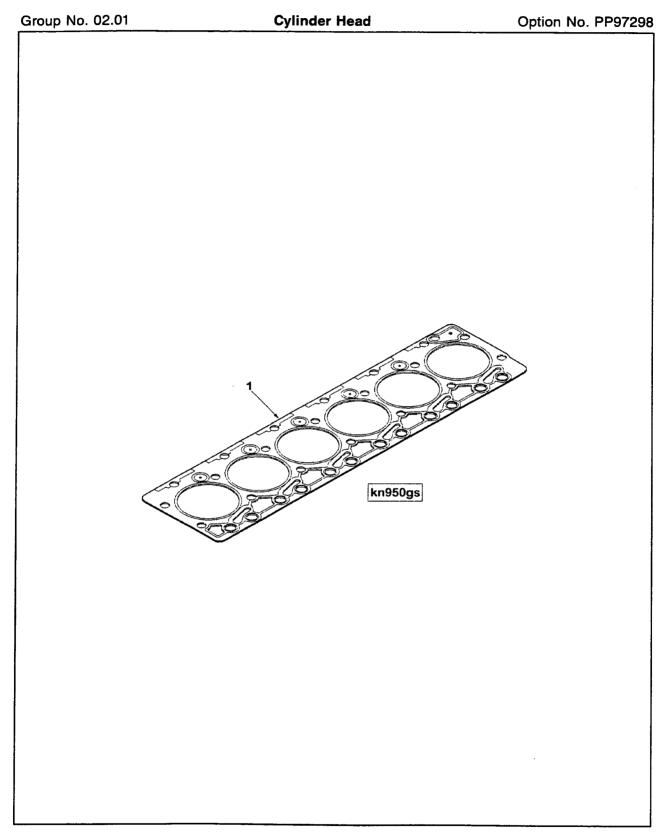
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Group No. 02.01

Cylinder Head

Gro			Cylinder Head	
Ref No.		Part Name	Req	Remarks
1 2 3 4 5 10 5 11 6 7 8 9 9 12 13 14 15	3934795 (3934783) 3812092 3906619 3008468 3802355 3900250 (3920867) 3802356 3900250 (3920868) 3926700 3900299 3901097 3921640 3008469 3920779 3920780 3926446	CYLINDER HEAD OPTION PP97222 Head, Cylinder Head, Cylinder Plug, Expansion Plug, Pipe Plug, Pipe Plug, Pipe Valve, Intake Collet, Valve Valve, Intake Valve, Exhaust Collet, Valve Valve, Exhaust Spring, Valve Retainer, Valve Spring Seal, Valve Stem Seal, Valve Stem Plug, Pipe Screw, Hex Flange Head Cap Screw, Hex Flange Head Cap Tube, Aftercooler	1 1 4 2 5 6 12 6 6 12 12 6 6 14 1	Cylinder Head Engine Family: B Series Cylinder: 6 Swirl: Low Exh Spring PSI: 36 Cylinder Head Material: Cast Iron Cylinder Head Valve Material: Standard Exhaust Manifold Type: Dry Exhaust Valve Seal: Improved Seal Aftercooler Water Supply Tap From FFOB (MM): 256.5 Forward Valve Seat Inserts: No Valve Bridge Scalloping: No Aspiration: Jacket Water Aftercooled 1/8 NPT 1/2 NPT 3/4 NPT M12 x 1.75 x 70 M12 x 1.75 x 120
16 17 18 19 20	3904105 3906854 3904408 3904409 3906206	Insert, Valve Insert, Valve Insert, Valve Guide, Valve Stern Guide, Valve Stern Guide, Valve Stern Guide, Valve Stern		Exhaust Intake Thick wall 60.50 mm long intake Thick wall 51.75 mm long intake Thin wall can be used on both intake and exhaust

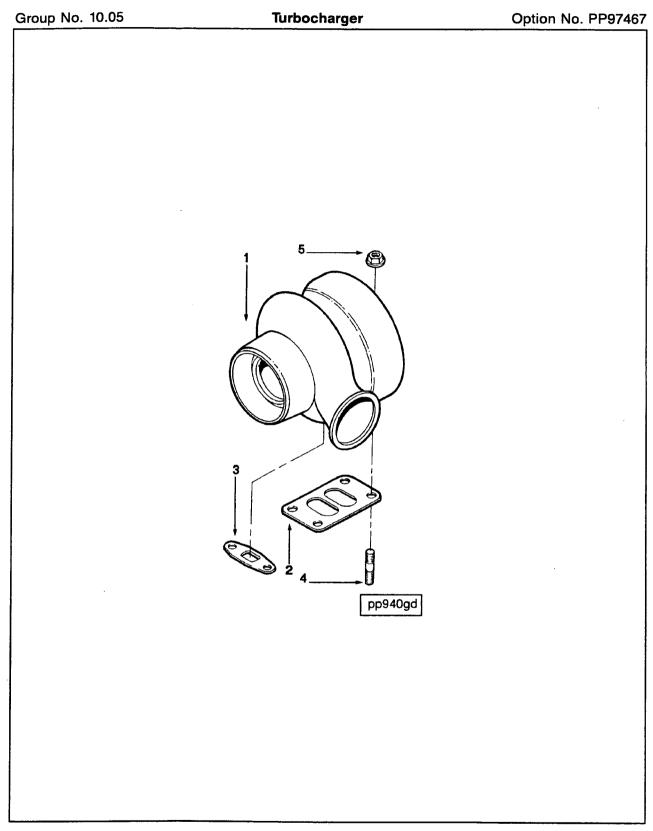
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	ıp No. 02.01	Cylinder He	ead	Option No. PP	97298
Ref No.	Part Number	Part Name	Req	Remarks	
		CYLINDER HEAD OPTION PP97298			
1	3283570	Gasket, Cylinder Head	1	Cylinder Head Mounting Structure Code: 02 EBM Engine Family: B Series Engine Cylinders: 6 Gasket Material: Standard	

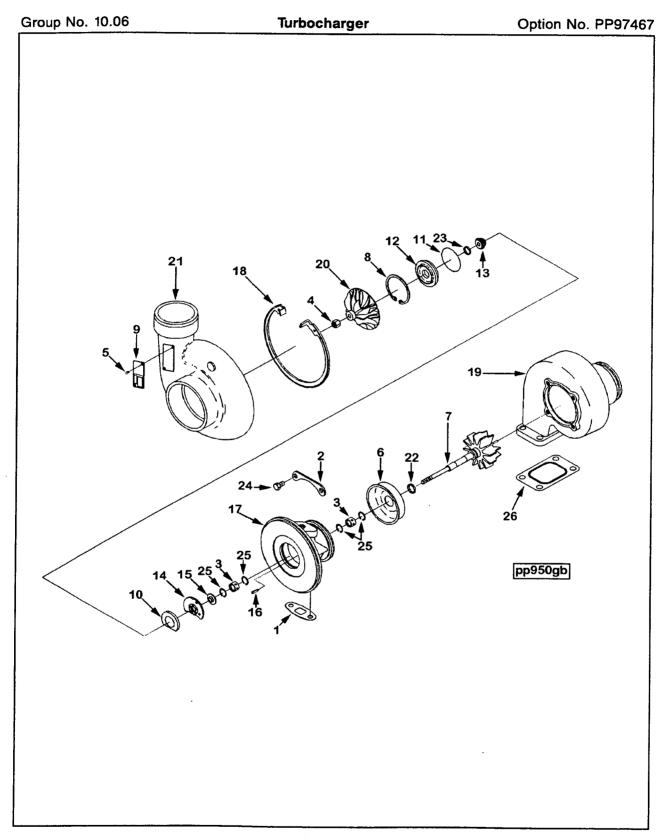
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Grou	roup No. 10.05 Turbocharger		ger	Option No. PP9746	
Ref No.	Part Number	Part Name	Req	Remarks	
Ref			- 		

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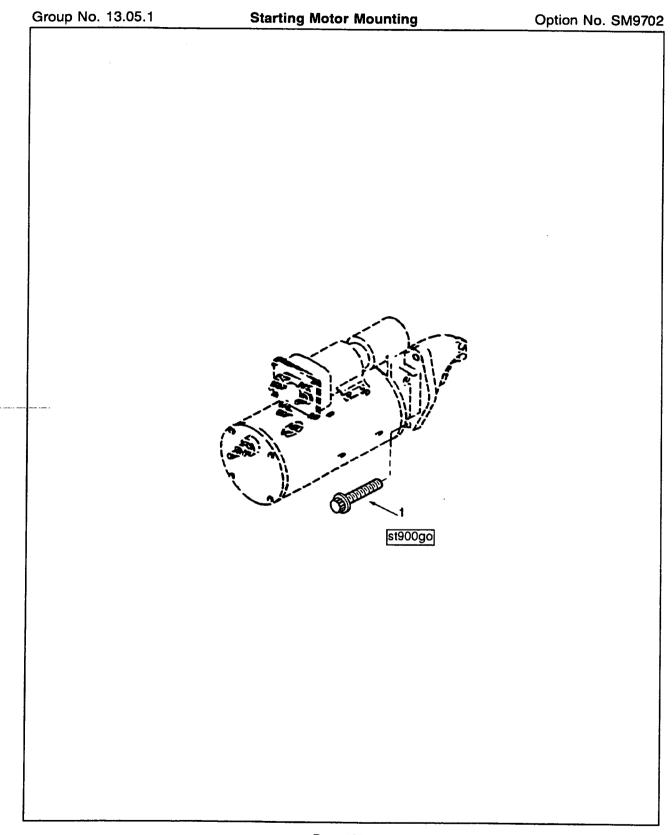
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Group No. 10.06

Turbocharger

	p No. 10.06 Iurbocharger		Option No. PP974			
Ref No. Part	Number	Part Numbe	Part Name	Req	Remarks	
	-		TURBOCHARGER OPTION PP97467		Turbocharger	
(3590) 2 3501 3 3503 4 3503 5 3519 6 3519 7 3519 8 3527 10 3528 11 3528 12 3530 13 3530 14 3532 15 3532 16 3522 17 (3532 18 3533 19 3536 20 (3537 21 3537 22 3756 23 3758 24 3759 26 3709	0100) 188 100 562 163 302 336 566 7619) 104 933 923 924 215 597 2631) 163 617 7164) 334 754 848 8917	3806295 (3590100) 3501188 3503100 3503562 3519163 3519302 3519336 3527566 (3527619) 3528104 3528933 3530924 3532217 3522597 (3532631) 35336617 (3537164) 3537334 3756754 3758848 3759917 3762259 3709861 3519807	Turbocharger Plate, Clamping Bearing, Turbocharger Nut, Lock Screw, Drive Shield, Turbocharger Heat Shaft & Wheel Ring, Retaining Dataplate Baffle, Oil Seal, O Ring Plate, Oil Seal Slinger, Oil Bearing, Tur Thrust Collar, Thrust Pin, Roll Housing, Tur Bearing Ring, Retaining Housing, Turbine Impeller, Tur Compressor Housing, Compressor Seal, Split Ring Seal, Split Ring Screw, Hexagon Head Set Ring, Retaining Gasket, Turbocharger Gasket, Turbocharger	1 1 2 2 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1	M7 x 1.0 Thd M8 x 1.25 x 12	

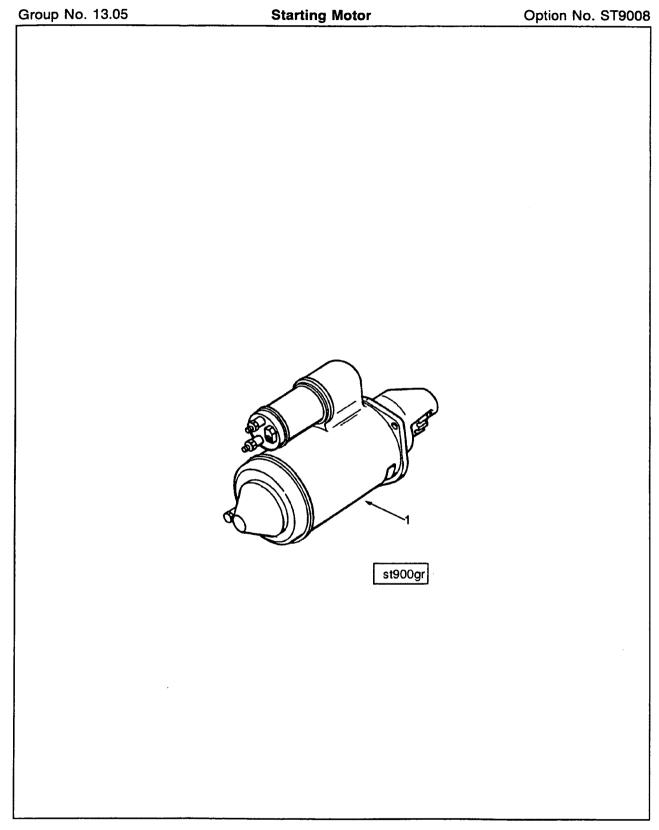
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Group No. 13.05.1 **Starting Motor Mounting** Option No. SM9702 Part Number Part Name Req Remarks No. STARTING MOTOR MOUNTING OPTION SM9702 Starter Mounting Clutch Type: Dry Mounting Capscrew Size or Nut Size: M10
Required Pilot Bore (MM): 88.9 Spacer Thickness (MM): 0.0 Engine Family: **B** Series C Series Starter Mount SAE: Chrysler Unique - 3 Bolt SAE #1-3 Bolt 90 Degree SAE #3-3 Bolt 120 Degree 3903834 Screw, Twelve Point Cap 3 M10 x 1.50 x 35

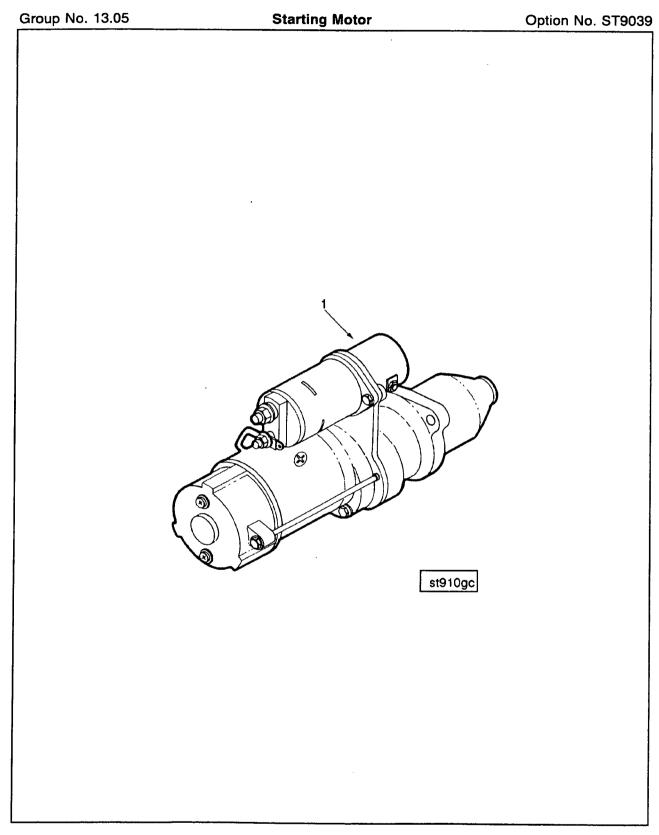
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		Starting Mo	tor	Option No. ST900
Ref No.	Part Number	Part Name	Req	Remarks
Ref	Part Number	Part Name STARTING MOTOR OPTION ST9008 Motor, Starting		Remarks Starting Motor Mfg: Lucas Volt: 12 Model/Type: M127 Dia Pitch: 10/12 Mt SAE: SAE #1 - 3 Bolt 90 Degree Wet/Dry: Dry Starter Style: Barrel Pilot Bore Diameter (MM): 88.90 W/Heat Shield: No Mtg Flg Thickness: 12.00 Angle Limitation High: 135 Angle Limitation Low: 315 Supply Method: Mounted Structure Code: 02 EBM Exposed Starter Length: 264.9 Starter Pinion Tooth Blank: 10 Starter Pinion Offset (MM): 0 Starter Solenoid Angle (Deg): 315 Engine Family: B Series

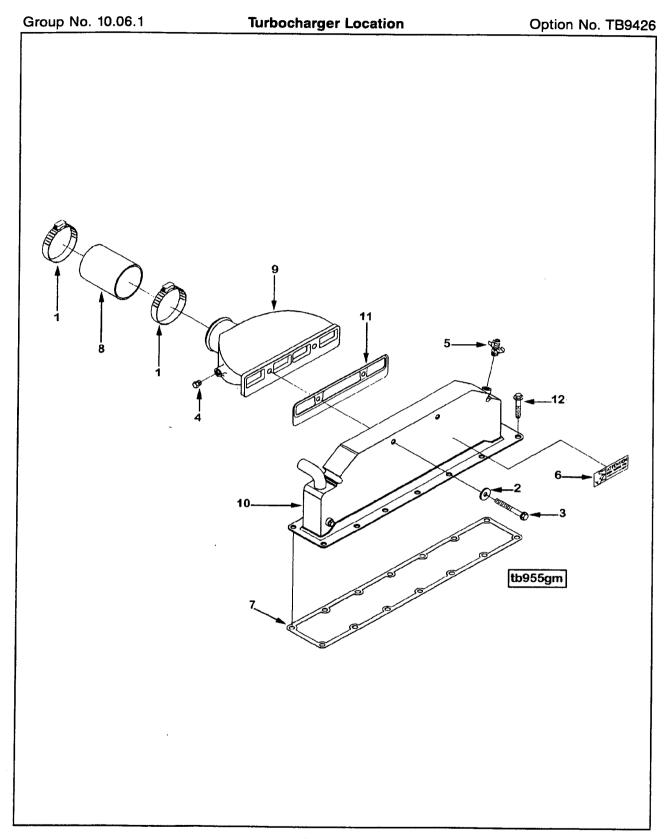
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Ref Part Number	Part Name	Req	Remarks
No. Part Number	- Tarrane	1104	nemarks
	STARTING MOTOR		
	OPTION ST9039		Starting Motor
1 3916854		7	Starting Motor Mfg: Delco-Remy Volt: 12 Model/Type: 28MT Type 171 Dia Pitch: 10/12 Mt SAE: SAE #1 - 3 Bolt 90 degree Wet/Dry: Dry Starter Style: Barrel Pilot Bore Diameter (mm): 88.90 W/Heat Shield: No Mtg Flg Thickness (mm): 13.00 Angle Limitation High (deg): 135 Angle Limitation Low (deg): 315 Supply Method: Mounted Structure Code: 02 EBM Exposed Starter Length (mm): 243.6 Starter Pinion Tooth Blank: 11 Starter Pinion Toffset (mm): 0 Starter Solenoid Angle (deg): 315 Engine Family: B Series

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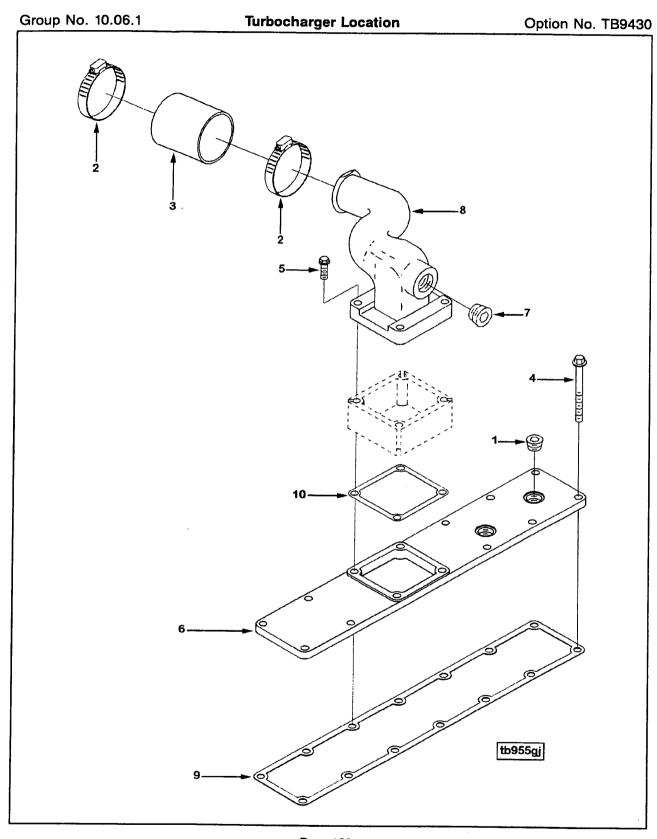


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Option No. TB9426

Group No. 10.06.1	Turbocharger Loca	ation	Option No. TB9420
Ref No. Part Number	Part Name	Req	Remarks
1 3026396 2 3278499 3 3903096 4 3906619 5 3909394 6 3910778 7 3931347 8 3916437 9 3928502 10 3928503 11 3930426 12 3930837	Clamp, Hose Washer, Plain Screw, Hex Flange Head Cap Plug, Pipe Draincock Decal Gasket, Int Manifold Cover Hose, Plain Connection, Air Crossover Aftercooler Gasket, Connection Screw, Hex Flange Head Cap	2 2 2 2 1 1 1 1 1 1 10	Turbocharger Location Engine Family: B Series Cylinders: 6 Exhaust Outlet Location: HMFO Turbo Exh Loc from FFOB (mm): 224 Exh Vert from Crank C/L (mm): 572 Exh Horz. Crank C/L (mm): 167 Aspiration: Jacket Water Aftercooled Crossover Routing: Top Standard Oil Supply Routing: Outboard Exh. Manifold Type: Dry Intake Cover Provided: No Turbocharger Type: Non- Wastegate Structure Code: 02 EBM Requires Air Heater/Spacer: Yes Mounting Studs Provided: None Additional Mounting Bosses: 0 Turbo Drain Location: Front Drain Bearing Housing Manufacturer: Holset Turbo Drain Tube Type: Rigid Exhaust Support Flange: 2- M14 44.50mm apart Base Turbo ID17 Number: 3537132 3590100 2 1/16 - 3 Inch M8 x 1.25 x 70 1/8 NPT

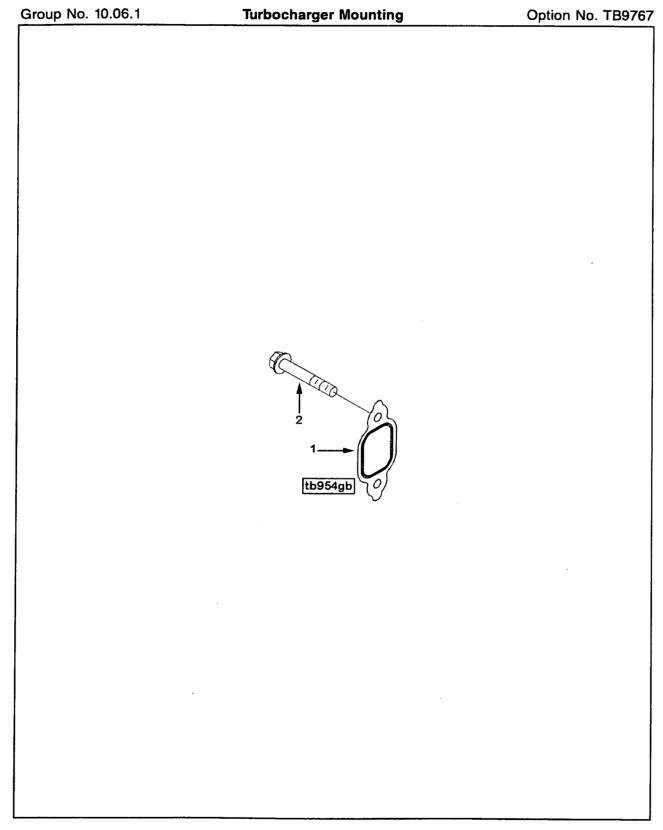
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Ref No. Part Number	Part Name	Req	Remarks
	Plug, Pipe Clamp, Hose Hose, Plain Screw, Hex Flange Head Cap Screw, Hex Flange Head Cap Cover, Intake Manifold Plug, Pipe Connection, Air Crossover Gasket, Int Manifold Cover Gasket, Connection	2 2 1 9 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Turbocharger Location Engine Family: B Series Cylinders: 6 Exhaust Outlet Location: HMFO Turbo Exh Loc from FFOB (mm): 223 Exh Vert from Crank C/L (mm): 572 Exh Horz. Crank C/L (mm): 166 Aspiration: Turbocharged Crossover Routing: Top Standard Oil Supply Routing: Outboard Exh. Manifold Type: Dry Intake Cover Provided: Yes Intake Connection OD (in): 2.5 Intake Conn. Orientation: Horizontal Turbocharger Type: Non- Wastegate Structure Code: 02 EBM Cylinder Head Type: Standard Intake Cover Opening Position: Rear Mounting Studs Provided: None Additional Mounting Bosses: 0 Turbo Drain Location: Front Drain Bearing Housing Manufacturer: Holset Turbo Drain Tube Type: Rigid Exhaust Support Flange: 2- M14 44.50mm apart Base Turbo ID17 Number: 3537132 3590100 Used with either an air heater or spacer connection. 1/2 NPT 2 1/16 - 3 Inch M8 x 1.25 x 25 M8 x 1.25 x 90 3/4 NPT

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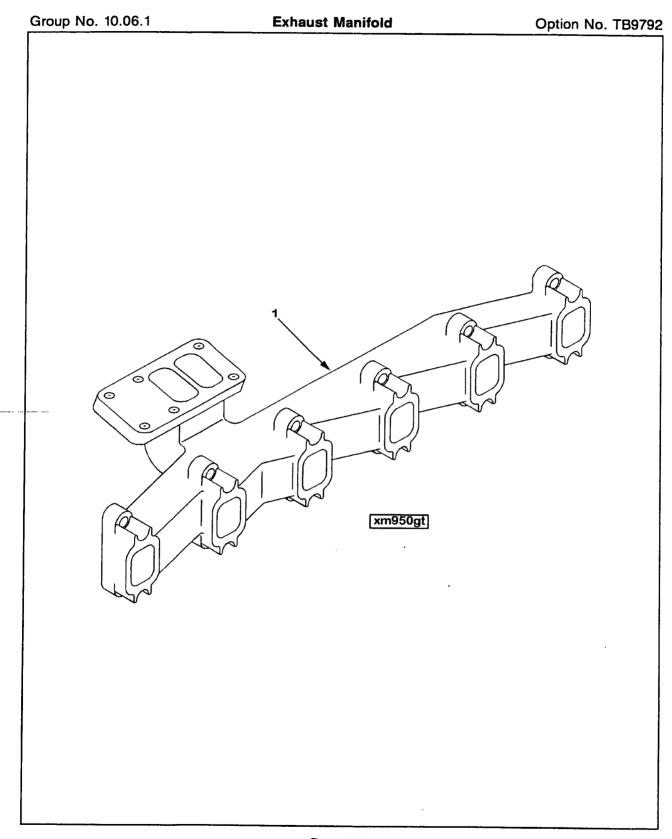


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ef o.	Part Number	Part Name	Req	Remarks	
+			+		
		TURBOCHARGER MOUNTING			
		OPTION TB9767		Turbo Location Mounting	
1	3927154	Gasket, Exhaust Manifold	6	Structure Code: 02 EBM Engine Family: B Series Cylinders: 6 Horsepower Limitation: < = 200 Mounting Studs Provided: None Premium Gasket	
2	3901448	Screw, Hex Flange Head Cap	12	M10 x 1.50 x 65	
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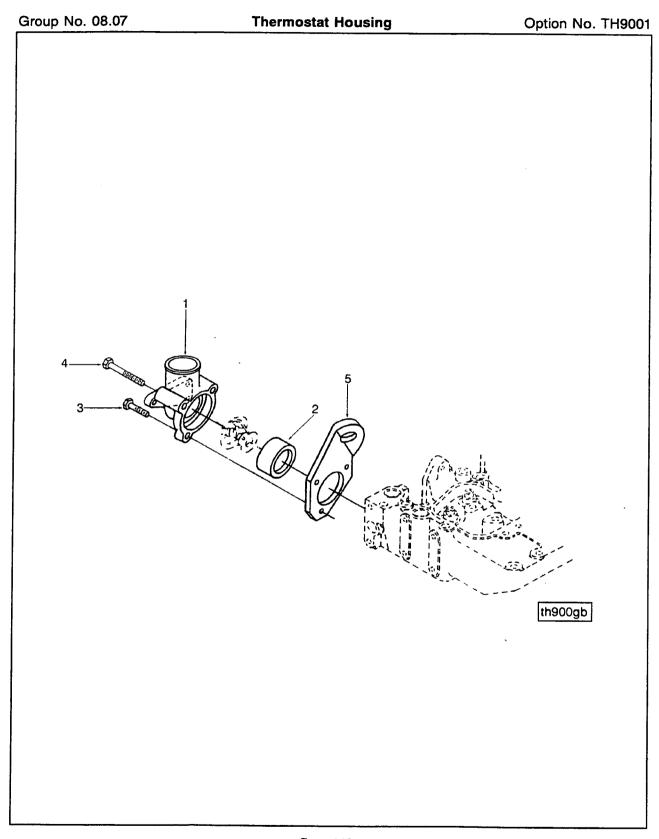
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Group No. 10.06.1 **Exhaust Manifold** Option No. TB9792 Ref Part Number Req Part Name Remarks No. **EXHAUST MANIFOLD OPTION TB9792 Exhaust Manifold** Structure Code: 02 EBM Engine Family: B Series Engine Cylinders: 6 Manifold Material: Standard Turbo Exhaust Location: HMFO Manifold Type: Dry Additional Mounting Bosses: 0 KCEC may substitute 3863107 for 3901683 manifold, exhaust . 3901683 Manifold, Exhaust 1

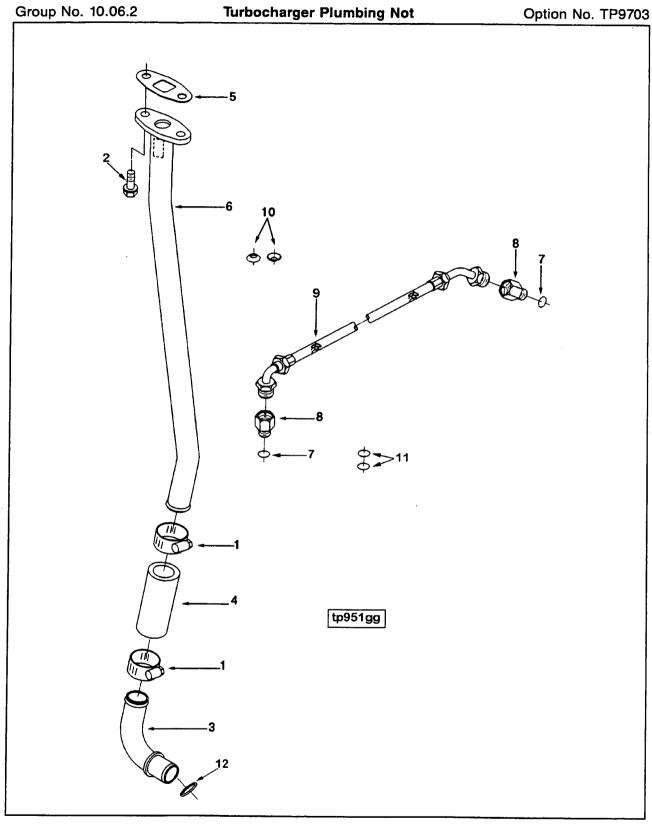
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Group No. 08.07 **Thermostat Housing** Option No. TH9001 Ref No. Part Number **Part Name** Req Remarks THERMOSTAT HOUSING **OPTION TH9001** Water Outlet O.D.: 45mm Water Outlet Flow Direction: Vertical Lifting Bracket Direction: Vertical/Back Housing, Thermostat Gasket, Thm Housing Cov Screw, Hex Flange Head Cap 3914409 3923331 1 1 2 2 3900632 M8 x 1.25 x 35 3926972 Screw, Hex Flange Head Cap .250 inch thick 3903757 Bracket, Lifting

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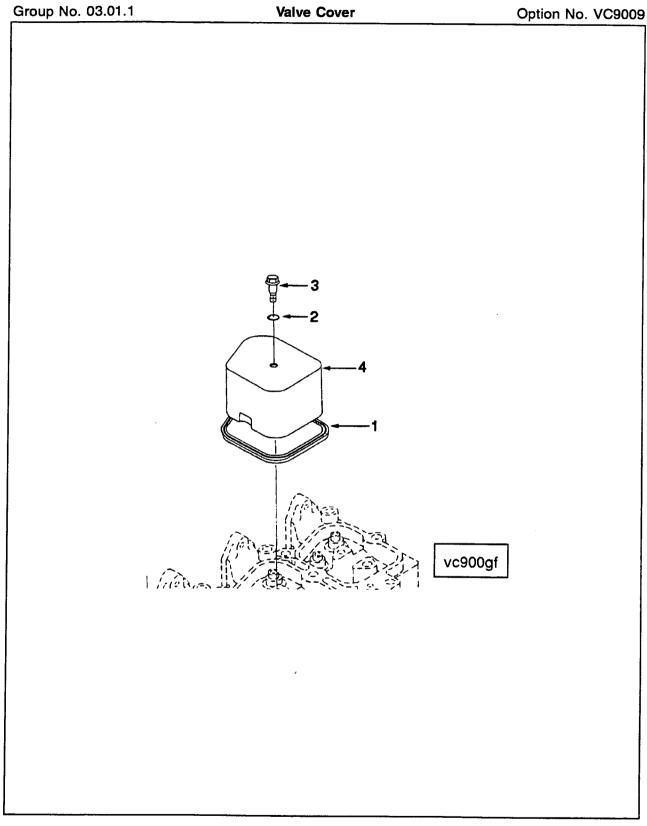
Group No. 10.06.2

Turbocharger Plumbing Not

Option No. TP9703

Ref No.	Part Number	Part Name	Req	Remarks	
1 2 3 4 4 5 6 7 8 9 10 11	43828 A 3900630 3931973 3931970 3931350 3934093 3919687 3037236 3920801 3918562 3924389 3928624 3931824	Clamp, Hose Screw, Hex Flange Head Cap Tube, Tur Oil Drain Hose, Plain Gasket, Oil Drain Connection, Tur Oil Drain Connector, Female Seal, O Ring Connector, Female Hose, Flexible Washer, Sealing Seal, O Ring Seal, O Ring Seal, O Ring	2 2 1 1 1 1 2 2 1 1 1 2 2 1	Turbocharger Plumbing Structure Code: 02 EBM Engine Cylinders: 6 Engine Family: B Series Turbo Exhaust Location: HMFO Oil Filter Mounted Location: Vertical Manifold Type: Dry Turbo Drain Line Routing: Outboard Block Drain Location: Front Drain KCEC may substitute 43828 A, 3918579, 3903744, and 3903745 by 3929516 and 3928624. DEP may substitute 43828A, 3918579, 3903744 and 3933201. 11 16 - 1 1/2 Inch M8 x 1.25 x 20	

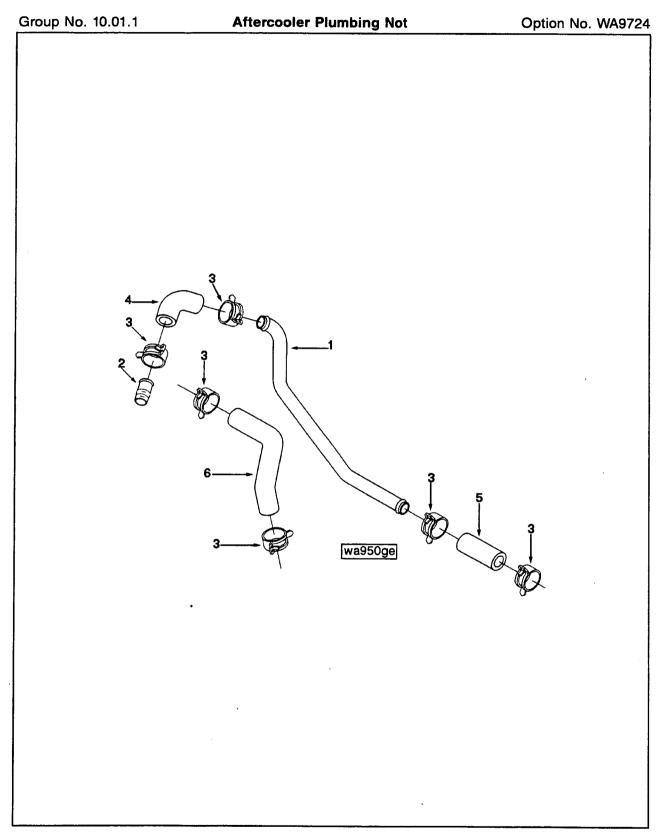
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Group No. 03.01.1 **Valve Cover** Option No. VC9009 Ref No. Part Number Part Name Req Remarks **VALVE COVER** OPTION VC9009 Valve Cover Family: B Series Cylinders: 6 Oil Fill Cylinder: None Noise Supression Provision: No Structure Code: 02 EBM Studded C/S Location: None. 3930906 Gasket, Valve Cover 1 6 3928406 Isolator, Noise Screw, Hex Flange Head Cap 2 3907049 6 3 M8 x 1.25 x 25 3928404 Cover, Valve

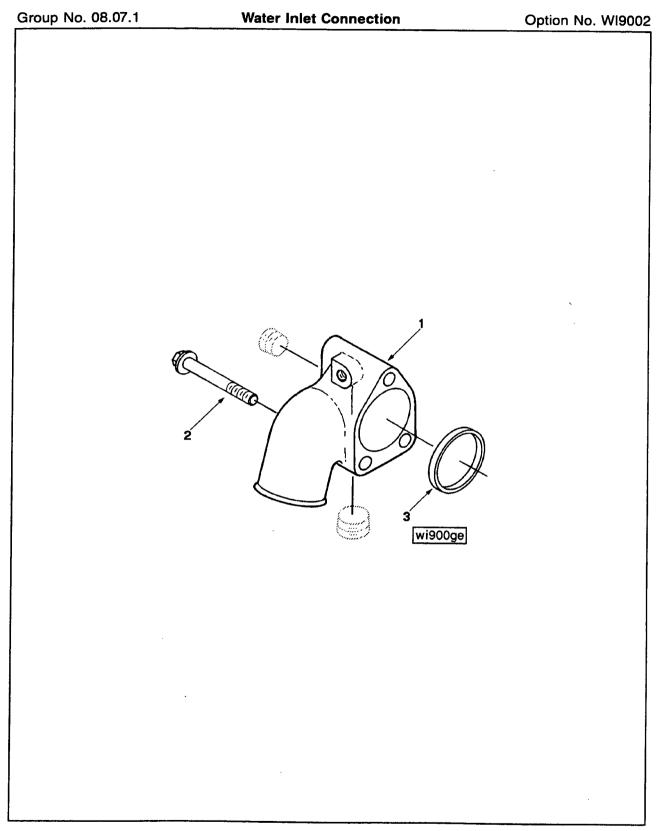
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Group No. 10.01.1 **Aftercooler Plumbing Not** Option No. WA9724 Req Part Number **Part Name** Remarks No. AFTERCOOLER PLUMBING **OPTION WA9724** Exhaust Manifold Type: Dry Compatible with grid heater DEP may use 3282704 tube, aftercooler; 3282444 coupling, elbow hose and (2) 3918611 hose, plain in place of 3927956 tube, aftercooler; 3907167 coupling, plain hose; (1) 3918611 hose, plain and 3918607 hose, elbow. 3927956 Tube, Aftercooler 2 3907167 Coupling, Plain Hose Clamp, Hose Hose, Elbow 3918163 6 3918607 5 3918611 Hose, Plain 1 3928492 Hose, Elbow

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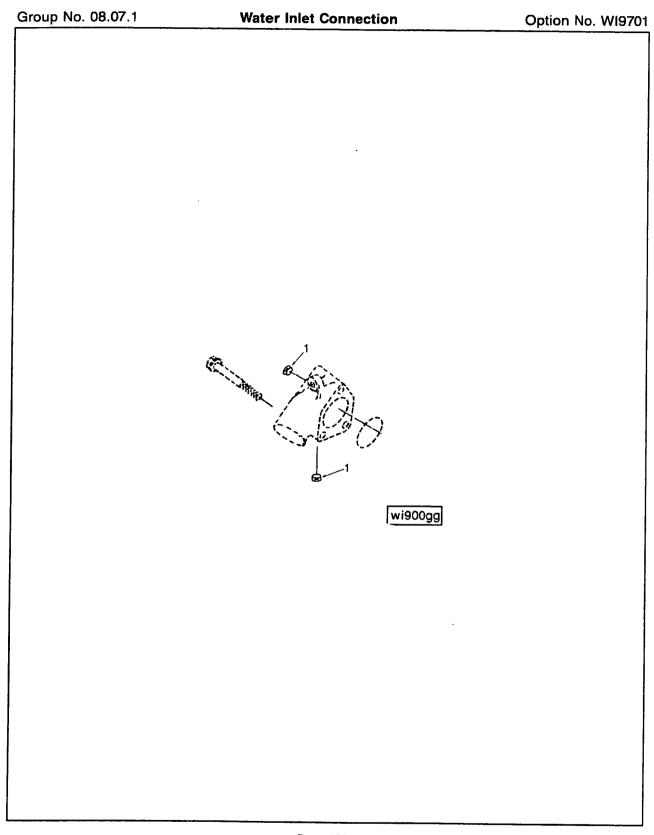
Group No. 08.07.1

Water Inlet Connection

Option No. WI9002

	up No. 08.07.1	Water Inlet Conne	ction	Option No. Wi900
Ref No.	Part Number	Part Name	Req	Remarks
	, , , , , , , , , , , , , , , , , , ,	WATER INLET CONNECTION		Wester Labor Co.
		OPTION WI9002		Water Inlet Connection Structure Code: 02 EBM Engine Family: B Series Inlet Connection OD (MM): 58.00 Connection Type: Beaded Connection Orientation: 73 Degree Down Contains Mtg Pad For Freon Compressor: No Attachment For Low Profile Tensioner: No
1 2 3	3903103 3901757 3906697	Connection, Water Inlet Screw, Hex Flange Head Cap Seal, Rectangular Ring	1 3 1	M10 x 1.50 x 75
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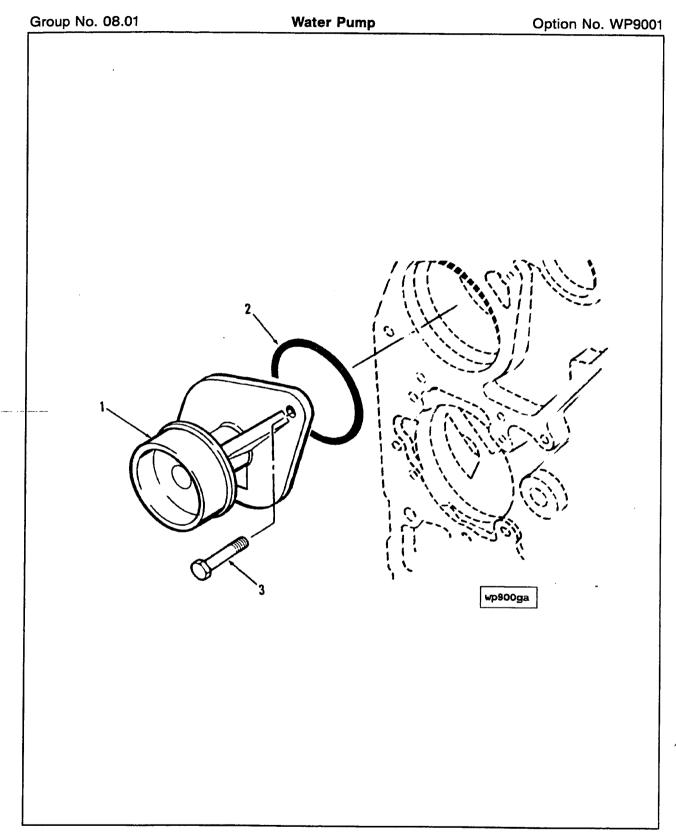
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Water Inlet Connection Group No. 08.07.1 Option No. WI9701 Ref No. Req **Part Number** Part Name Remarks WATER INLET CONNECTION **OPTION WI9701** Plugs for use in water inlet connection to be used without water cooled exhaust manifold . 2 1/2 NPT 3008468 Plug, Pipe 1

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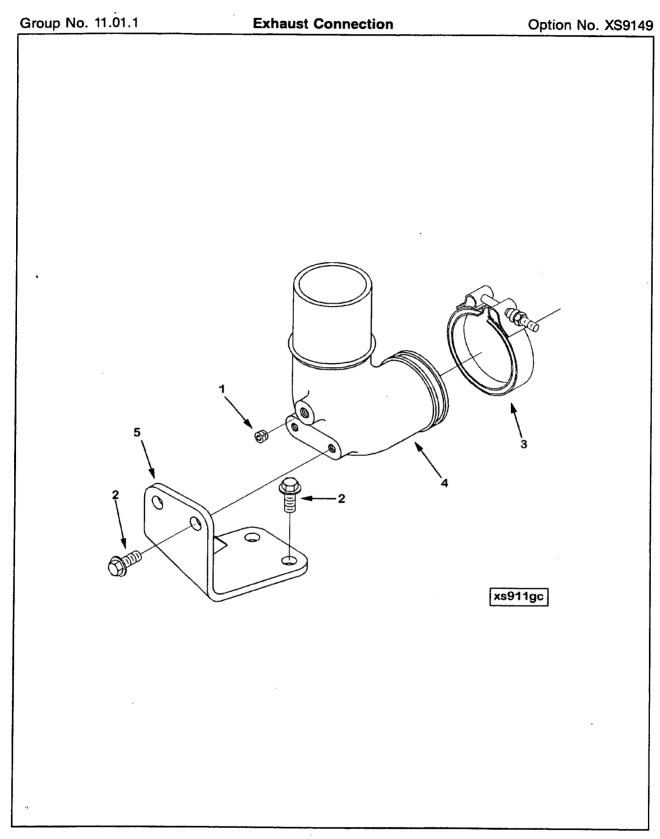
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Group No. 08.01

Option No. WP9001

Gro	up No. 08.01	No. 08.01 Water Pump		Option No. WP9001		
Ref No.	Part Number	Part Name	Req	Remarks		
		WATER PUMP				
		OPTION WP9001		Water Pump Pulley Type: Standard Engine Family: B Series Pulley Diameter (MM): 88.00 P/N 3903297, O-Ring Seal is interchangeable with P/N 3906698		
1 2 3	3802971 (3283602) 3906698 3941981	Kit, Water Pump Pump, Water Seal, Rectangular Ring Screw, Hexagon Head Cap	1 1 1 2			
		•				
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Group No. 11.01.1 **Exhaust Connection** Option No. XS9149 Ref Req Part Number **Part Name** Remarks No **EXHAUST CONNECTION** OPTION XS9149 **Exhaust Connection** Structure Code: 02 EBM Engine Family: B Series Support Flange Bolt Pattern: 2-M14 44.50mm Apart Exhaust Manifold Type: Dry
Exhaust Pipe Diameter (In.): 3.00
Connection Orientation: To Be Determined Turbocharger Type: Wastegate Restricted Cylinders: 6 Restricted Turbocharger Location: HMFO Restricted Aspiration: Turbocharged Jacket Water Aftercooled 1/4 NPT S 910 B Plug, Pipe Screw, Hex Flange Head Cap 3902460 M10 X 1.50 X 25 4 3903652 Clamp, V Band 3 1 3910991 Pipe, Exhaust Outlet 5 3930717 Brace, Exh Out Connection

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Service Gasket Set

	up 140. 17.02	Service Gasket	1 1	
Ref No.	Part Number	Part Name	Req	Remarks
		SERVICE GASKET SET		
		UPPER ENGINE SET BR		
		.25MM OVER THICKNESS		•
	3802364	Set, Upper Engine Gasket Seal, Injector	1 1	
	3900808 3901356	Gasket, Turbocharger	6	
	3902363	Seal, Rectangular Ring	i	
	3902425	Washer, Sealing	1 1	
	3930906 3903380	Gasket, Valve Cover Seal, Banjo Connector	6	
	3927154	Gasket, Exhaust Manifold	6	
	3906694 3906773	Seal, Rectangular Ring Washer, Sealing		
	3910824	Seal, O Ring	6	
	3912220	Gasket, Exh Out Connection	1	
	3931347 3931350	Gasket, Int Manifold Cover Gasket, Oil Drain		
	3918188	Washer, Sealing	2	
	3919358	Sleeve, Injector	6	1
1 1	3923261 3906659	Seal, Injector Seal, Injector	6	
] [3283337	Gasket, Cylinder Head	1	
	3901097	Seal, Valve Stem	12	
	3923331 3921640	Gasket, Thm Housing Cover Seal, Valve Stem	1 12	
	3930543	Isolator, Noise	1 1	
		UPPER ENGINE SET BR		
	0000045	.50MM OVER THICKNESS Set, Upper Engine Gasket		
	3802245 3900808	Seal, Injector	6	
	3901356	Gasket, Turbocharger	1	
1	3902363 3902425	Seal, Rectangular Ring Washer, Sealing		
i l	3930906	Gasket, Valve Cover	6	
	3903380	Seal, Banjo Connector	6	
	3927154 3906694	Gasket, Exhaust Manifold Seal, Rectangular Ring	6	
	3906773	Washer, Sealing	1	
	3910824	Seal, O Ring Gasket, Exh Out Connection	6	
	3912220 3931347	Gasket, Int Manifold Cover		
	3931350	Gasket, Oil Drain	1	
1 1	3918188 3919358	Washer, Sealing Sleeve, Injector	6	
	3923261	Seal, Injector	6	
	3906659	Seal, Injector	6	
	3283339 3901097	Gasket, Cylinder Head Seal, Valve Stem	1 12	
	3923331	Gasket, Thm Housing Cover	1	
	3921640 3930543	Seal, Valve Stem Isolator, Noise	12	
	3830043	isolatol, INUISO	1 1	
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Service Gasket Set

	up No. 17.02	Service Gask	et Set		4
Ref No.	Part Number	Part Name	Req	Remarks	
		SERVICE GASKET SET		· · · · · · · · · · · · · · · · · · ·	
		LOWER ENGINE SET BR			
		STANDARD THICKNESS			
	3802376 154916	Set, Lower Engine Gasket Gasket, Hydraulic Pump	1 1		
	3008400	Gasket, Lub Oil Pump	1 1		İ
ļ	3804899	Seal, Oil	1		
	3901020 3902425	Nozzle, Piston Cooling Washer, Sealing	6 2		
	3903475	Seal, Rectangular Ring	1 1		l
	3905595 3906696	Gasket, Timing Housing Seal, Rectangular Ring	1 1		
ĺĺ	3906697	Seal, O Ring			
	3906698	Seal, Rectangular Ring	11		
	3908096 3909410	Gasket, Cover Plate Kit, Seal	1 1		
	3912473	Seal, O Ring	1 1		
	3913994 3914385	Seal, O Ring Gasket, Gear Cover	1 1		
	3915772	Seal, Rectangular Ring	1		
	3915800 3916042	Seal, Rectangular Ring Gasket, Hydraulic Pump	1 1		
	3918673	Gasket, Gear Cover			
	3920773 3928493	Washer, Sealing Gasket, Rear Cover	1		
	3928759	Seal, Grommet	1 8		
	3928832	Gasket, Push Rod Cover	1 1		
	3930139 3931346	Nozzle, Piston Cooling Gasket, Oil Pan	1 1		
	3931348	Gasket, Cover Plate	1 1		
	3931349 3931351	Gasket, Flange Gasket, Gear Housing			
	3931607	Gasket, Fuel Pump	1		İ
	3942914 3942915	Gasket, Oil Cooler Core Gasket, Filter Head	1 1		
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Service Gasket Set

Ref	Part Number	Part Name	Req	Remarks
No.	3804897 3283335 3900808 3901097 3901356 3902363 3902425 3903380 3906659 3906773 3910824 3912220 3918188 3919358 3921640 3923331 3927154 3930543 3930543 3930543 3931347 3931350	SERVICE GASKET SET UPPER ENGINE SET BR STANDARD THICKNESS Set, Upper Engine Gasket Gasket, Cylinder Head Seal, Injector Seal, Valve Stem Gasket, Turbocharger Seal, Rectangular Ring Washer, Sealing Seal, Banjo Connector Seal, Rectangular Ring Washer, Sealing Seal, O Ring Gasket, Exh Out Connection Washer, Sealing Sleeve, Injector Seal, Valve Stem Seal, Injector Gasket, Thm Housing Cover Gasket, Exhaust Manifold Isolator, Noise Gasket, Valve Cover Gasket, Int Manifold Cover Gasket, Oil Drain	1 1 6 1 2 6 2 6 1 1 6 6 6 1 1 1 6 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 6 6 6 1 1 1 1 6 1	Remarks

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Group No. 17.01 Service Repair Kits					4
Ref No.	Part Number	Part Name	Req	Remarks	
		SERVICE REPAIR KITS BR			1
		MAIN BEARING KITS			l
	3802070 3802071 3802072	Set, Main Brg (std) Set, Main Brg (.010) Set, Main Brg (.020)	1 1 1	Standard 0.25 mm Oversize 0.50 mm Oversize	
	3802073 3802074	Set, Main Brg (.030) Set, Main Brg (.040)	1 1	0.75 mm Oversize 1.00 mm Oversize	
	3800330 3800331	Bearing, Crankshaft Thrust Bearing, Crankshaft Thrust	1 1	.5mm Oversize Bore/.5mm Oversize Thrust 1.0mm Oversize Bore/1.0mm Oversize Thrust	
		PISTON RING SETS			
	3802421 3802422 3802423	Set, Piston Ring Set, Piston Ring Set, Piston Ring	6 6 6	Standard 0.50 mm Oversize 1.00 mm Oversize	
		PISTON KITS	į		ļ
	3802747 3802764 3802765	Kit, Engine Piston Kit, Engine Piston Kit, Engine Piston	6 6 6	Standard 0.50 mm Oversize 1.00 mm Oversize	
	3602703	Nit, Engine Fision		1.00 mm Oversize	
					ļ
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	Engine Block		
	Crankshaft		
	Engine Block		
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	Cam Follower Cover		
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