Section **5**

Electrics, Instruments and Controls

ELECTRICAL SYSTEM

GENERAL DESCRIPTION

The MH-40 electrical system is a flameproof system consisting of a power supply (alternator), an hour meter, pressure switches and four 50 W headlight assemblies. The system is interconnected with approved cabling covered in fire resistant, anti-static protective hose.

A self excited 12 V dc alternator is coupled to a hydraulic motor driven from a pump coupled to the transmission. The motor turns the alternator at a constant speed to deliver 12 V power to the 50 W headlights. The lights are only operational when the engine is running.

Only suitably qualified personnel should service and inspect flameproof electrical components to ensure that the electrical system explosion protection properties remain in the approved and/or certified condition.

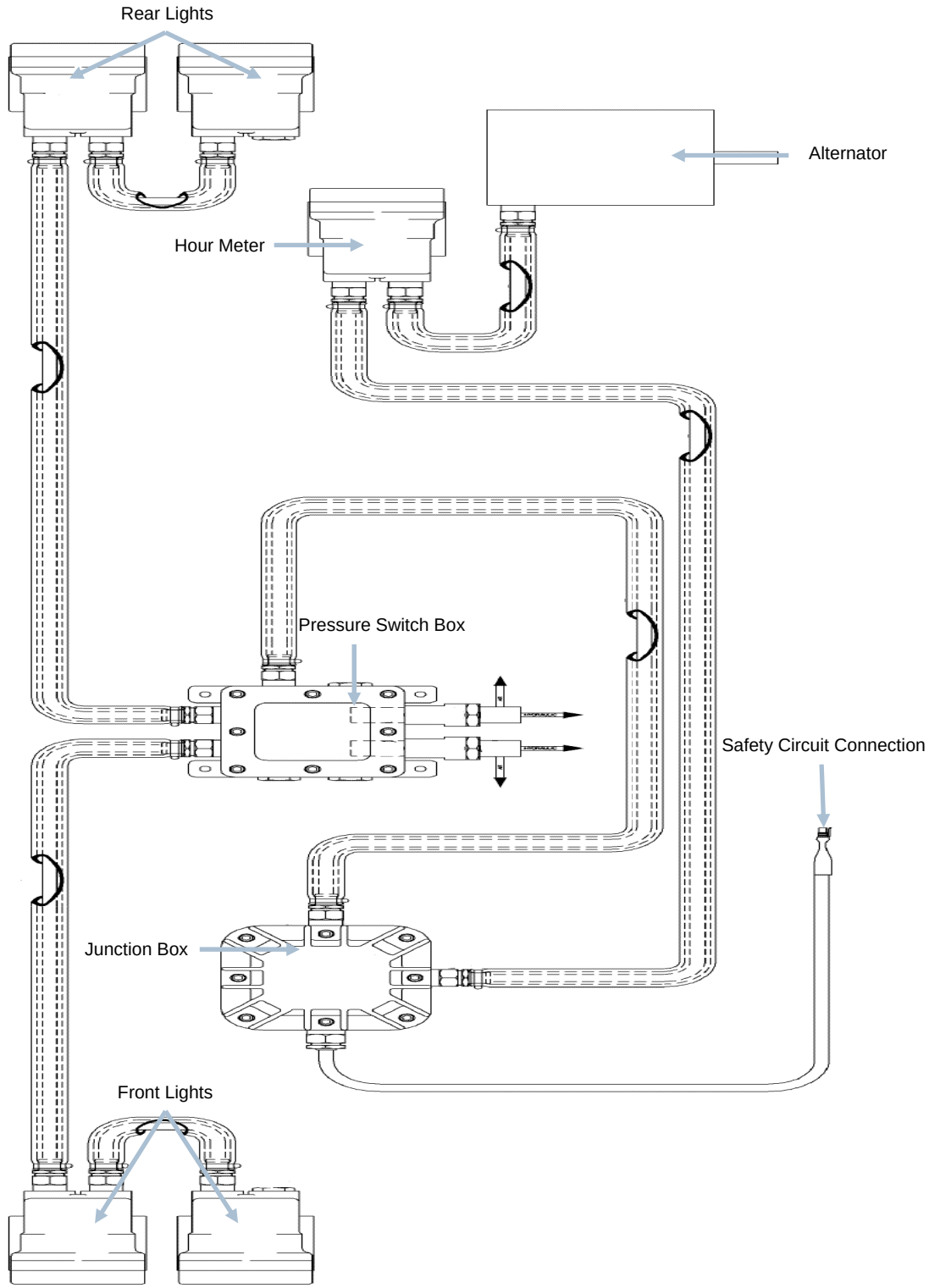
SAFETY PRECAUTIONS

The following safety precautions are not intended to be exhaustive. Safe work practices should be used when servicing or operating heavy machinery.

ALWAYS give the engine an opportunity to cool down before performing electrical system servicing at the location of these components are in the vicinity of hot surfaces.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys) when accessing the engine compartment including pneumatic stored pressure, engine coolant pressure and other heat sources such as engine block and exhaust system components.

ALTERNATOR, LIGHTS AND HOUR METER GENERAL ARRANGEMENT



Alternator, Lights and Hour Meter General Arrangement

ELECTRICAL LIGHTING COMPONENTS

Lighting

Care and Maintenance

Daily:

1. Visually inspect the headlights for correct operation.
2. Wipe headlight lenses clean and remove any built up debris around the housings.
3. Check lenses for cracks and damage and ensure that the retaining bolts are in place.

Front Headlight Assemblies

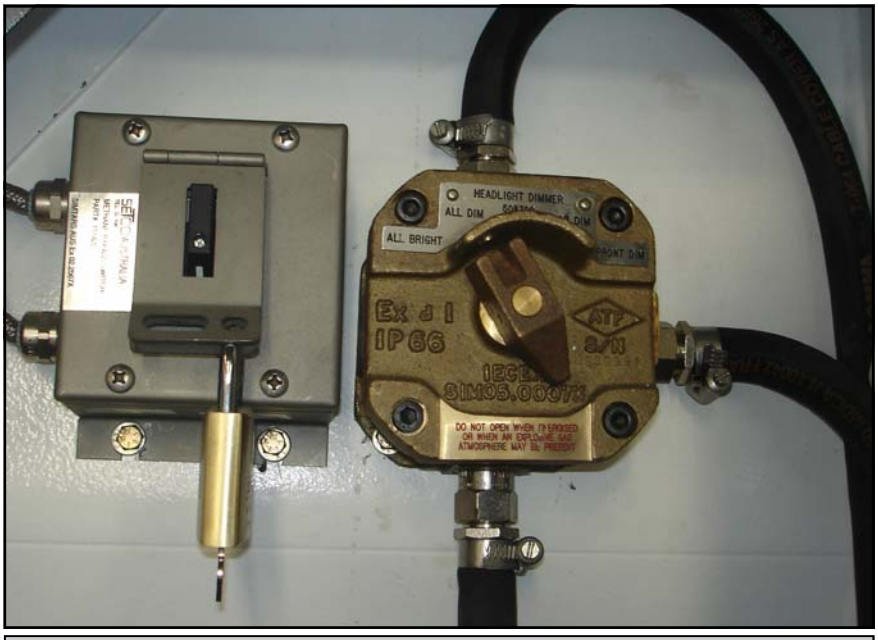
Lighting Switch

The light switch has four positions All Bright, All Dim, Front Dim and Rear Dim.

Care and Maintenance

Daily:

1. Visually inspect the headlights for correct operation.
2. Wipe headlight lenses clean and remove any built up debris around the housings.
3. Check lenses for cracks and damage and ensure that the retaining bolts are in place.



Manual Light Switch Box

Servicing:

Servicing of flameproof electrical components should be conducted in accordance with the mine statutory maintenance schemes.

The following is recommended.

Every 250 service hours:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 50 hour service.
3. Visually inspect cable gland/hose termination on the rear of the headlight for any damage and security.
4. Verify security of the headlight retaining bolts by hand tightening.
5. Record inspection in mine statutory log book.

Every 1000 service hours:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 250 hour service.
3. Remove the covers from each headlight and inspect the electrical connections for signs of heating or fatigue.
4. Clean out interior as required, check the condition of the spigot flame paths and reapply approved fluid film to the spigot flame paths.
5. Secure the headlight retaining bolts by hand tightening.
6. Record inspection in mine statutory log book.

Every 2000 service hours:

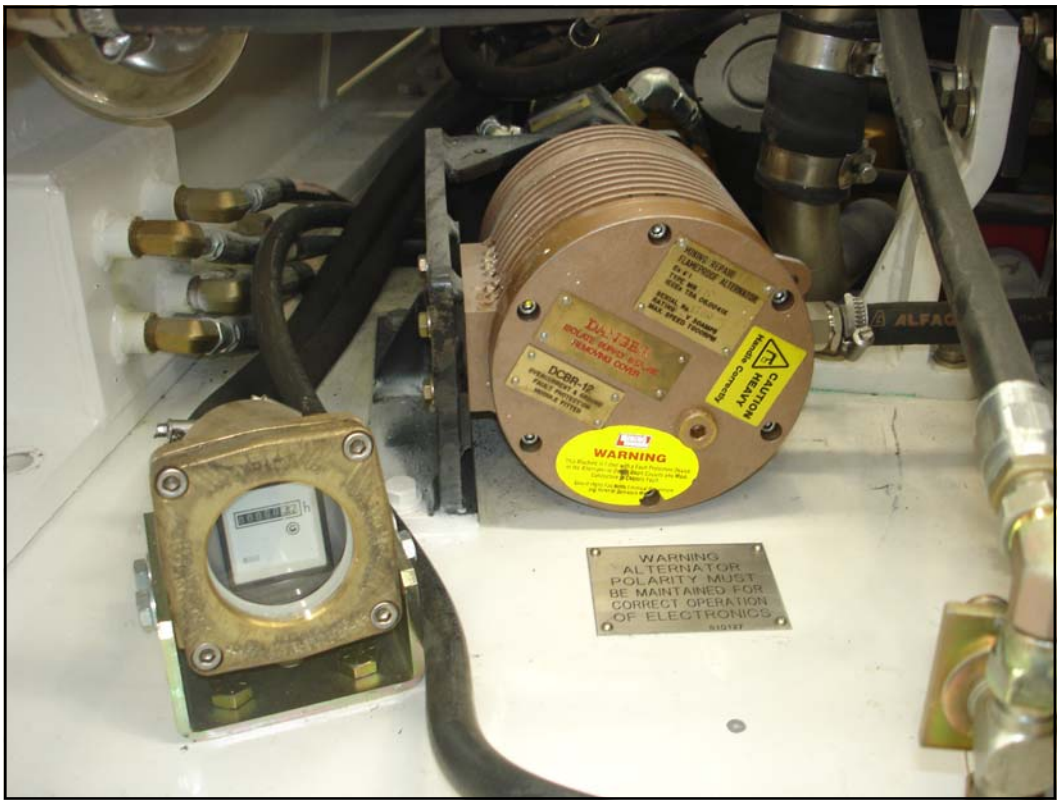
1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 1000 hour service.
3. Remove the covers from each headlight, dimensionally inspect the spigot flame paths against the certification drawings.
4. Ensure the cable gland/hose connection is secure.
5. Verify approval/certification number against the mine log.
6. Record inspection in mine statutory log book.

ENGINE SERVICE HOUR METER

Care and Maintenance

Daily or every 10 service hours (Code A external examination):

1. Visually inspect the hour meter for correct operation.
2. Wipe lens clean and remove any built up debris around the housing.
3. Check lens for cracking or other damage, ensure that the retaining bolts are in place.



Hour Meter Mounting Position

Servicing:

Servicing of flameproof electrical components should be conducted in accordance with the mine statutory maintenance schemes.

The following is recommended.

Three monthly or every 500 service hours (Code B external examination):

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 10 hour service.
3. Visually inspect cable gland/hose termination on the rear of the housing for any damage and security.
4. Verify security of the cover retaining bolts by hand tightening.
5. Record inspection in mine statutory log book.

Six monthly or every 1000 service hours (Code C semi internal examination):

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 500 hour service.
3. Remove the cover from the housing, inspect the electrical connections for signs of heating or fatigue.
4. Clean out interior as required, check the condition of the flame paths and reapply approved fluid film to the flame paths
5. Secure the cover retaining bolts by hand tightening.
6. Record inspection in mine statutory log book.

Twelve monthly or every 1500 service hours (Code C1 internal examination):

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 1000 hour service.
3. Remove the cover from each housing, dimensionally inspect the flame paths against the certification drawings.
4. Ensure the cable gland/hose connection is secure.
5. Verify approval/certification number against the mine log.
6. Record inspection in mine statutory log book.

ELECTRICAL SYSTEM TROUBLESHOOTING

The following electrical system troubleshooting guide is intended to provide basic guidance for analysing faults and determining probable causes.

The electrical system must only be serviced by suitably trained and authorised personnel. This is a flameproof electrical system. DO NOT energies the electrical system with covers removed in the mine's hazardous or potentially gassy atmosphere.

Symptom	Probable cause	Caused by	Remedy
One light is not illuminated when the engine is running.	Blown headlight bulb.	Fatigue.	Replace suspect bulb.
	Faulty connections in headlight housing.	Vibration fatigue or heat damage.	Inspect connections and repair as required.
All headlights not illuminated when the engine is running.	Blown supply fuses in alternator.	Short circuit.	Locate fault, rectify and replace fuse(s).
		System overload.	Check load and remove excess (Note system maximum load of 20A).

ALTERNATOR AND DRIVE ASSEMBLY

GENERAL DESCRIPTION

The alternator self-excites when electro magnetic field (EMF) is produced by the rotating magnetic field. This alternating current is rectified and regulated internally and is protected by 32A HRC fuses before leaving the enclosure via cable gland connection. The alternator is hydraulically driven by means of a hydraulic motor and drive coupling.

SAFETY PRECAUTIONS

The following safety precautions are not intended to be exhaustive. Safe work practices should be used when servicing or operating heavy machinery.

ALWAYS isolate the machine and tag out as appropriate before accessing the alternator/drive assembly.

ALWAYS be aware of, and isolate, other forms of energy and pinch points (fan, belts, pulleys) when accessing the engine compartment including pneumatic stored pressure, engine coolant pressure and other heat sources such as engine block and exhaust system components.

ALTERNATOR ASSEMBLY

Care and Maintenance

Daily:

Visually inspect the housing for damage, ensure that the retaining bolts are in place.

Servicing:

Servicing of flameproof electrical components should be conducted in accordance with the mine statutory maintenance schemes.

The following is recommended.

Every 1000 service hours:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per daily service.
3. Visually inspect cable gland/hose termination on the alternator housing for any damage and security.
4. Verify security of the cover retaining bolts by hand tightening.
5. Record inspection in mine statutory log book.

Every 2000 service hours:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 1000 hour service.
3. Remove the cover from the alternator, inspect the electrical connections for signs of heating or fatigue.
4. Clean out interior as required, check the condition of the spigot flame paths and reapply approved fluid film to the spigot flame paths
5. Secure the cover retaining bolts by hand tightening.
6. Record inspection in mine statutory log book.

Every 3000 service hours:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Carry out inspection as per 2000 hour service.
3. Remove the cover from the housing, dimensionally inspect the spigot flame paths against the certification drawings.
4. Ensure the cable gland/hose connection is secure.
5. Verify approval/certification number against the mine log.
6. Record inspection in mine statutory log book.

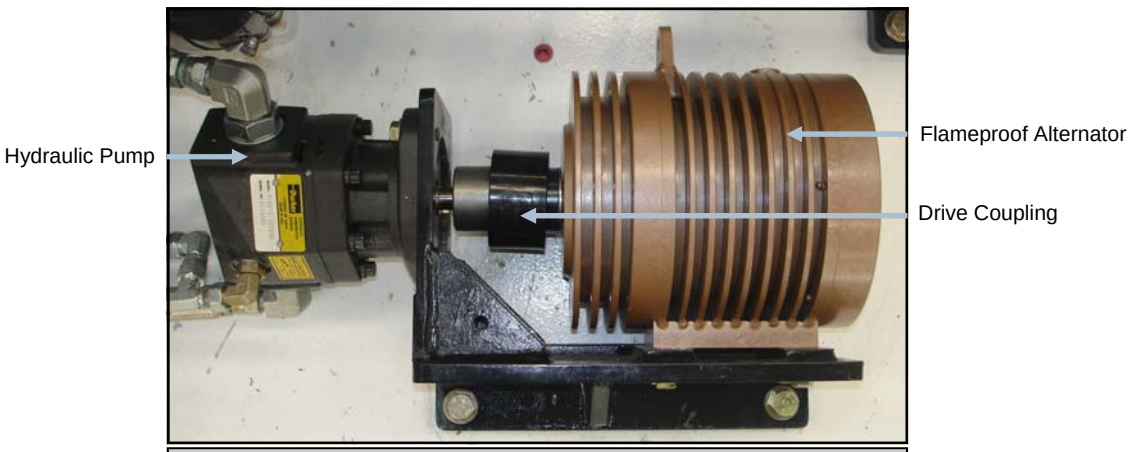
ALTERNATOR DRIVE ASSEMBLY

Every 250 service hours check the condition of drive coupling from the hydraulic drive motor to the alternator.

To check drive coupling:

1. Ensure that the engine has had sufficient time to cool and is isolated and tagged as described in Section 1.
2. Remove coupling guard.
3. Check wear on plastic drive coupling and check alternator and pump sprockets are tight.

No lubrication of the alternator coupling is required.



Hydraulically Driven Alternator and Motor Arrangement

DIESEL CONTROL SYSTEM (DCS)

GENERAL DESCRIPTION

Diesel Control System is an electronic methane and engine monitoring shutdown system for the use on diesel engine powered machinery used for underground coal mining. If the methane in the atmosphere reaches a pre-determined low (but still safe) level, the DCS will alert the operator to the presence of methane with a message. If the methane level in the atmosphere reaches a pre-determined high (dangerous) level, the DCS will shutdown the machine's engine and indicate with an error message the reason for the shutdown. The DCS, also checks for several alarm conditions on the machine. If any hazard is detected, it will shutdown the machine and display a message on the display panel. The shutting down of the machine is effected via a solenoid valve that controls the pilot air pressure for the shutoff valve on the machine. Should there be a malfunction in the solenoid circuit, the operator is also alerted with a message.

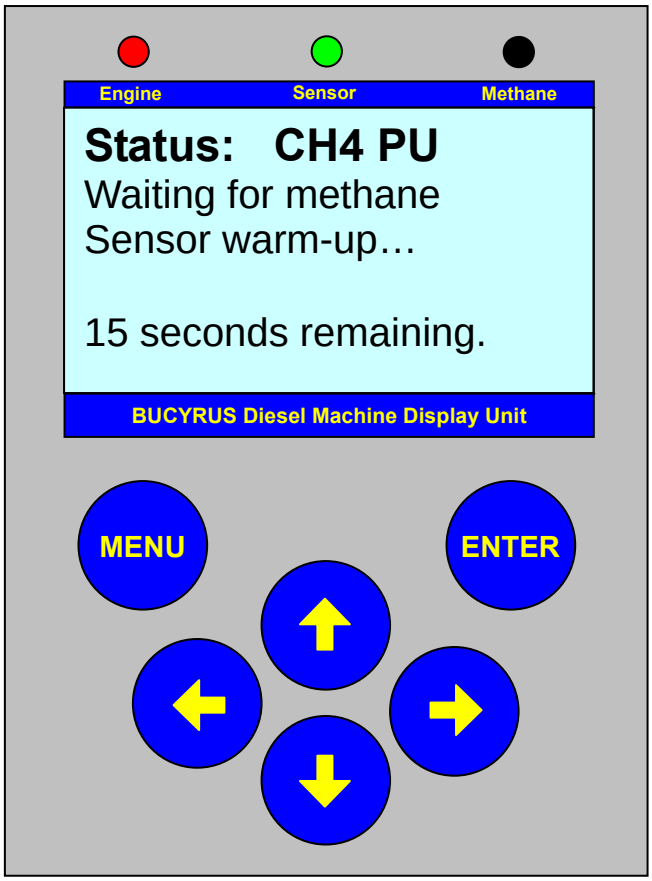
POWER SUPPLY

The Diesel Control System has an internal, intrinsically safe battery that allows the system to power up and then be charged by the alternator. The battery will run the system for a number of hours if not charged from the alternator but after 30 minutes there will be a shutdown of the system.

DISPLAY ILLUSTRATIONS

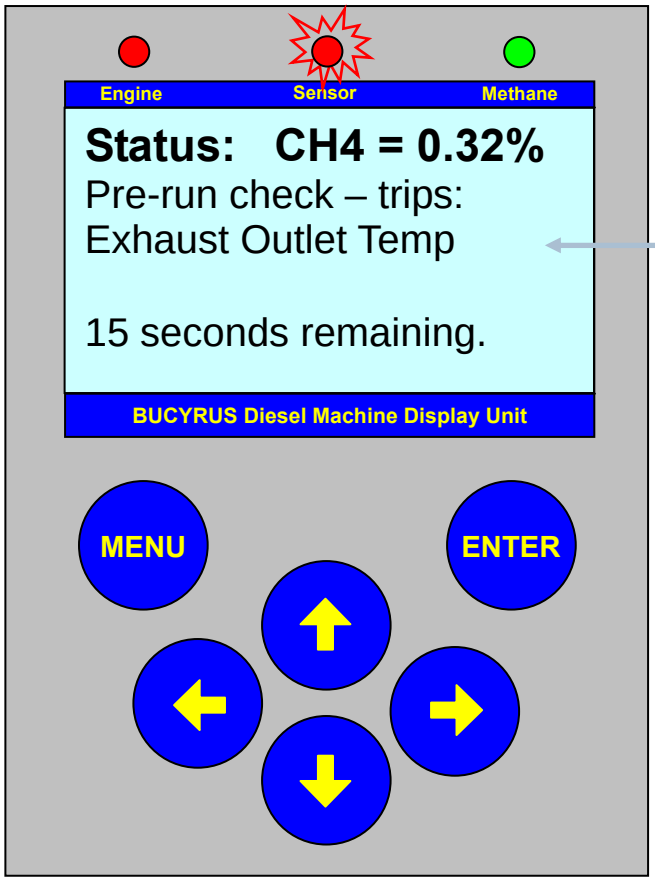
Methane Sensor Warm Up

This screen is typically displayed as soon as the DCS is powered up. A nominal time period of 20 seconds is provided for the sensor to reach operating status. During this period, the Methane lamp is extinguished and the methane level is reported as “PU”.



Pre-Run Check

This screen is displayed while the DCS is performing its pre-run check. The display lists the sensors that are preventing the check from passing, and the time remaining for them to be resolved. If the time expires, the DCS will power itself down.



Sensor Name	Value Required to Pass Check
Engine Coolant Level	Closed – ‘o-o’
Engine Coolant Temp	Less than 105 °C
Exhaust Scrubber Temp	Less than 80 °C
Exhaust Outlet Temp	Less than 70 °C
Methane	Less than 0.5%
Scrubber Level 1	Closed – ‘o-o’
Scrubber Level 2	Closed – ‘o-o’

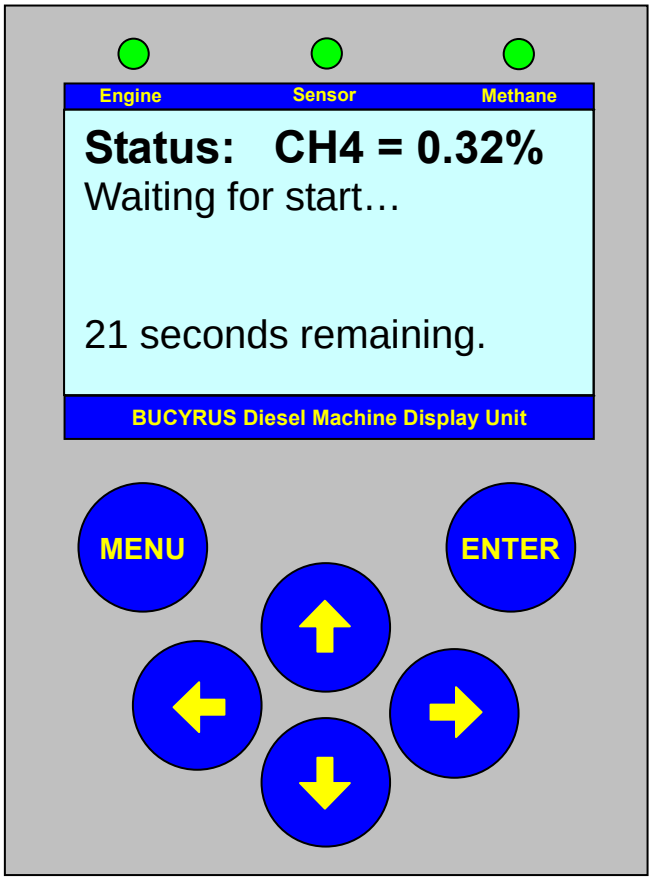
Ready To Start

The operator can now start the machine.

A countdown is displayed – if the machine is not started before the countdown expires, the DCS will switch itself off.

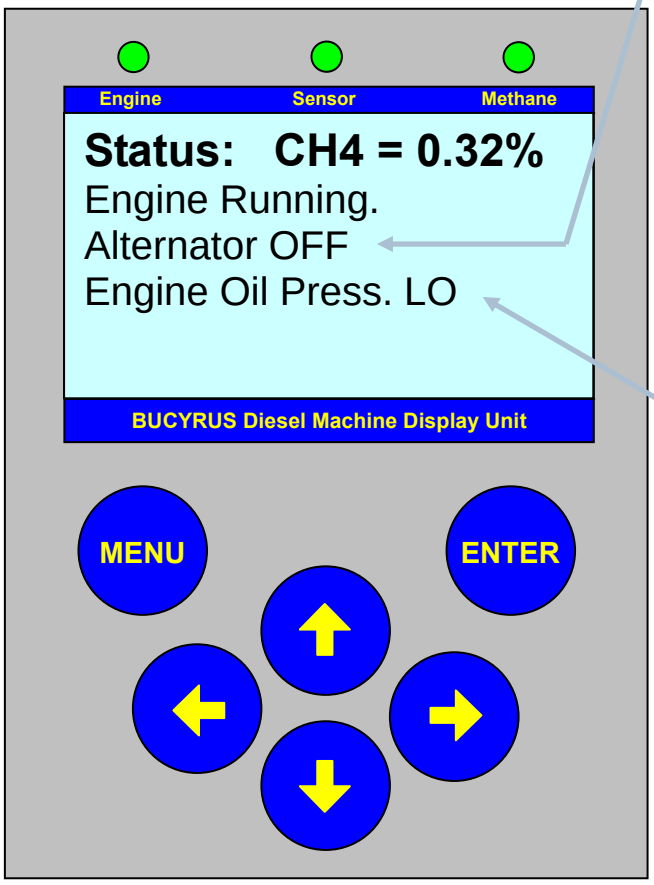
The DCS will consider the engine to be started if any of the following sensors give the specified signal:

Sensor Name	Value to Show Running
Alternator	On (supplying current)
Engine Oil Pressure	Greater than 0.7 Bar



Engine Running

The DCS has observed that the engine has started.



A list of alarms may be displayed:

Sensor Name	Value That Will Cause Alarm
Alternator	Off (Not supplying current)
Engine Coolant Temp	Greater than 100 °C
Exhaust Scrubber Temp	Greater than 75 °C
Exhaust Outlet Temp	Greater than 65 °C
Hydraulic Oil Level	Open – 'o/o'
Methane	Greater than 0.5%

A list of trips may be displayed – if they remain tripped for a pre-defined amount of time, the engine will be shutdown.

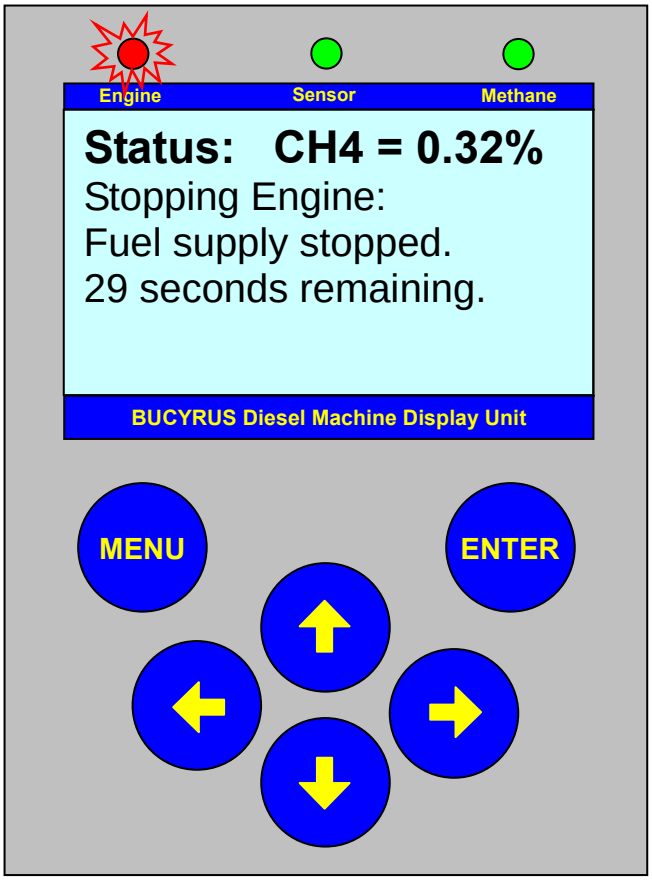
Sensor Name	Value That Will Cause Trip
Alternator	Off (Not supplying current)
Engine Coolant Level	Open – 'o/o'
Engine Coolant Temp	Greater than 105 °C
Exhaust Scrubber Temp	Greater than 80 °C
Exhaust Outlet Temp	Greater than 70 °C
Engine Oil Pressure	Less than 0.7 Bar
Methane	Greater than 1%
Scrubber Level 1	Open – 'o/o'
Scrubber Level 2	Open – 'o/o'

Fuel Cut Shutdown

The DCS is attempting to stop the engine by stopping the fuel supply to the engine. In this screenshot, the DCS is detecting the engine is still running, as *exhaust coolant flow* is still being indicated. If this does not cease within the time period shown, the operator will be requested to follow the emergency manual shutdown procedure.

If any of the following sensors give the relevant signal, then the engine will be considered still running.

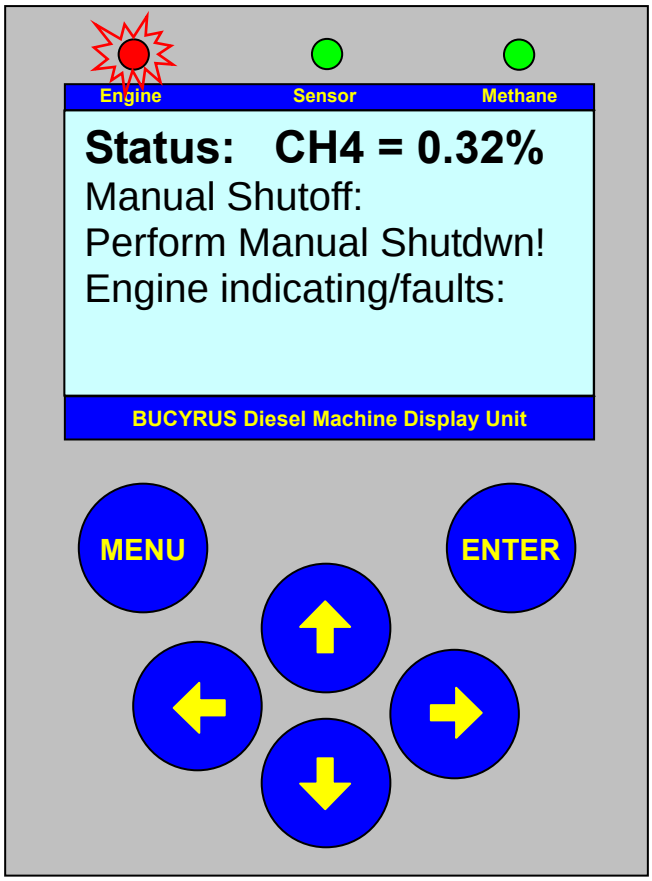
Sensor Name	Value to Show Running
Alternator	On (supplying current)
Engine Oil Pressure	Greater than 0.7 Bar



Manual Shutdown

As mentioned in the last screenshot, this is displayed when the operator must manually shut the machine down.

The same sensor conditions apply.

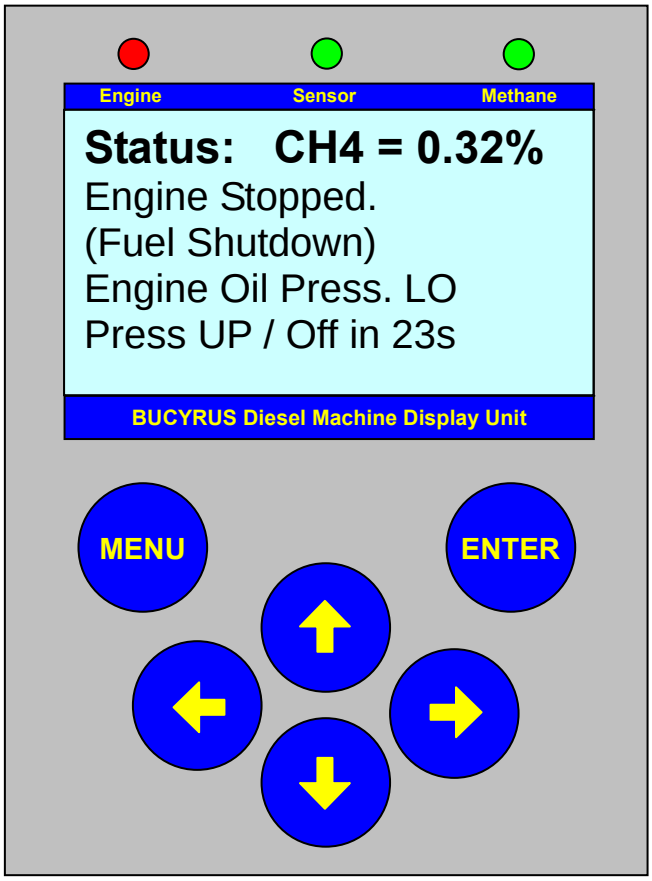


Engine Stopped

This screen shows that the engine has been successfully stopped, and the original cause of the shutdown (in this case *low engine oil pressure* – see Engine Running screenshot for list - page 5).

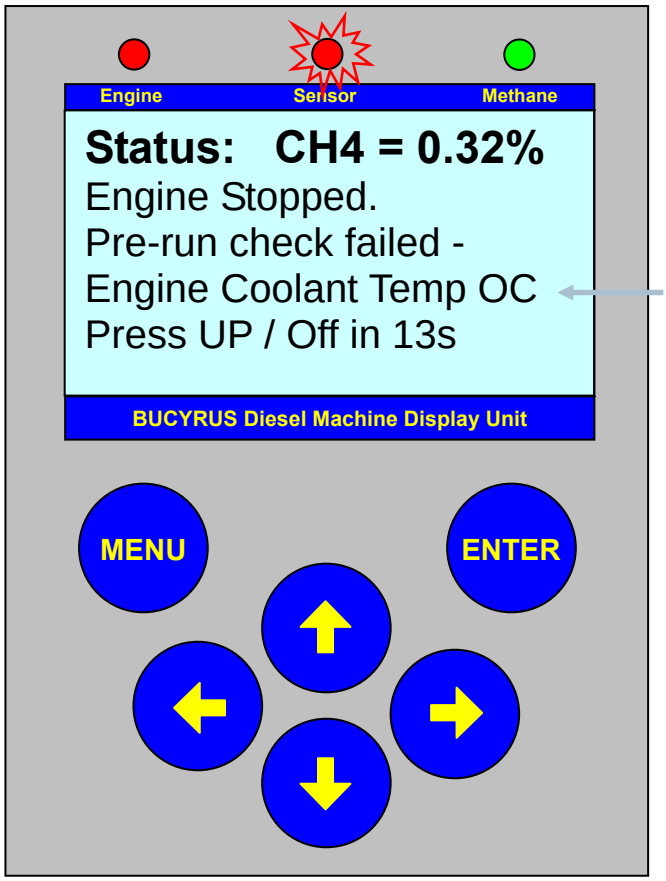
The display will show if either fuel cut off was successful, or if the manual shutdown was required.

The operator may either leave the machine, or press the up key for the DCS to allow the machine to be restarted.



Engine Stopped - Pre-Run Check Failed

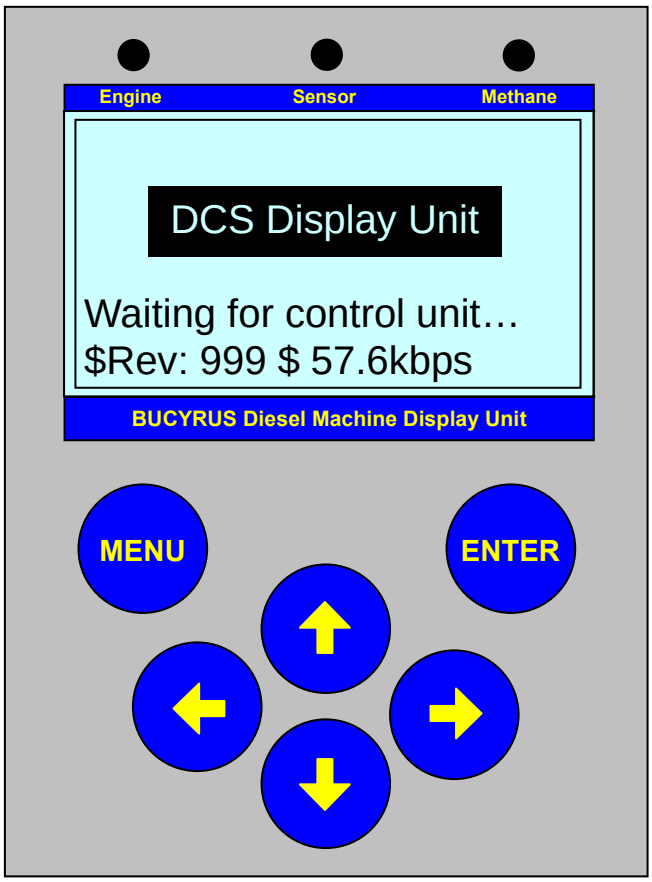
This screen may be displayed if the pre-run check fails, and is not resolved within the time allowed. The machine may no longer be started until the up key is pressed, or the system shuts itself down and is restarted.



See Pre-Run Check screen for list of failure reasons - page 3.

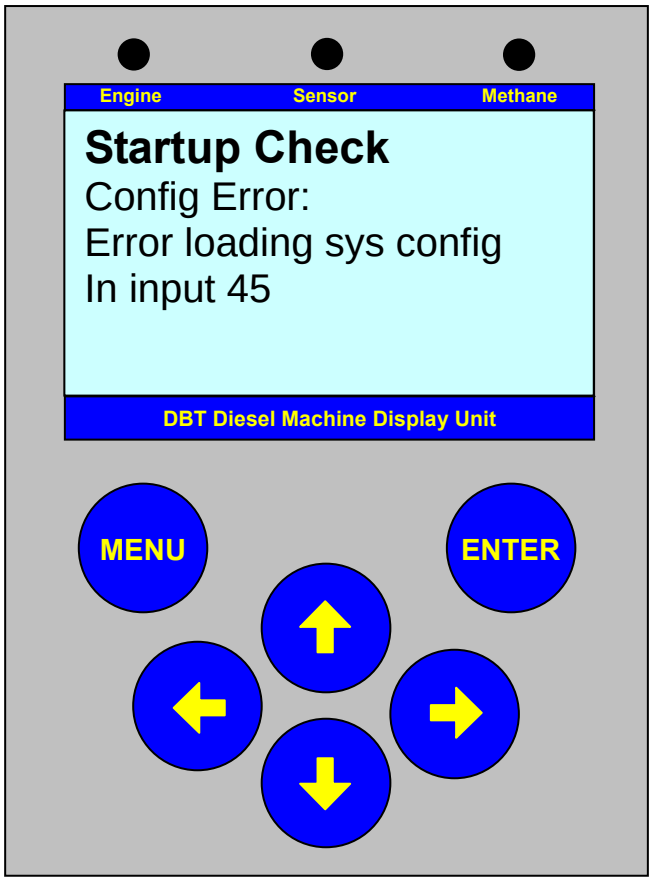
Display Startup Screen

This will be displayed momentarily as the system powers up. If this is displayed for more than a few seconds, a system fault has occurred and will need to be rectified by service personnel.



Startup Check Fail

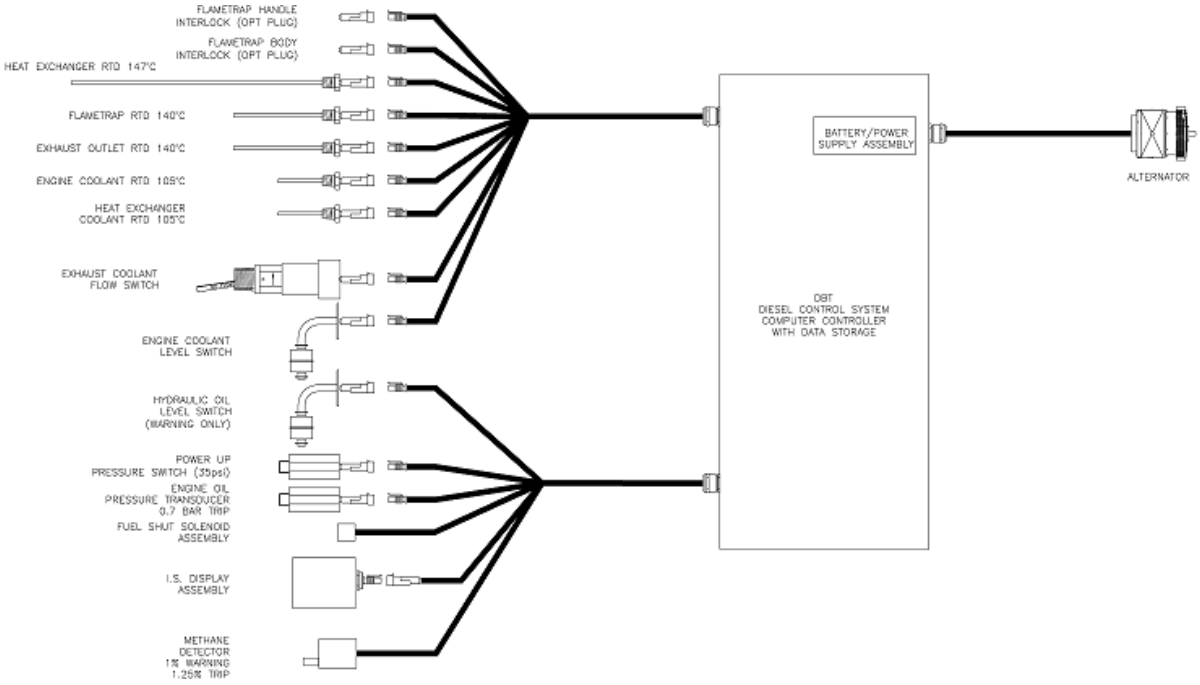
If this screen is displayed, a system fault has occurred and will need to be rectified by service personnel.



DISPLAY ASSEMBLIES

Operator's Display Panel

GENERAL ARRANGEMENT



The shutdown system consists of a :

- Main control box
- Display panel
- Methane head (optional)
- Low hydraulic oil sensor
- Low engine coolant level sensor
- High engine coolant temperature
- Low engine oil pressure
- Power up pressure switch
- Heat exchanger scrubber temperature
- Scrubber level 1
- Exhaust outlet gas temperature
- Run solenoid
- Scrubber level 2

These sensors and switches are connected via two looms.

WARNING

The power supply cable is part of the control unit assembly explosion protection property and should not be removed from the control unit.

SWITCHES

The switch inputs are:

1. Power Up Pressure Switch
2. Coolant Level Switch
3. Hydraulic Level Switch

Each switch has 220 ohms in parallel and 220 ohms in series with switch. The digital inputs are monitored as follows:

R	≤		Short Circuit
90<R	≤	90 ohm	Closed
130<R	≤	130 ohm	Fault
190<R	≤	190 ohm	Open
250R	>	250 ohm	Open Circuit

SENSORS

RTD

All the temperature inputs are PT 100 type RTD. The temperature range is from –20 °C to 200 °C. If a reading is below 92 ohms a short circuit on the sensor will be indicated. A reading of over 176 ohms will cause an open circuit fault on the sensors.

4-20 mA Input

The pressure transducer input is a 4-20 mA (0-10 bar) sensor. If the system receives a current input of less than 3.8 mA, a sensor short circuit will be indicated. A current greater than 20.2 mA will be indicated as an open circuit fault.

SENSOR LOCATIONS

Engine Coolant Level Sensor

The engine coolant level sensor is located in the engine make up tank adjacent to the engine. This sensor monitors the engine coolant level and will shut the machine down by stopping power to the solenoid valve. This valve will open exhausting air pressure from the system thus the fuel shutdown cylinder will close the fuel rack, this closes of fuel to the engine and shuts the engine down. There is no need for routine calibration of the coolant level sensor as long as routine testing is carried out daily.

Engine Coolant Level Sensor

Engine Oil Pressure Sensor Testing

The engine oil pressure sensor is located under the dash panel in the line to the engine oil pressure gauge. There is no need for routine calibration of the oil pressure sensor as long as the correct operation is verified at start up. A test valve is located in the operator's compartment to verify the oil pressure sensor is operating correctly. This will shutdown the machine by blocking oil pressure to the transducer and drain the remaining oil pressure at the transducer to the engine sump. The DCS will then shut the engine down.

Engine Oil Pressure Sensor

Engine Oil Pressure Test Button Test Valve

Low Hydraulic Oil Sensor

The low hydraulic oil level sensor is located on the inspection cover of the hydraulic tank, when the oil level drops below the prescribe level the machine will shutdown by stopping power to the solenoid valve. This valve will open exhausting air pressure from the system thus the fuel shutdown cylinder will close the fuel rack. This stops the fuel to the engine and shuts the engine down.

Low Hydraulic Oil Sensor

INSTRUCTIONS FOR DIESEL CONTROL SYSTEM HEAD

Purpose

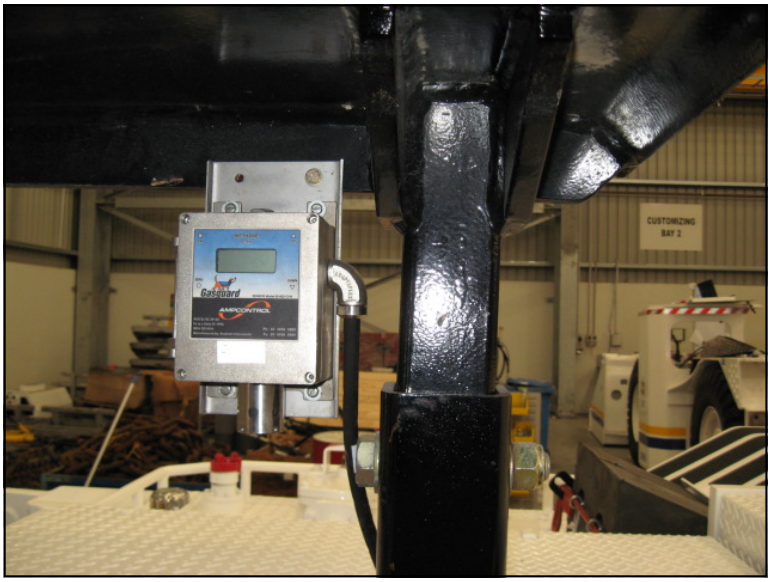
The DCS methane sensing head is designed as part of the electronic monitoring system. Its purpose is to detect methane in the surrounding air and to signal the condition of the air to the DCS main control board. The control board can then alert the operator of the machine to a potentially hazardous *low alarm* level of methane, or can shutdown the machine if the concentration has reached a *high alarm* level. The concentration levels at which the low and the high alarm signals are given are set up during calibration by means of two adjusting buttons in the side of the head.

General

The head is an intrinsically safe encapsulated device that is connected to the main control board to the main control board of the DCS system. It is powered by the intrinsically safe supply of the DCS.

The alarm signals are not latching within the head. After the methane level drops, the alarm signal soon disappears, but the high alarm signal shuts down the machine, this can be construed as a latching effect because the machine then has to be manually restarted.

Do not disassemble the sensor whilst in the hazardous area or use a sensor that has a damaged housing in the hazardous area.



Commissioning and Calibration

Introduction

Commissioning is the performance of initial checks, adjustments and calibration prior to placing the system in operation for the first time. Calibration, however, is not limited to performance of commissioning. Calibration is also performed throughout the life of the system on a periodic basis and after major repairs to the system.

During commissioning and subsequent re-calibration, it is vital to ensure that procedures are followed to prevent any abnormal sensor signal from initiating any fault, warn or alarm status indicator, or equipment control function. Consult the relevant control unit manual for details of how to do this.

The instruments supplied as complete units have already been calibrated at the factory prior to delivery. However, before putting the system into operation, it is important to check the calibration. This is especially important if the instruments are commissioned some time after delivery.

Preliminary Checks

Perform the following preliminary checks:

1. Verify that all connections are correct and complete as detailed in the AMP Control Manual.
2. Apply power to the system.
3. Check that voltage applied to the Amplifier PCB is 12V DC.

Gasguard Display Panel

To assist in fault finding the Gasguard display panel will indicate the following:

Display	Description
-777	There is no sensor plugged into the amplifier
-888	Sensor is faulty/expired
-999	Amplifier needs reconfiguration
Er	Error has occurred
CAL	Calibration mode initiated (display blinks when in calibration mode)
SAU	Calibration settings have been saved
PU	Powering Up

System Calibration

Before the start of calibration, the system should be left in a powered up operational (no fault) state to allow the gas sensors to stabilise. However, if such a delay is not practical, observe the meter indications with the sensor in a gas free atmosphere, until there is no appreciable meter movement for a period of time. The system should then be sufficiently stable to allow calibration.

- Calibration of sensors can only be achieved by using the appropriate gas. That is the gas that the sensor is designed to detect. A calibration gas should ideally be about 50% of full scale of the relevant monitor. However, sometimes, due to practical restraints and safety reasons, the gas may be 20% or less of full scale. While calibration at such a low level is not ideal, the resulting inaccuracies are usually within the safety tolerances for the system.

- For toxic gas detection, if reading inaccuracies cannot be avoided, they should always be on the high side for safety reasons. For example, with an actual gas density of 50 PPM, the system may safely display 53 PPM. The opposite is true of oxygen detection; the inaccuracies should always be on the low side. For example with an actual oxygen density of 20.9% in volume of air, the system may safely display 20% volume. As calibration gases have a tolerance, it is advisable to adjust the system to the highest reading (toxic gases) or lowest reading (oxygen) in this tolerance to maintain an assured safety margin.

- Calibration gas should be applied to the sensor at a rate of approximately 0.5 to 1.0 litre per minute. It is not advisable to leave the gas flow on the sensor any longer than is needed for the output to stabilise and the calibration adjustment to be made. Note that with some gases, the sensor takes considerable time to reach zero after the gas has been removed. While the output should drop to less than 10% of the applied gas level within several minutes, the last drop to zero could take hours under some conditions. Because of this, do not readjust to zero for some hours after span calibration.

Zero Calibration

Perform zero calibration as follows:

1. Ensure that the sensor is in a fresh air environment, or apply fresh air to the sensor via the calibration plug, in the case of oxygen apply high purity nitrogen via the calibration plug.
2. Place the magnetic tip of the calibration pen over the *Cal* symbol (1) for five seconds.
3. Now that the *Cal* mode is accessed place the magnetic tip over the *Zero* symbol (3) for five seconds.
4. The display should have a zero reading. To save the zero setting place the magnetic tip over the *Cal* symbol (1) for five seconds.
5. The sensor display (5) will show *Sav* to confirm that it has saved the zero setting.

Span Calibration

Perform span calibration as follows:

1. Apply calibration gas to the sensor at the rate of 0.5 to 1 litre per minute. Use a calibration gas of the same density as the most critical measurements to be made. If that is not possible, use gas of between 20% and 50% of the instrument range. For oxygen sensors, ensure the sensor is in fresh air, or apply gas with an oxygen content of approximately 21%
2. To adjust the display so that it reads the correct value for the gas applied enter *calibration mode* by placing the magnetic tip of the calibration pen over the *Cal* symbol (1) for five seconds.
3. Place the magnetic tip of the pen over the *Up* symbol (4) to increase the display reading and over the *Down* symbol (6) to decrease the display reading. Place the magnetic tip over the *Cal* symbol (1) for five seconds once the display reads the correct value for the gas applied.
4. Shut off the calibration gas. If the zero calibration is to be checked, wait for the sensor to stabilise before proceeding.

Maintenance

Periodic Maintenance

Periodic maintenance consists mainly of scheduled checks to ensure the instrument remains in adjustment and gives the required response to sampled gas. The following maintenance schedule is recommended.

Daily:

Verify operation by visually checking the reading on the respective control unit/monitor.

Investigate any abnormal deviations from zero reading.

Monthly:

1. Check the zero reading in fresh air or by accurate measurement of ambient air for a non-zero point; readjust as necessary.
2. Check the span calibration on a known sample of toxic gas in air. Readjust as necessary.

As required:

Replace the toxic gas sensor whenever it becomes impossible to adjust to zero, or when the span adjustment is insufficient to enable adjustment to the calibration gas value. If this occurs, re-calibrate the unit as described in Commissioning and Calibration.

Following power removal:

If power has been removed from the unit for a long period of time, a re-commissioning check should be carried out.

Corrective Maintenance

During fault isolation it is vital to ensure that suitable procedures are followed to prevent any abnormal sensor signal from unintentionally operating any fault, warn or alarm status indicator, or equipment control function. Consult the relevant control unit manual for details as to how to do this.

There are only two active replaceable units in the sensor system, the Amplifier PCB and the gas sensor. Therefore, fault isolation is limited to the following possible faults and remedies.

No 4-20 mA output:

1. Check that voltage applied to the Amplifier PCB is 12V DC and that polarity is correct. If not correct, rectify.
2. Check for loose plug and terminal connections.
3. If Step a) above is correct and the problem persists, replace the Amplifier PCB.

Sensor cannot be spanned, or zeroed:

1. Check that voltage and polarity applied to the amplifier is correct.
2. Check for loose plug and terminal connections.
3. If the above is correct and the problem persists, replace the sensor.
4. If the sensor still cannot be spanned or zeroed, replace the Amplifier PCB.

Erratic output:

1. Check that voltage and polarity applied to the Amplifier PCB is correct. Also, check that there are no severe voltage swings, indicating an intermittent fault in the field wiring or control unit.
2. Check for loose plug and terminal connections.
3. If the above is correct and the problem persists, replace the sensor.
4. If the output is still erratic, replace the Amplifier PCB.

The operation of the bypass switch is as follows:

Methane Trip

If a methane trip occurs the system cannot be restarted until the trip has been reset by a deputy unlocking the deputy switch and turning the actuator to the *bypass* setting for one second and returning it back to the lock position.

Other functionality:

Bypass

The switch can be unlocked and moved to bypass so the system can be run regardless of the methane level.

Methane Bypass Switch

SYSTEM OPERATION

1. **Toggle the on/off toggle switch to the *on* position:** This will activate the DCS electronics. The system will display “Waiting for methane sensor warm up”. After approximately 20 seconds the screen display will read “Pre run checks” while the DCS checks that the system is ready to start. Once this is completed the screen will display “Waiting for start”. The engine can now be started. If the engine is not started within 20 seconds the DCS will shut itself down. To restart the system toggle the on/ off toggle switch to *off* then back to *on*

On/Off Toggle Switch on the Operator’s Display Panel

2. **Start engine:** Activate the engine start button. After the engine has started, the display will read “Engine running”.

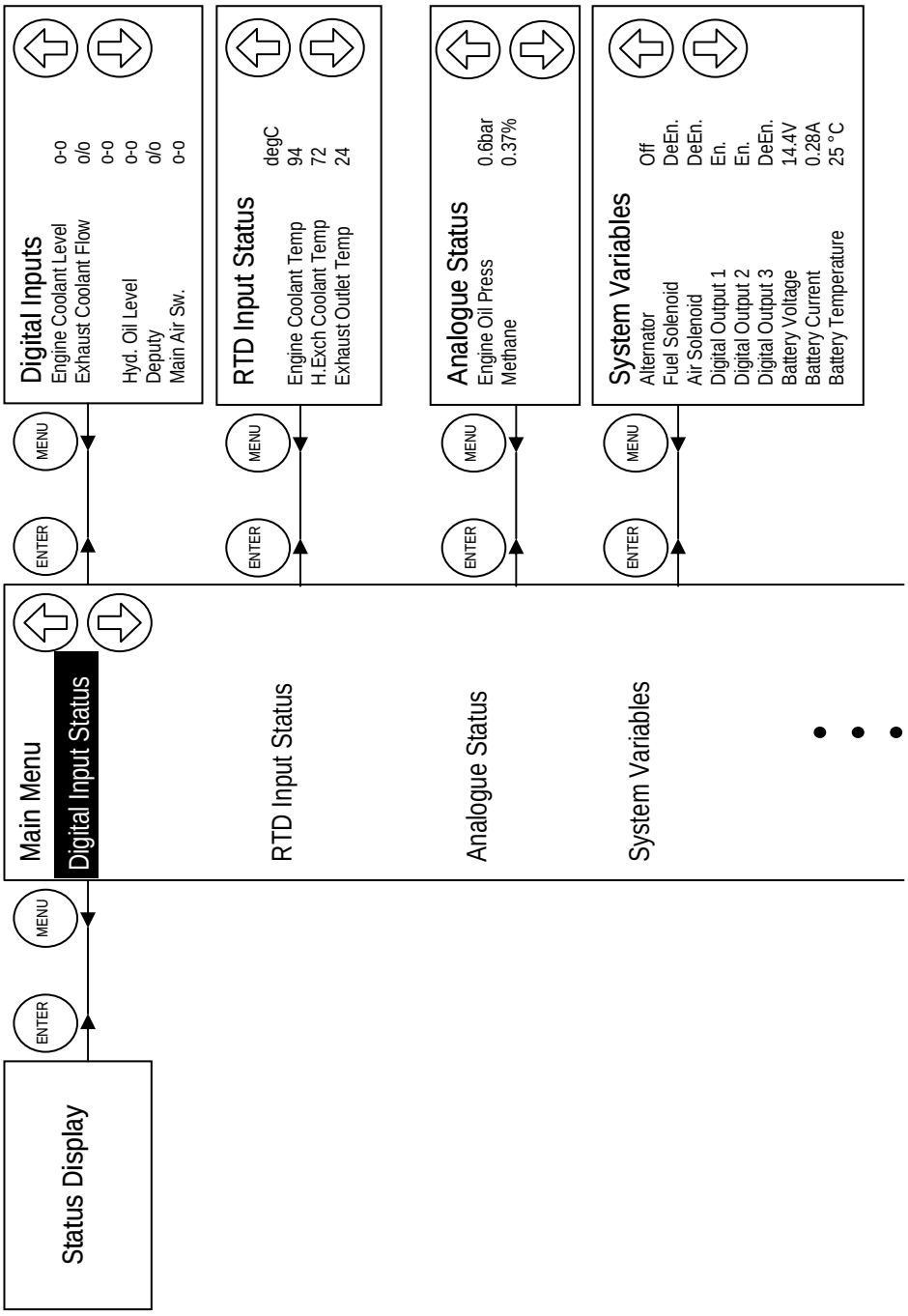
3. **After starting the engine** if the alternator is not charging the engine will run for a predetermined period of time before shutting down.

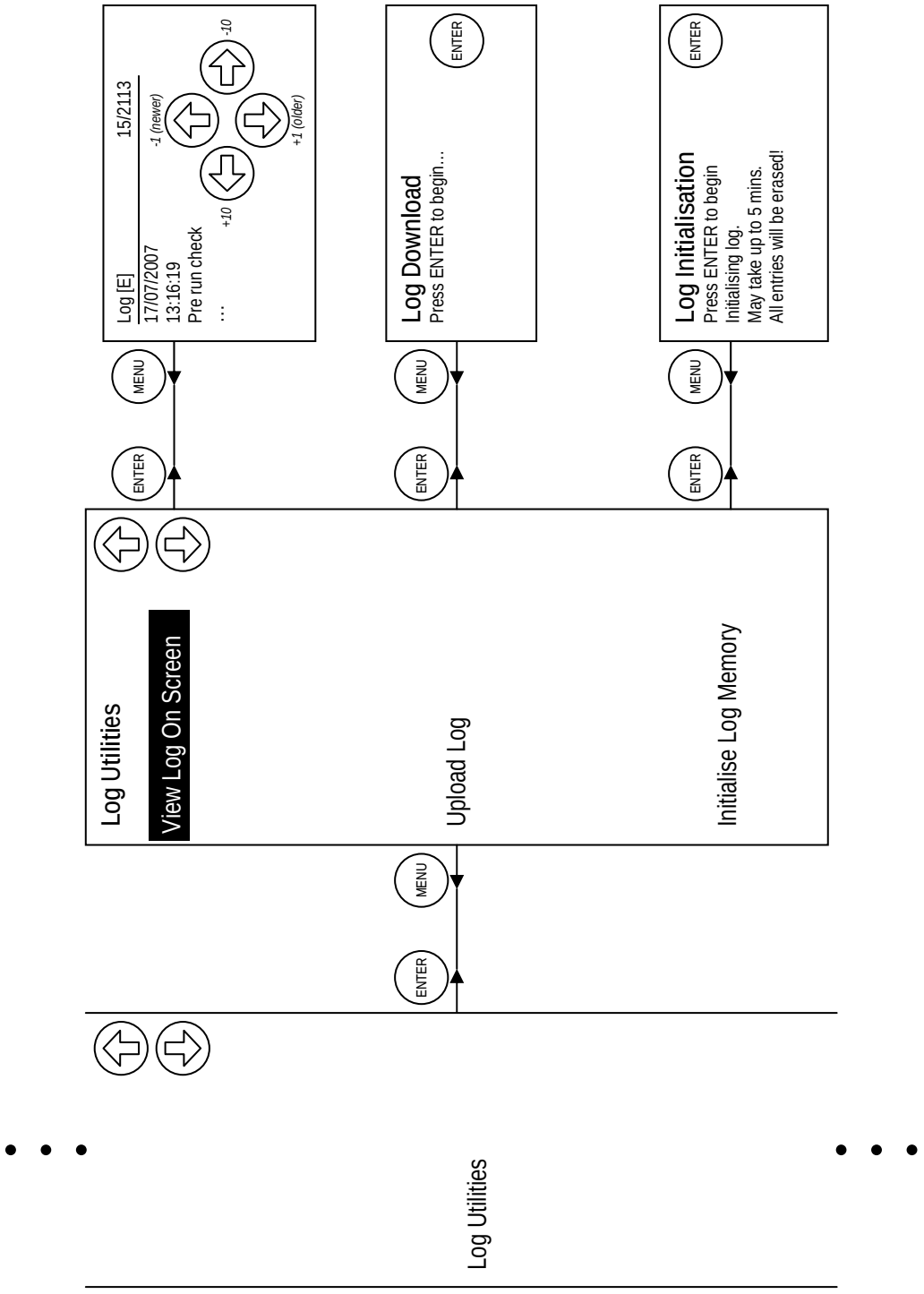
4. **Drive machine normally.**

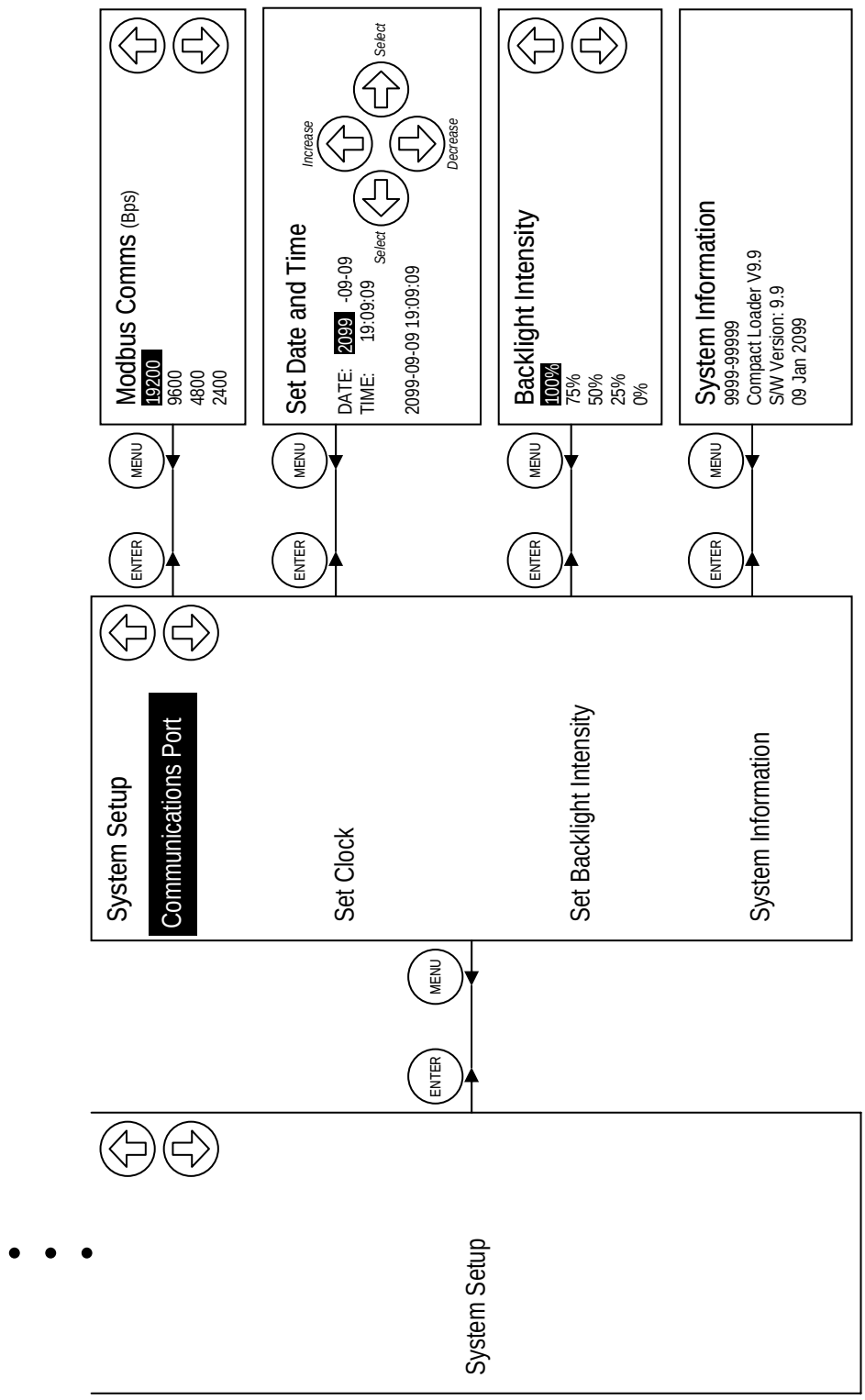
5. **Shutdown:** When finished with the machine, toggle the on/off toggle switch to the *off* position. This will deactivate the DCS electronics, thus cutting power to the solenoid and shutting off pilot air pressure to the fuel shut off cylinder and the engine will stop.

6. **After a shutdown** whether by the operator or an engine trip, if the up or down arrows are pressed the system will return to “Waiting for start”.

FAULT DIAGNOSIS GUIDE




Log [E] 15/2113
17/07/2007
13:16:19
Pre run check
...
-1 (newer)
+1 (older)
-10
+10
Log Download
Press ENTER to begin...
Log Initialisation
Press ENTER to begin
Initialising log.
May take up to 5 mins.
All entries will be erased!
MENU
ENTER
Log Utilities
View Log On Screen
Upload Log
Initialise Log Memory
Log Utilities


Modbus Comms (Bps)
19200
9600
4800
2400
Set Date and Time
Increase
Select
Decrease
Select
DATE: 2099 -09-09
TIME: 19:09:09
2099-09-09 19:09:09
Backlight Intensity
100%
75%
50%
25%
0%
System Information
9999-99999
Compact Loader V9.9
S/W Version: 9.9
09 Jan 2099
MENU
ENTER
System Setup
Communications Port
Set Clock
Set Backlight Intensity
System Information
System Setup

INSTRUMENTS AND CONTROLS

COMPARTMENT DOOR

The compartment door must be closed and locked after entering the compartment before the park brake button can be released and the declutch valve deactivated.

Maintenance

Grease door latch and hinges weekly and ensure interlock door valve is secure.

Never use the door to apply the park brake. Always manually apply by the park brake button and ensure the brake head pressure gauge reads zero. The steering pressure will automatically bleed down, never assume the steering pressure has bled down unless the steering pressure gauge reads *zero*.

When the door is open the machine can not be operated, as the park brake will be on and the transmission will be declutched. There is a roller cam valve in the door lock, that needs to be activated, to release the park brake. Also the brake system pressure is dumped with the door open. The engine will run with the door open.

Operator's Door

Door Interlock Valve

TRANSMISSION GEAR CONTROL LEVER

The transmission gear control lever has four positions, *first, second, third* and *fourth*. Shifting to a higher or lower speed may be made at full engine RPM.

Maintenance

Lubricate cable and linkages if hard to shift gears.

NOTICE

The transmission in the machine is modulated. This prevents severe shocks being transmitted through the drive train when the transmission is shifted between gears.

TRANSMISSION DIRECTIONAL CONTROL LEVER

A directional control lever controls the transmission. This lever has three positions, *forward, neutral* and *reverse*. The engine should be at low idle when the transmission is shifted from the *neutral* position to either *forward* or *reverse* direction.

Maintenance

Lubricate cables if hard to shift gears.

NOTICE

The transmission must be placed in the *neutral* position for the starter motor to engage when starting the engine.

WARNING

If the engine starts when the transmission is not in *neutral* the neutral start on the transmission needs to be adjusted or replaced.

Transmission Gear Control Lever

Transmission Directional Control Lever

Transmission Controls

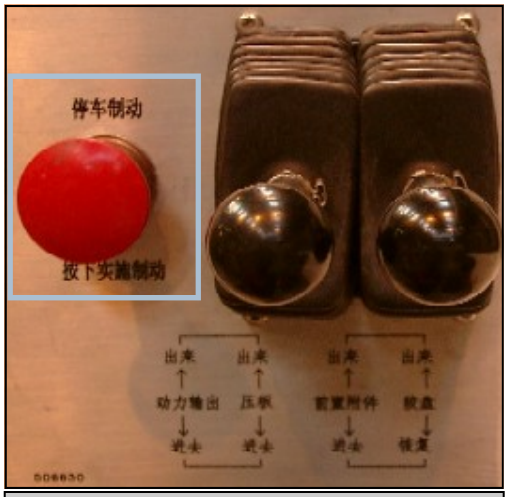
PARK BRAKE BUTTON

The park brake button has two positions and it is held in the release position by pilot air pressure. By pushing the button inwards, the park brake is applied, and by pulling the button out the park brake will be released. The park brake cannot be released until the system pressure is sufficient to overcome the spring force of the brake control, it also will not release unless the door is closed (there is a roller cam valve inside the door lock which needs to be activated to release the park brake).

If the engine shuts down the park brake will *automatically apply* itself by dumping the pilot air pressure via the low oil pressure pilot valve. The *brake head pressure gauge must read zero* when the brake is applied.

Never use the door interlock to actuate the park brake when exiting the machine. If there is a malfunction on the door interlock system, the park brake could possibly not apply when exiting machine and the machine could run away resulting in serious damage or injury.

The park brake must be applied for the starter motor to engage whenever an engine start is required.



Park Brake Button

Brake Head Pressure Gauge

FOUR-WAY JOYSTICK CONTROL LEVER

This lever has five positions, *tilt back*, *tilt forward*, *lift*, *lower* and *hold*. Pushing the lever to the *right* tilts the lift arms back for loading and tramming. Pulling the lever to the *left* tilts the lift arms down for unloading. Pushing the *forward* lowers the lift arms. Pulling the lever *back* raises the lift arms. The lever is spring centred to the *hold* position.

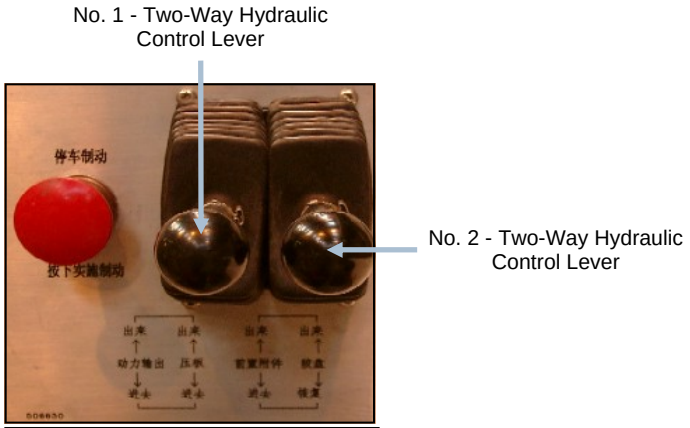
Two functions may be engaged at the same time by pushing the four-way joystick control lever at 45° in the direction of the two required functions.

NO. 1 - TWO-WAY HYDRAULIC CONTROL LEVER

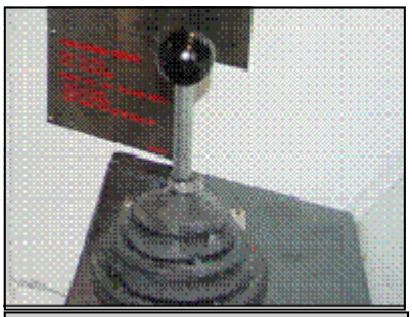
There are two hydraulic two-way control levers fitted to the machine. The first lever closest to the operator is used to auxiliary hydraulic power take off fitted to the rear of the machine. This lever has three positions, *up, down* and *hold.* The lever is spring centred to the *hold* position.

NO. 2 - TWO-WAY HYDRAULIC CONTROL LEVER

The second lever, furthest from the operator, is used to control the winch. This lever has three positions, *up, down* and *hold*. When operating the winch, the *down* position winches the rope in and pulling the lever up winds the winch rope out. The lever is spring centred to the *hold* position.



Two-Way Control Levers

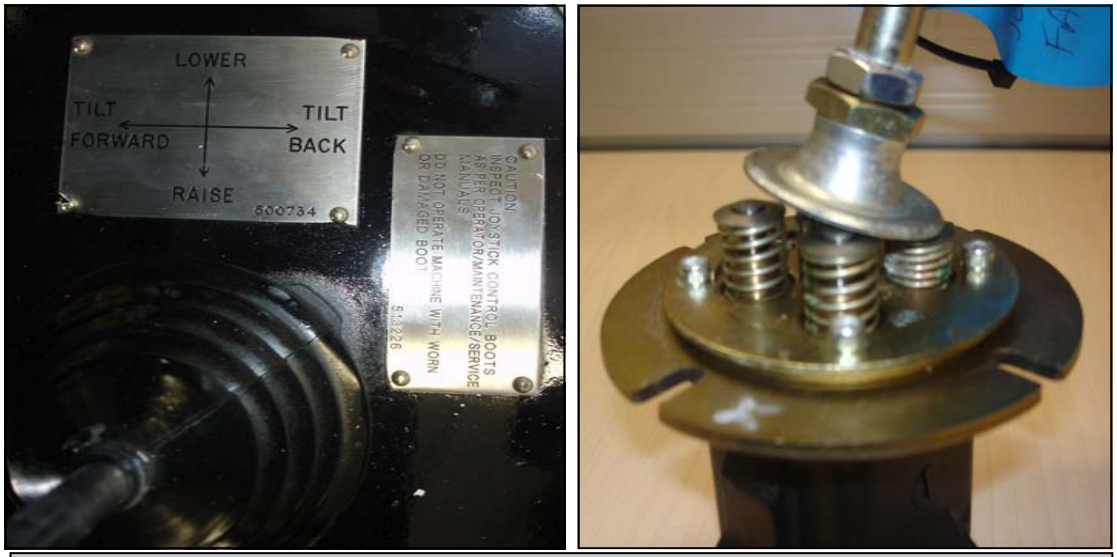


Four-Way Joystick Control Lever

CONTROL LEVER MAINTENANCE

Maintenance

Inspect the tilt/lift and attachment control valve for damaged or missing boot or parts and replace as necessary. Carry out operational performance test as per Section 7.1 of Bucyrus Australia Preventative Maintenance Inspections if replacement is required.



Control Levers

OPERATOR'S SEAT

On the operator's seat *the height, backrest tilt* and *seat suspension* are all adjustable. The controls for these functions are beside the seat. Some machines are fitted with a swivel seat which may need lubricating from time to time, a seat belt is fitted to the seat assembly that needs to be inspected for correct operation and replaced if required

ACCELERATOR PEDAL

The accelerator pedal is connected to the engine fuel pump governor via a hydraulic slave and master cylinder system. When the accelerator pedal is depressed the engine speed increases. The accelerator pedal is spring returned so that when pedal pressure is removed, the engine returns to low idle.

Always keep the operator's compartment clean. Dirt, etc. can build up under the accelerator pedal restricting its movement.

BRAKE PEDAL

The brake pedal when depressed applies the brakes on the front and rear axles. There are four liquid-cooled Posi-Stop brakes located internally in each axle. Whenever possible use the engine compression to slow the machine on a grade or decline by selecting a lower gear and driving the machine using engine revs.

DO NOT ride the brakes while tramming the machine.

If the engine should stall, the machine is fitted with fail-safe brake system that will fully apply the brakes. The operator can apply the brakes at any time following an engine stall to immediately bring the machine to a controlled stop.

Always keep the operator's compartment clean. Dirt, etc. can build up under the brake pedal restricting its movement.

STEERING WHEEL

The steering wheel controls the flow of hydraulic oil to the steering cylinder via an orbital steering valve. As the cylinder strokes, the machine articulates to the *left* or to the *right*.

Turning the wheel *anti-clockwise* articulates the machine towards the operator. This effectively turns the machine to the *left* in the forward direction (lift arm end).

Turning the wheel *clockwise* articulates the machine away from the operator. This effectively turns the machine to the *right* in the forward direction (lift arm end).

The machine will turn in the opposite directions when travelling in forward and reverse. Operator training and familiarity with shield hauler operation is important to ensure that collisions are avoided.

If the engine should stall, the machine is fitted with a system that will dump the steering pressure. The operator can steer the machine via a six litre back up accumulator at any time following an engine stall to immediately bring the machine to a safe controlled stop.

If the door is opened or the park brake is applied, the machine is fitted with fail-safe steering system that will immediately dump the steering system pressure. This is to protect the operator or personnel from being crushed in the articulation area. Steering cannot be used until the door is shut and latched and the park brake control reset to the *off* position.

Steering Wheel

BRAKE HEAD PRESSURE GAUGE

This gauge shows the service and park brake system's brake head pressure. Operators should periodically check this gauge. The gauge will read *zero* pressure when the brakes are fully applied via the service and/or park brake controls.

NOTICE

If the operator's foot is off the brake pedal and the park brake is released, the indicated pressure shall be a minimum of 12000 kPa (1750 psi). If the pressure is below this it is likely that the brakes are dragging. The machine shall not be operated with dragging brakes as fire or brake failure may result.

CAUTION

Observe that the brake head pressure is on *zero* after applying the park brake.

BRAKE ACCUMULATOR PRESSURE GAUGE

This gauge indicates the service and park brake system's accumulated pressure. Normal operating system pressure is 17200 kPa (2500 psi).

CAUTION

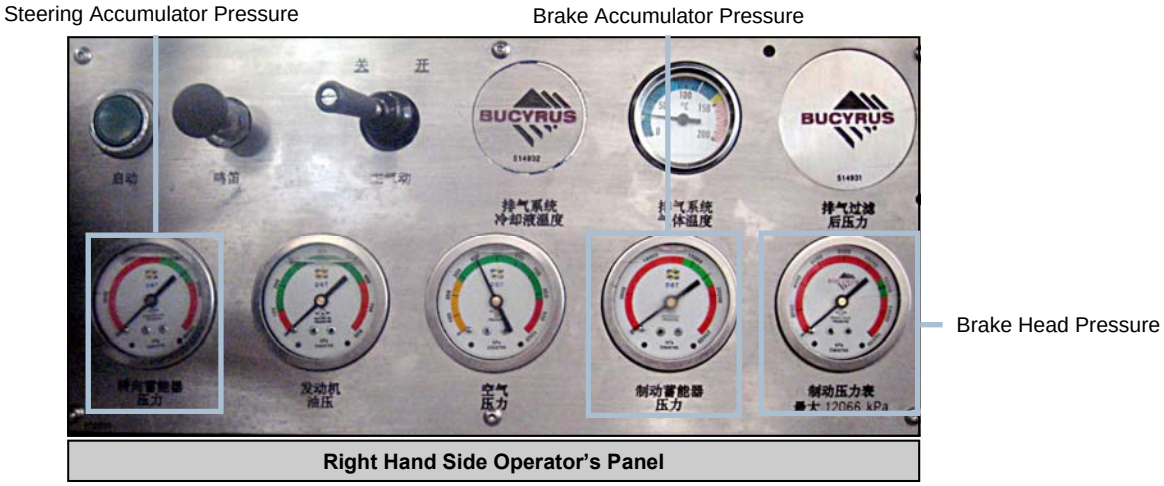
Do not operate the machine if the brake accumulator pressure gauge is less than 17200 kPa (2500 psi).

STEERING ACCUMULATOR PRESSURE GAUGE

This gauge indicates the steering system's accumulated pressure. The normal operating system pressure is 17200 kPa (2500 psi).

NOTICE

If the pressure constantly drops below or will not hold 17200 kPa (2500 psi), steering may become difficult. The machine should not be operated and the problem shall be rectified.



Right Hand Side Operator's Panel

ENGINE START BUTTON

Depressing the engine start button engages the starter motor to start the engine. The engine start button will not activate the starter motor unless:

The start button will not activate the starter motor unless:

1. The transmission is in *neutral*.
2. The park brake is applied.
3. The diesel control system shows no fault.
4. The on/off toggle switch is *on.*
5. Sufficient air is in the receiver and air valve is turned on.

Depress the accelerator pedal ⅓ before a start to ensure sufficient fuel is available. Immediately remove finger from the engine start button when the engine fires.

AIR PRESSURE GAUGE

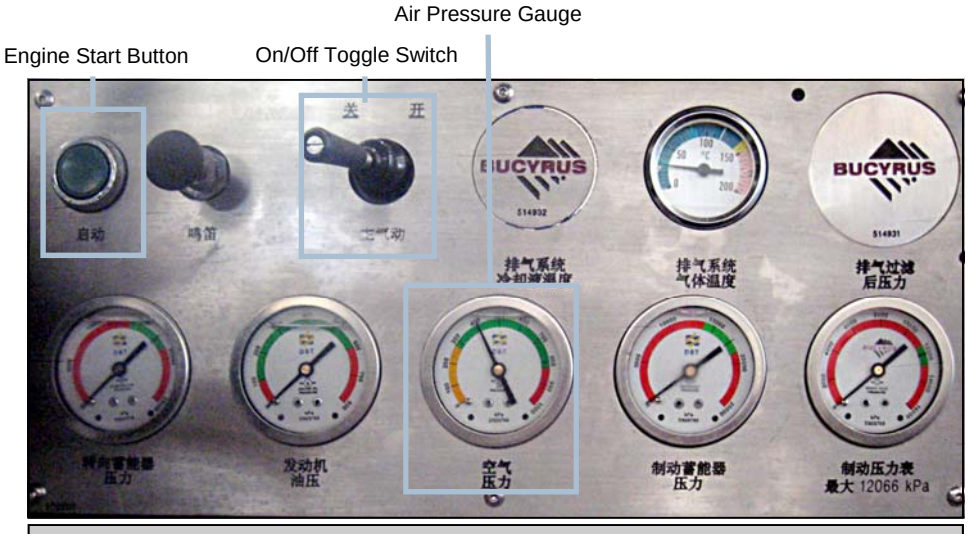
This gauge indicates the air pressure in the air receiver. Normal air pressure is set at 760 kPa-860 kPa (110 psi-125 psi).

The main air isolation valve is mounted on the engine compartment. Turn this valve on before entering the machine. The gauge will read *zero* when the valve is shut.

ON/OFF TOGGLE SWITCH

The on/off toggle switch controls the supply of pilot air pressure to the air pressure switch on the diesel control system, which allows air to pilot the starter motor.

1. To start the engine, place the on/off toggle switch in the *on* position.
2. To shutdown the engine place the on/off toggle switch in the *off* position.



Right Hand Side Operator's Panel

TRANSMISSION OIL TEMPERATURE GAUGE

This gauge indicates the oil temperature in the transmission and torque converter. Normal oil temperature is between 82°C-93°C.

If the temperature should rise above 121°C, carry out the following procedure:

1. Bring the machine to a halt, lower the lift arms to the ground and apply the park brake.
2. Put the transmission in *neutral* and rev the engine to about ½ speed.

Observe the temperature gauge for about two minutes. If the temperature does not begin to fall within two minutes, shutdown the machine and do not attempt to operate it until corrective action has been taken.

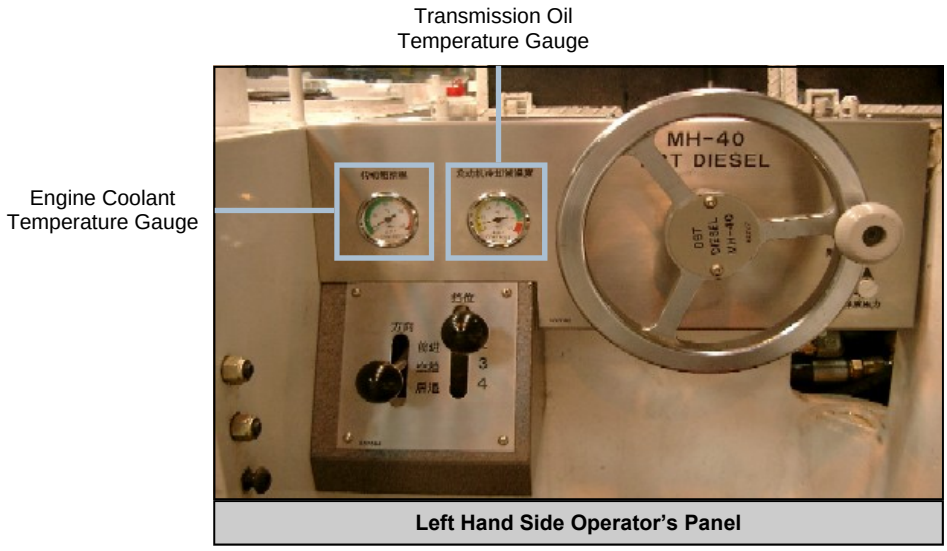
DO NOT operate the machine if the oil temperature is above 121°C.

Transmission temperature can be affected by incorrect gear selection for the load being carried and or the road conditions.

ENGINE COOLANT TEMPERATURE GAUGE

This shows the coolant temperature circulating through the engine, exhaust and radiator systems. Normal operating temperature is between 82°C-95°C. The engine should not be operated under heavy load until it has time to warm up approximately five minutes. The engine must also be shut off and cooled when the coolant level is to be topped up.

Shut off the engine immediately if the coolant temperature gauge goes above 105°C. The diesel control system will give an alarm at 100°C and should shutdown the engine at 105°C.



Left Hand Side Operator's Panel

HORN BUTTON

Pushing this button sounds the air horns.

NOTICE

It is good operating procedure to sound the horn 2-3 seconds before an engine start or whenever approaching blind intersection.

Right Hand Side Operator's Panel

EMERGENCY FUEL SHUT OFF VALVE

This valve is located after the fuel filter/water separator. Closing this valve will stop the flow of fuel to the engine. This provides the machine with a second means of shutting down the engine should the on/off toggle switch fail.

Emergency Fuel Shut Off Valve

ENGINE SERVICE HOUR METER

This electric meter is mounted on the off driver's side at the rear of the machine.

Use the hour meter to determine servicing intervals.

Engine Hour Meter

AIR CLEANER SERVICE INDICATOR

The air cleaner service indicator is located at the air cleaner and indicates the condition of the air cleaner element. When the service indicator is in the *red* zone, the air cleaner elements should be removed and serviced.

Air Cleaner and Indicator

Air Cleaner Indicator

EXHAUST OUTLET GAS TEMPERATURE GAUGE

This shows the exhaust gas temperature entering the mine atmosphere from the exhaust outlet. The machine will shutdown if this temperature exceeds 140°C.

ENGINE OIL PRESSURE GAUGE

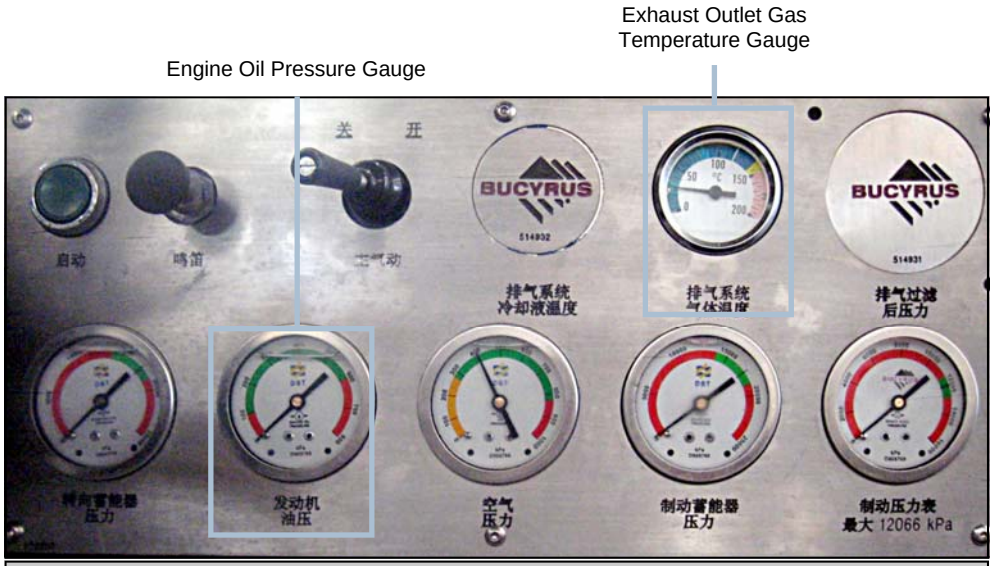
This gauge indicates the engine lubricating oil pressure. Normal pressure is between 210 kPa-550 kPa (30 psi-80 psi).

CAUTION

Shut off the engine if the oil pressure drops and stays below 70 kPa (10 psi). The diesel control system should shutdown the engine at 70 kPa (10 psi).

CAUTION

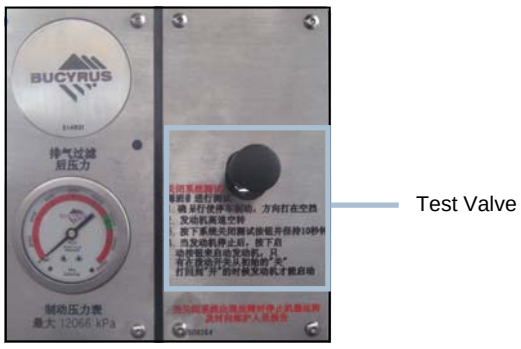
DO NOT run the engine with low oil pressure, as engine damage will result.



Right Hand Side Operator's Panel

SHUTDOWN SYSTEM TEST VALVE

The test valve is used to check the integrity of the Fail-Safe Shutdown System. This test should be carried out on a daily basis as part of the *10 Hour Daily Off Line Mechanical Inspection.* (Refer to Section 8 - Operator's Manual - Post Start Checks).



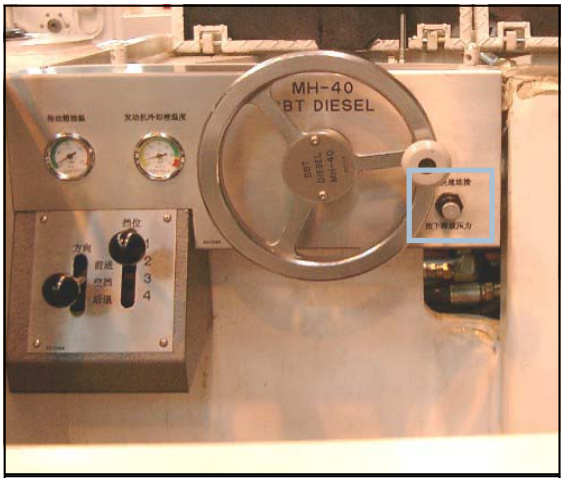
FUEL PRIMER HAND PUMP

If the engine fuel system has been run dry or serviced, the fuel system should be primed via manual activation of the hand fuel primer pump. The pump is located adjacent to the fuel water separator in the engine compartment. Normally no priming is required to start the engine.

Engine Fuel Primer Pump

ATTACHMENT QUICK CONNECTS BUTTON

This button releases all of the pressure in the PTO lines to allow the couplings to be easily released. To release the pressure, release both of the two-way control levers and press in the pressure release button for two seconds.

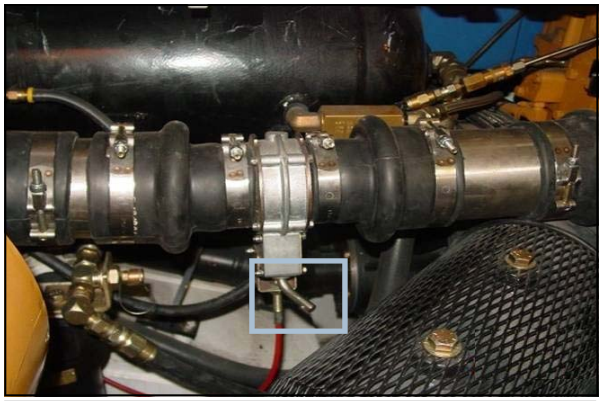


Attachment Quick Connects Button

EMERGENCY INTAKE SHUT OFF VALVE

This valve is used in the event that the machine fails to shutdown under normal circumstances as stated in Section 8. *Closing this valve will stop the flow of air to the engine*. This provides the machine with a second means of shutting down the engine should the on/off toggle switch fail.

Emergency Intake Shut Off Valve Stop Button



Emergency Intake Shut Off Valve Reset Lever

The valve is activated from the operator's compartment by a button which is pushed, once activated and the engine shuts down the valve will need to be reset before restarting. Ensure that the button in the operator's compartment has been pulled out and there is a lever down on the main body of the valve that will rotate and latch into the operating position. If the valve has not been reset the engine will not start. When valve has been reset the engine can be started.

If the emergency intake shutoff valve has been activated, the restarting of the engine should be done in compliance with the relevant regulations and Manager's Rules.