A6474X253
June 2012

Operation and Maintenance Manual

SU488D Scoop

About this manual

This chapter provides important information making it easier for you to use this manual. You will also be given information on the structure of the manual and the symbols and characters used.

Before starting to work

applicable operating manual

Take care to ensure that the operating manual available to you is applicable for the type of equipment or machine used.

machine type

This operating manual is intended for:

Model, SU488 D Scoop
Serial No.: N/A

and is only permitted to be used for equipment of this type.

new operation manual

The operating manual must be accessible at all times to all persons working on or with the machine.
It should, if possible, always be available at the place of operation.

Send for a new operation manual immediately if the present manual is no longer complete or has become illegible.

Who is this operating manual intended for?

This operating manual is intended for those persons who work with or on the machine.
Every person working on the face or in the intersection between face and entry or in the entry must read this operating manual.

This includes persons who:

- are in charge of transport
- prepare the rise heading
- perform assembly / disassembly work
- operate the machine
- eliminate faults
- perform daily routine work on the face or in the entry
- perform maintenance work
- perform repair work

supervisory personnel who:

- initiate and/or
- supervise the activities just indicated.

Safety instructions

General rules:

general

Always work with full concentration.

Familiarize yourself with your working environment.

noise emissions

Always wear your personal protective equipment. This also includes ear protectors as the noise emitted by other equipment in the area may at times exceed 85 db(A).

Inform your colleagues of:

- your exact location.
- the work you are performing.
- the time that you will probably require.

safety equipment

Start the machine only when it is in a good and safe operating condition and all protective devices, cover plates, etc. are correctly installed.

Observe the acoustic and optical start-up warnings of the machine.

symbol plates

Observe the symbol plates on the machine.

cordon off working area

Cordon off your working area widely for the machine.

moving parts

Never allow parts of your body to come between parts which could move, such as e.g.:

- bucket
- pivot points
- ejector

steering lockout

Connect the steering lockout device before performing maintenance or repairs on the machine.

Overview of the safety instructions

This is a summary of all the safety instructions which have to be observed in the following chapters. This summary is intended only to give you an overview of all the instructions. In some cases, there is no logical relationship between the individual instructions.

Chapter 2: Safety Instructions

NOTICE!
The fuel buffalo enables the fuel to remain clean during transition to fuel tank

Keep the tank topped off to minimize the moisture buildup in the tank

Excessive intake restriction causes significant increase in carbon monoxide and soot emissions—restriction (>50”WG)

When increased carbon monoxide and black smoke are detected, the intake air cleaner may need to be replaced

A mostly blocked intake system can lead to carbon monoxide increases of 50-250% and increases in smoke

Chapter 3: Storage and transport

Instructions on the storage of concentrates for hydraulic fluids can be found, if required, in chapter 6 in this operating manual.

IMPORTANT!
Take care to insure that new supplies are stored separately from existing stock and that removal takes place on the “first in, first out” principle.

Additional information on the dimensions and weights can be found in chapter 6 in this operating manual.

WARNING!
Use only load handling devices complying with the technical and legal regulations for the transport of loads.
You could be seriously injured or even killed by falling loads.
Use only suitable load handling devices.

Chapter 4: Installation

CAUTION!
Serious damage can be caused to the scoop as a result of incorrect installation.
The unit should therefore only be installed under the instruction of specialists.

3 Storage and transport

Pre-installation check list

NOTICE!
The machine was inspected prior to shipment from the factory to ensure proper functioning and installation of all components. However, to ensure that no transit damage has occurred, the following pre-startup checks should be performed:

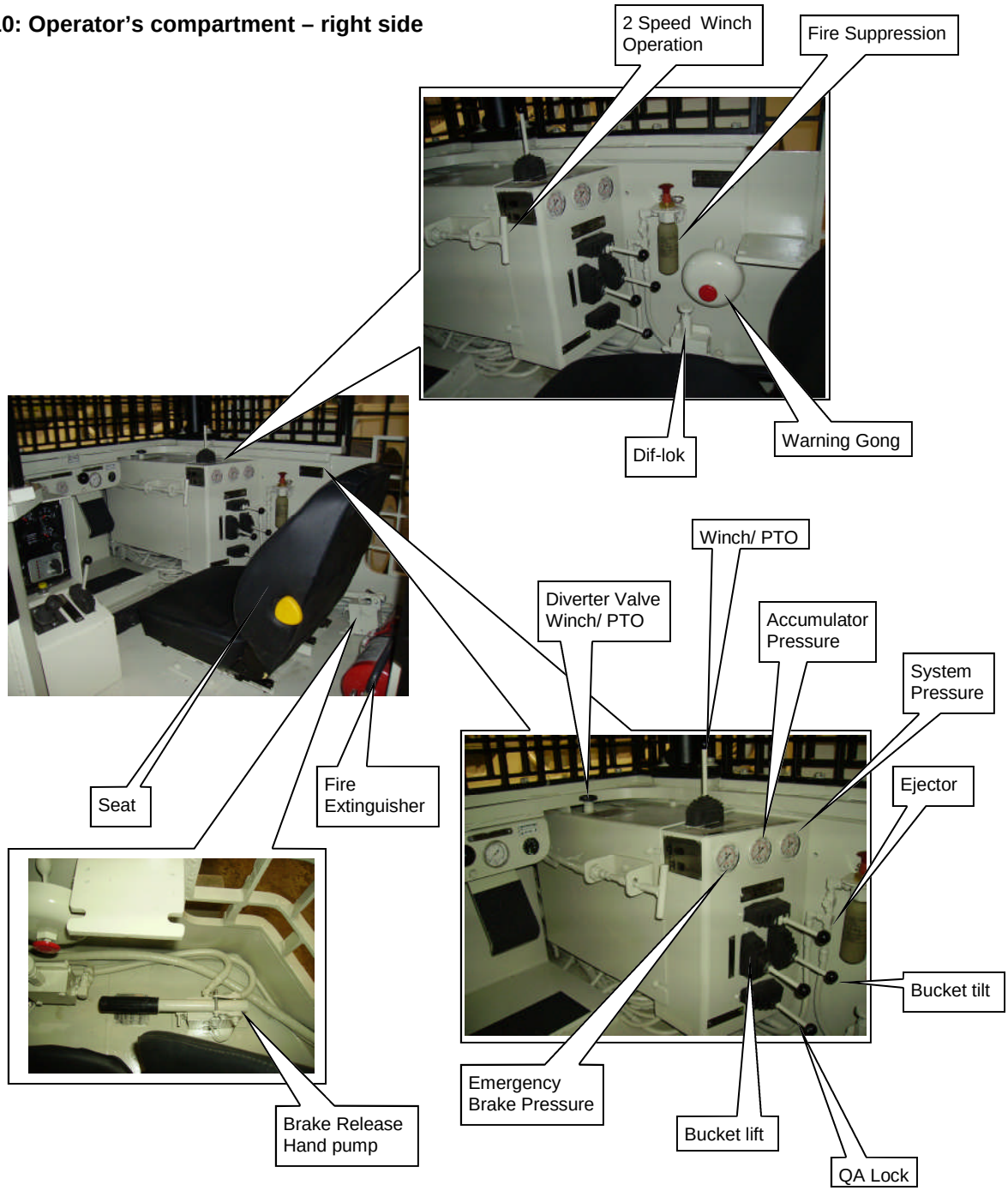
- perform daily maintenance
- visually inspect all hydraulic hoses and electrical cables for damage
- clean any foreign material from the operator's compartment
- if equipped with bucket, clean any foreign material from behind the ejector blade
- check safety provisions for operational condition on fire suppression system
- check that all covers and guards are in place and secure
- check that all tags and instruction labels are in place and secure
- check that operator's canopy is secure and in place
- start the machine and allow the hydraulic system to warm up for five (5) to ten (10) minutes
- check hydraulic system pressures (refer to the hydraulic schematic supplied for your particular machine for pressure settings)
- Check all engine gauges in the operator's comportment to ensure all systems are functioning properly

Controls and indicators

Operator's compartment – right side

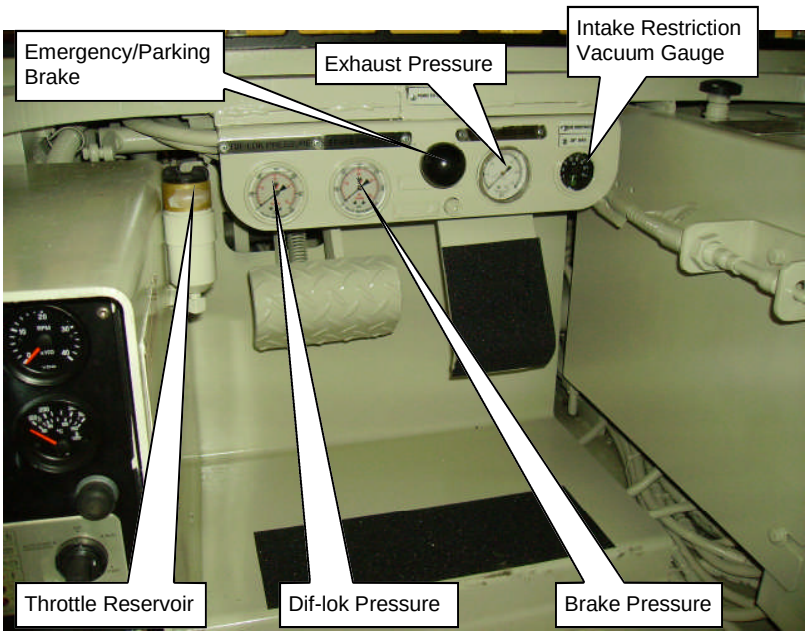
The primary controls for the machine are located in the operator's compartment (Fig.10).

Fig. 10: Operator's compartment – right side



Note:
Typical operator's compartment shown, location of controls may vary.

Fig. 19: Operator's compartment



LOFA EP250 series control panel

The EP250 series control systems (Fig. 20) are a very flexible platform for diesel engine control, monitoring, and protection, featuring LOFA's powerful First Fault Diagnostics (FFD). After pinpointing the initial failure, FFD stores it in memory and alerts the end user via a single bright LED. FFD monitors battery charge, low oil pressure, high temperature, overspeed and up to three additional contact closure inputs. The field programmable, expandable microprocessor-based solid-state design uses high-power semiconductors instead of outdated electromechanical relays to ensure reliable high-current switching.

Some of the EP250 programmable features include:

- automatic preheat duration
- afterglow duration
- failure indication with shutdown or indication only
- over-speed shutdown
- normally open or normally closed shutdown switches

The standard system includes a 12 inch wiring harness terminating into a sealed weatherproof plug. This durable connection performs well in harsh environments and provides efficient installation of custom plug-and-play engine harnesses as well as standard harness extensions.

WARNING!
When replacement parts are required, LOFA Industries recommends using replacement parts supplied by LOFA or parts with equivalent specifications. Failure to heed this warning can lead to premature failure, product damage, personal injury or death. Improper operation, maintenance or repair of this product can be dangerous and may result in injury or death.

Hazard zone

Fig. 28: Hazard zone

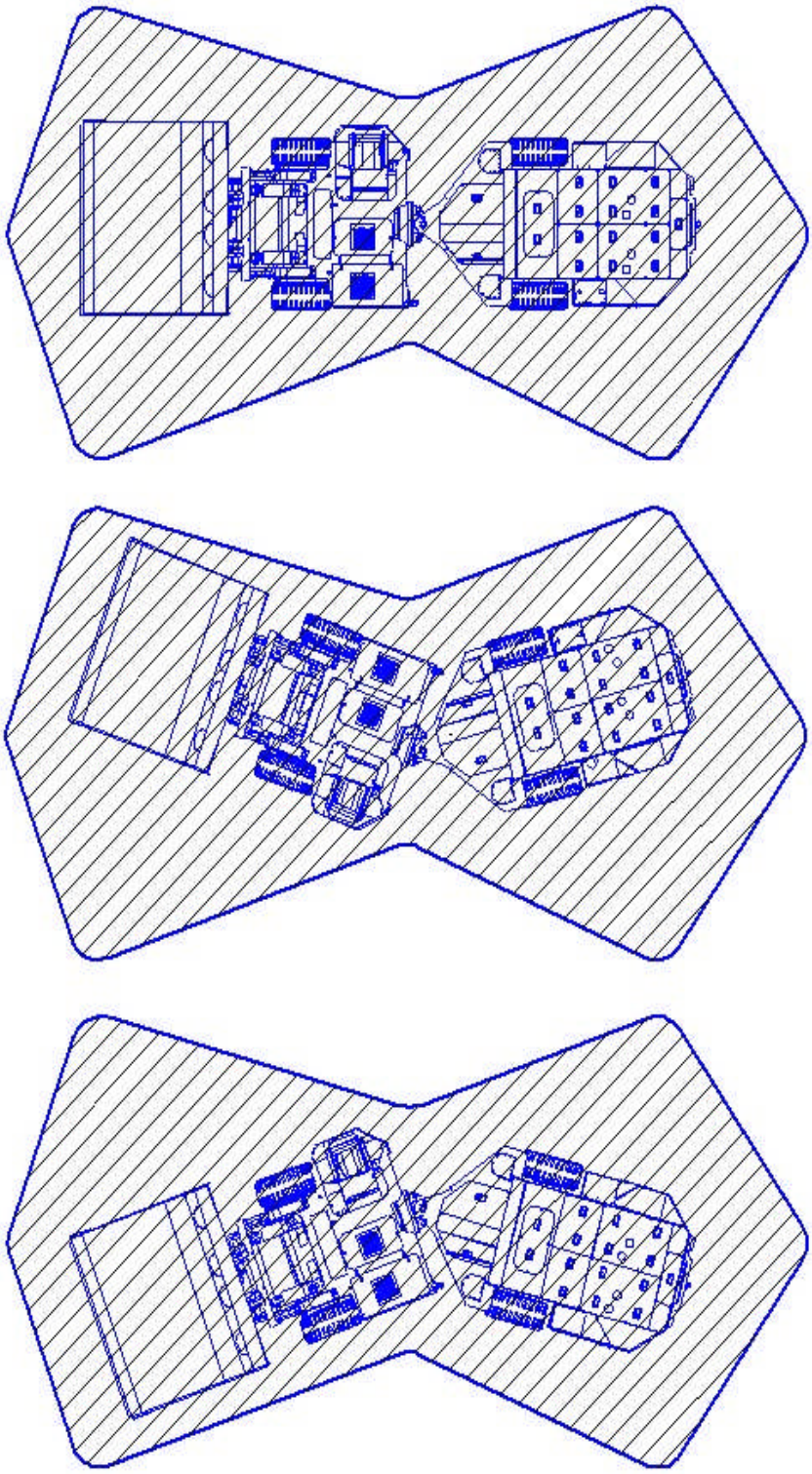


Table 3: Lubrication and maintenance schedule (continued)

Item	Description	Places	Lubricant	Specification
38	Pressure filter (Main) (Inspect/change as required)	1		
39	Return filter (Inspect/change as required)	1		
40	Axle oil level (Check)	2	Hypoid gear oil SAE 90W	
41	Planetary wheel end oil level (Check)	4	Hypoid gear oil SAE 90W	
42	Wet disc brake oil level (No service required)	4	Cooling oil	
	Every three months			
43	Axle oil (Change)	2	Hypoid gear oil SAE 90W	
44	Planetary wheel end oil (Change)	4	Hypoid gear oil SAE 90W	
45	Wet disc brake oil level (No service required)	4	Cooling oil	
46	Hydraulic oil (Change)	1	Mobilfluid 424	Spec. 100-12
47	Tank suction strainer (Clean/change)	1		
48	Pressure filter (Change)	1		
49	Return filter (Change)	1		
50	Winch oil (Change) (Optional)	1	API GL4 (140) Gear oil Peragma Grade 8	
	1st 50 Hours of service			
51	Engine oil and filter	Change	10W40 API CF/ 4	
	Every 100 hours of service			
52	Engine air cleaner	Change		
53	Radiator	Clean		
54	Engine oil and filter	Change	10W40 API CF/ 4	
55	Fuel pre-filter	Change		
56	Fuel final filter	Change		
	Every 500 hours of service			
57	Converter/transmission filter	Clean		
58	Radiator coolant	Change	Avia Antifreeze Extra Glysantin G 48 DEA radiator anti-freeze Shell GlycoShell	
59	Scrubber heat exchanger	Inspect		
	Every 1000 hours of service			
60	Scrubber heat exchanger	Clean		

fasteners (nuts, bolts and screws)

Loose fasteners will cause premature wear and failure to machine and components. Visually inspect for loose fasteners and tighten as required.

electrical cables, conduits and glands

Visually inspect all electrical cables, conduits and glands for signs of wear or damage.

hydraulic hoses and connections

Visually inspect all hydraulic hoses and connections for signs of wear, damage or leakage.

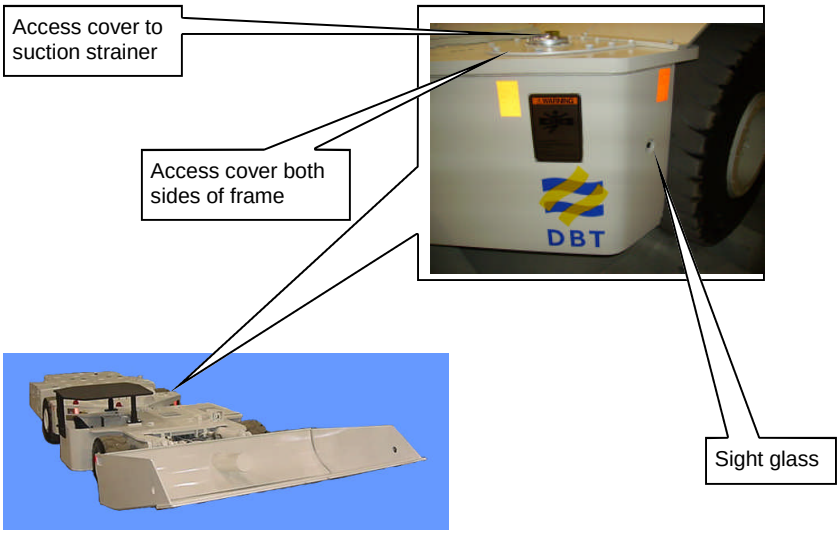
tires

Visually inspect all tires for signs of wear or damage.

hydraulic oil level

Check the hydraulic oil level by looking at the sight glass located on the oil tank (Fig. 43). If the oil level is low, add oil (Spec. 100-12) via the jet fill pump until oil is visible in the sight glass.

Fig. 43: Hydraulic oil level

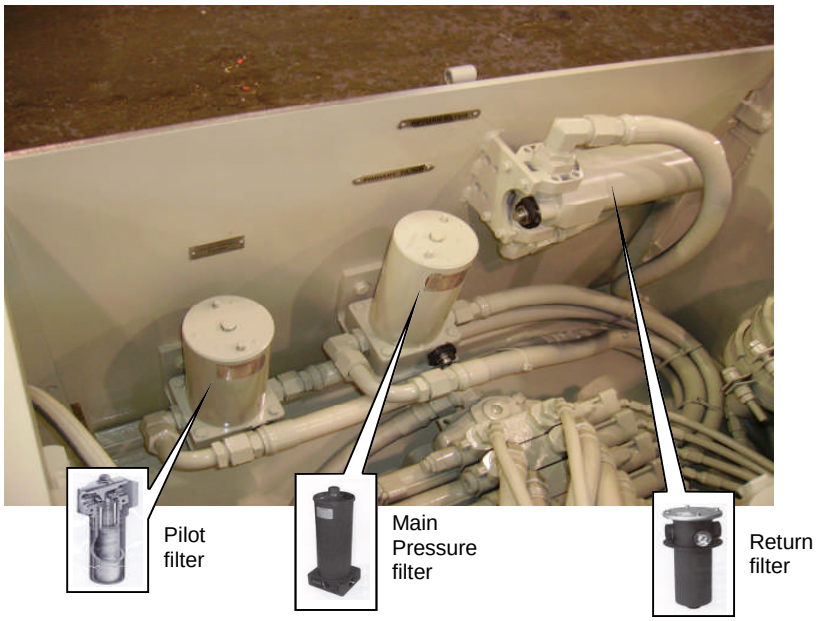


main pressure filter Change the pressure filter element (Fig. 55). If the element is extremely dirty, a more frequent interval may be required.

return filter Change the return filter element (Fig. 55). If the element is extremely dirty, a more frequent interval may be required.

pilot filter Change the pilot filter element (Fig. 55). If the element is extremely dirty, a more frequent interval may be required.

Fig. 55: Filter location



winch oil Change oil in the winch (Fig. 56). (Refer to the winch operation and maintenance manual included in your parts manual)

- ☞ Park the scoop on solid level ground, clean dirt and debris from around the drain plug.
- ☞ Remove drain plug and allow oil to completely drain from the winch.
- ☞ Clean and reinstall drain plug.
- ☞ Clean dirt and debris from around the check plug and remove plug.
- ☞ Clean dirt and debris from around the breather and remove breather.
- ☞ Add oil (API GL4 (140) Gear oil Peragma Grade 8) through the breather hole slowly, just until it starts to flow out of the check plug hole. Allow sufficient time for the oil to travel throughout the winch when filling.
- ☞ Clean and reinstall breather and check plug.

Diesel emissions maintenance

Introduction

This section of this manual was prepared with the intent to provide mechanics and operators of diesel engine equipment with a set of guidelines for an introduction to the maintenance of diesel emission systems.

With the continuing increase in environmental and health concerns, there has been growing trend to cut down on the release of any unnecessary exhaust gas pollutants into the environment. Regulations are in place limiting the maximum pollutant concentrations in diesel engine exhaust gas. Furthermore, sufficient ventilation must be provided in order to ensure that pollutant levels in the working environment don't exceed Threshold Limit Values (TLV). This manual has been developed to address these issues from a maintenance perspective. To better understand the relationship between engine maintenance and engine emissions, it's important to know the factors which affect the formation of the exhaust gas components.

Experience has shown that emission characteristics remain constant during the life of the diesel engines, providing that maintenance is performed in accordance with manufacturers' recommendations. Improper or insufficient maintenance will have a negative effect on the combustion process and lead to accelerated wear of engine components resulting in an increase in emissions. This usually occurs before a decrease in performance becomes noticeable.

The traditional approach towards maintenance operations was to look at it as an expensive exercise not yielding any direct benefit. A piece of equipment will be repaired if and when it fails, not before. This type of approach doesn't make sense from an economical standpoint. Timely maintenance extends the life of the equipment, increases the machine's availability for production, and reduces operating cost. Purchasing and operational cost calculations can easily prove the benefits of timely preventive maintenance.

An improved strategy toward diesel engine maintenance requires not only a firm commitment from management and planners, but an implementable set of best practices that mechanics can adopt into their everyday routine. This guide provides the foundation from which the maintainers of diesel engines can build a system that best suits the needs of their equipment.

The following guide is divided into two categories of equal importance. Part I (Operational Issues) targets the practices of both mechanics and operators concerning diesel engines. The system specific section (Part II) targets the six primary engine systems outlined in previous research and expands on improved practices that address the needs of today's engine technologies.

Typical exhaust gas components:

carbon dioxide (C02)

Although this gas is non-poisonous, it may still be considered a problem, especially if it is produced in large enough quantities to displace oxygen in the working environment

carbon monoxide (CO)

CO is the result of the incomplete combustion of the fuel, caused by localized insufficiencies of oxygen (rich fuel/air ratio). Quenching of the reaction by cold combustion chamber walls also increases the CO levels. (Example: cold engine operating temperatures) CO gas is a colorless, odorless, and tasteless gas. Inhalation of as little as 0.3% by volume can cause death within 30 minutes. For this reason, it is important never to allow the engine to run in enclosed spaces such as a closed garage without good ventilation. Increased CO concentrations may be the result of poor mixture formation caused by a defective injection system, injectors with defective spray characteristics, or engine overfuelling.

oxides of nitrogen (NOx)

The formation of NOx is dependent on the temperatures during the combustion process, the concentrations of the components nitrogen (N_2) and oxygen (0_2) and the time available for them to react with each other. NO and NO_2 are generally lumped together and referred to as oxides of nitrogen (NOx). A rise in the combustion temperature increases the NO concentrations in the exhaust gas In a diesel engine, the combustion process forms only NO, a small portion of which oxidizes to $N0_2$ at lower temperatures and in the presence of 0_2. The sum of NO and $N0_2$ is called NOx. These gases belong to two different classes. Nitrogen monoxide (NO) is a colorless, odorless, and tasteless gas that is rapidly converted into nitrogen dioxide (NO_2) in the presence of oxygen - O_2. Advanced injection timing can cause an increase of NO in the exhaust gas. Measures which decrease the NO concentrations, such as low compression ratio or retarded injection timing, also tend to decrease the efficiency of the combustion process. This can result in increased fuel consumption and higher CO and HC concentrations in the exhaust.

hydrocarbons (HC)

HC in exhaust gases is usually from very small quantities of unburned diesel fuel and engine lubricating oil. Since the measurement of concentrations of different hydrocarbons involves the use of sophisticated instrumentation, only total HC is usually measured and reported. In the presence of nitrogen oxide and sunlight, hydrocarbons form substances, which irritate the mucous membranes. Some hydrocarbons are cancer-causing. Incomplete combustion in a diesel engine produces unburned hydrocarbons. Increased HC levels in the exhaust gas are found when an diesel engine suffers from high oil consumption, a defective injection system, rich fuel/air ratio, or quenching of the combustion process in the proximity of the cold combustion chamber walls.

1. Intake system:

Introduction

The intake system (Fig. 72, Fig. 73 and Fig. 74) on a diesel engine must provide an adequate supply of clean air for good combustion at all operating speeds, loads, and operating conditions. As much as 1500 cubic feet of air per minute or more may be required. This depends on engine size and horsepower. On naturally aspirated (non-turbocharged) and turbocharged engines, air is as important to good operation as the quality of the fuel used. Lack of adequate airflow to an engine can result in high emissions along with poor performance

Contaminated air can quickly wear out a diesel engine - a condition often referred to as "dusting". This condition is particularly noticeable when an engine has been overhauled, and after a short period in service, compression and power losses are noticeable.

Tests conducted by major diesel engine manufacturers have shown that as little as two tablespoons of dirt can dust out an engine within a very short time. Unfiltered air contains small particles of dirt and abrasive material that are not always visible to the naked eye.

Intake air can also be contaminated by partially burned fuel. Some of it washes down the cylinder wall and can dilute lubrication oil. Some of the unburned fuel dries up and sticks to pistons, rings, and valves as well as fouling up the small orifices in the injector tip, resulting in higher emissions. Nothing wears out a diesel engine faster than contaminated air entering the intake system. The dirt and oil mixture acts as an abrasive lapping compound. On the cylinder walls it proves to be disastrous. Imagine how the continuous rubbing action of the piston rings against the liner surface contaminated with abrasive dirt in the oil quickly accelerates wear.

Fig. 72: A two-stage intake system

To effectively maintain diesel oxidation catalysts the following points should be adhered to:

- Perform emissions measurements on a regular basis to calculate CO (Carbon Monoxide) conversion efficiency. Refer to section with procedure on emission testing. Efficiency should be between 65% and 95%.

- Use exhaust backpressure for monitoring purifier condition. Establish a baseline value for each engine series with a new or clean purifier. Maintenance checks should not exceed 3 inches of water above baseline value. Backpressures exceeding this indicate need for service.

- Clean catalytic purifiers using compressed air, steam cleaning, and fuel. After blowing out and washing with steam, soak the purifier in a clean container of diesel fuel for at least 2 hours to loosen and dissolve hard carbon build-up. After soaking, re-steam and blow out with compressed air.

- When blowing out purifiers with compressed air, ensure the safety of yourself and others with adequate ventilation to avoid exposure to airborne soot.

To effectively maintain diesel particulate filters the following points should be adhered to:

- Exhaust backpressure and temperature should be continuously monitored with a permanent on-board system including an alarm system to warn the operator of either a high exhaust temperature condition or a high backpressure condition. If available, smoke density or opacity measurement systems are useful in determining a pass or fail condition of a particulate filter as well. (For a detailed explanation of this procedure refer to page 5.96)

- Filters can be cleaned manually using compressed air. Blow out the filter in the reverse and then forward direction of exhaust flow. This can be a very dirty operation and extreme caution should be exercised to avoid exposure to airborne soot. If possible it is a good idea to set up a device for servicing filters that traps the soot in water or another filter mechanism so that it does not get vented to the shop fresh air supply.

- Filters can also be serviced using a kiln or similar controlled heating device. This simulates the thermal regeneration of the filter that is normally done by the engine exhaust temperature. It is important to note that the kiln must support the burning of soot in a controlled environment and have proper environmental controls for safely ventilating and avoiding exposure to harmful compounds.

Job aid check list for exhaust system analysis tools:

ECOM AC+ gas analyzer

The electro-chemical gas sensors used in the ECOM unit are recommended for calibration every six months. The analyzer for the project was purchased new from ECOM America and was delivered with all sensors calibrated. The calibration gases used are:

- Carbon monoxide - 1000 ppm
- Nitrogen oxide - 100 ppm
- Nitrogen dioxide - 100 ppm
- Oxygen - Verified against O2 concentration in NO or NO2 cal gas

The ECOM analyzer incorporates a three-minute calibration each time the unit is started. All gas sensors are "zeroed" against the ambient air drawn through the probe for the three-minute period. For this reason it is critical that each time the analyzer is turned on the probe remains in as fresh an ambient environment as possible and nowhere near any running exhaust gases.

Particulate sampling - Gilian pump:

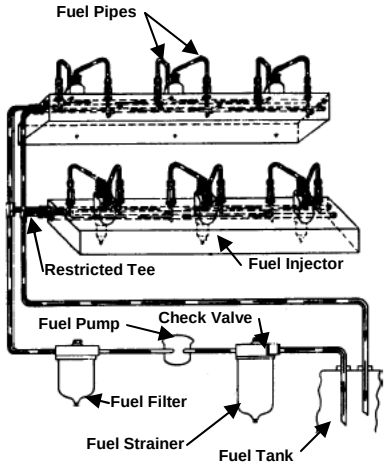
The undiluted particulate sampling system incorporated a Gillian high volume 30 LPM pump (Fig. 89) for drawing the exhaust through the 37 mm cassettes. Under ideal conditions this instrument would be calibrated for each sampling session. Calibration of this instrument might be beyond the scope of the mechanics expected work and therefore it may be necessary to have it performed by the ventilation department.

Fig. 89: Gilian pump

Unit injectors:

The unit injector system (Fig. 108) has been used by Detroit Diesel Corporation (DDC) since the late 1930's when they first released their two-stroke cycle diesel engine models. Basically, a unit injector fuel system combines the pump and nozzle in a single body. The fuel is supplied to each DDC injector at between 50 and 70 psi (345 to 483 kPa) by a gear fuel pump; a common inlet manifold feeds all injectors simultaneously. The unit injector times, atomizes, meters, and pressurizes the fuel for combustion. Fuel is used for cooling and lubrication purposes and flows through a common return manifold which has a restricted fitting at the outlet to maintain system pressure. Excess fuel flows back to the fuel tank.

Fig. 108: Unit injector system circuit



Electronically controlled fuel injection systems

Electronically controlled unit injector fuel systems (Fig. 109) are now widely used by many of today's engine manufacturers. Detroit Diesel, Caterpillar, Cummins, Volvo, and Deutz all offer these advanced control systems. The injector pumping plunger is activated mechanically by a rocker arm or by the camshaft directly depending on the manufacturer - all except for the HEUI (hydraulically actuated electronic unit injection) system (pronounced "Hughie"). No rocker arm is necessary in this system as high-pressure oil is used to activate the injector pumping plunger. Both Caterpillar and Navistar International are currently using the HEUI system in a number of their engines.

Fig. 109: Unit injector system

Fuel quality and handling recommendations

An education and awareness program for fuel handling can be easily implemented at any mine. It is important that responsibilities be delegated to ensure that this basic area is consistently kept clean and orderly to reduce the possibility of fire and contamination.

- Always use high quality low sulfur fuel less than 0.05% (500 ppm) by volume. The fuel should be tested regularly for quality assurance.
- Put together a team responsible for efficient identification, transportation, and handling of fuel to minimize the chance of the fuel becoming contaminated with water and dirt. This would involve everyone from supplier, service and shaft crews, to operators and mechanics. Responsibilities should be assigned to specific groups and a scheduled program put into place to ensure that it is carried out.
- Bulk storage tanks should be serviced regularly to make sure they are kept clean and dirt-free.
- Cubes that are used for transporting and storing fuel should be cleaned and serviced on a scheduled basis.
- Vehicle storage tanks should also be equipped with filtered vents and water separators. The fuel tanks should be equipped with a quick connect fill system to prevent dirt from entering the system, or should be equipped

Pressure reducing valve – HRC pilot control circuit

To insure dependable service of the HRC pilot controls fitted to this machine, an auxiliary pressure reducing valve is rigid coupled to the outlet port of a dedicated pilot filter (Fig. 119) located under the top cover of the component bay in the front frame of the machine, directly opposite the operator's compartment. This circuit is monitored by a panel mounted gauge in the operator's compartment or may be checked from a pigtail connection found on a distribution manifold behind the hinged panel to the right of the operator's seat. The proper setting of this valve is 500 psi and adjustment is achieved by loosening the jam nut of the adjustment stem (ccw) and then turning the adjustment stem in (cw) or out (ccw) with a hex key until the designed setting is achieved. To secure this adjustment, snug the jam nut back down (cw) before returning the machine to normal service.

Fig. 119: Pressure reducing valve - HRC pilot control circuit adjustment

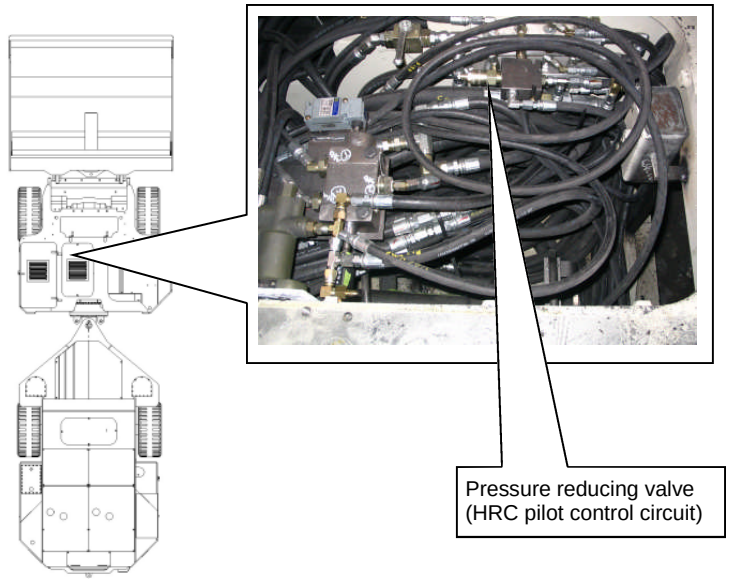


Table 10 (continued): Hydraulic pump troubleshooting

Trouble, symptom or cause	Probable cause	Test, check and/or remedy
seal leak (continued)	☞ Oil viscosity too high or operating temperature too low.	☞ Replace with recommended oil.
	☞ Air leak in suction line or fittings.	☞ Replace lines or fittings if badly worn.
	☞ Loose or worn pump parts.	☞ Replace worn pump parts.
	☞ Air leak at pump shaft seal.	☞ Replace pump shaft seals.
	☞ Oil level too low and drawing air in through inlet pipe opening.	☞ Check oil level.
	☞ Air bubbles in intake oil.	☞ Check oil level and tighten any loose fittings.
	☞ Pump housing bolts loose or not properly torqued.	☞ Tighten the housing bolts and re-torque bolts.
pump failure to deliver oil	☞ Low oil Level in reservoir.	☞ Fill to proper level.
	☞ Oil intake hose suction strainer plugged.	☞ Clean or replace strainer.
	☞ Air leak in suction line and preventing priming.	☞ Tighten or replace suction lines.
	☞ Pump shaft turning too slowly.	☞ Gears are worn and need replacing.
	☞ Oil viscosity too high.	☞ Replace with recommended oil.
	☞ Wrong shaft rotation.	
	☞ Pump shaft or parts broken.	☞ Check pump motor wiring.
	☞ Dirt in pump.	☞ Replace shaft or broken parts.
		☞ Clean pump .
oil leakage around pump	☞ Shaft seal worn.	☞ Replace seals.
	☞ Head of oil on suction hose connection leaking.	☞ Tighten bolts. Tighten or replace connections.
	☞ Pump housing bolts loose or improperly torqued.	☞ Tighten bolts.

Leaking intake system

Dust and coal particles may be ingested into the intake system

- This is referred to as “dusting”
- The engine may be destroyed in as little as a single shift
- The impact on emissions is due to the damage of components, which in turn cause excessive blowby of oil and low engine compression

Air intake system restriction and fuel flow

- The engine is designed to have unrestricted airflow into the engine
- Fuel flow is adjusted according to the available air
- Any significant additional restriction on the intake system upsets this balance causing over fuelling and excessive harmful emissions

Catalyst failure

The catalyst is designed to last the duration of the engine and contains no wear parts

- Likely failure would be caused by:
  - Excessive idling of the vehicle
  - Contaminated fuel or
  - Unauthorized aftermarket fuel additives
- Since the catalyst performance is checked at least weekly, any failure would be detected promptly

machine accessories (continued)

- Extra Parts Manual (Optional)
- Extra Operations and Maintenance Manual (Optional)
- Front Steel Fenders (Optional)
- Rear Steel Fenders (Optional)
- 10,000 LB Winch (Optional)
- QA Module Bucket

SU488D Scoop cooling package

- 4 ½ fins/inch
- 3000 psi pressure wash capability
- 130°F ambient capability
- Temperature controller fan speed
- Beaded manifold connections
- Water to oil transmission cooler

cooling facts

The BF4M 1013 FC cooling facts

- 47.6 GPM cooling pump
- 21.8 PSI cooling system
- 7.8 qt coolant in engine
- 230°F shut down
- 190°F thermostat opens

engine facts

The BF4M 1013 FC facts

- Consumes 15.4 GPH diesel at max rating
- Consumes 8.3 GPH diesel at max torque
- 26” maximum intake restriction
- 35” maximum exhaust restriction
- 2300 high idle
- 2200 converter stall
- 650 low idle

fuel requirements

Must use over the road diesel fuel

-Less than .5% sulfur

-ASTM D 975-88; 1 D and 2 D

-Cetane of at least 49

Table 33: Extreme pressure gear oils (Spec. 100-2)

	Supplier	Brand name
1	Amoco Oil Company	Amoco Permagear EP 460
2	Gulf oil	EP Lubricant HD 460
3	Mobil Oil Corporation	Mobil Gear 634 Mobil Gear 636
4	Chevron U.S.A.	Chevron Gear Compound EP ISO 460
5	Sun Oil Company	Sunep 460
6	Unocal 76	Extra Duty NL Gear Lube 7 EP Extra Duty NL Gear Lube 8 EP
7	Shell Oil company	Shell Omala 680
8	Century Lubricating Oils, Inc.	Hulbest EP-7 Powergear 460
9	Texaco Lubricants Company	Meropa 680
10	Exxon	Spartan EP 460
11	Pennzoil	Super Maxol EP 460 Gear Lube Super Maxol EP 460 Gear Lube
12	Lubricating Engineers	608 Almosal Vari-Purpose Gear Lubricant
13	Conoco Inc.	Gear oil 460
14	Hydrotex	933 Industrial Gear Lubricant
15	Phillips	All Purpose Gear Oil 85W-90 5EP
16	Miners Oil	Gear Oil EP460